

Implications of remote working for commute travel patterns in Australia

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Abstract

This study assesses the viability of remote working across different industries and occupations; measures potential impacts of remote working on commute patterns; and identifies implications of changes in transport demand for the supply of transport infrastructure in urban areas. Data for our analysis comes from a nationwide survey of 2,694 employees across the 17 largest urban areas in Australia. We estimate that roughly 51 per cent of employees working in these urban areas believe that some of their jobs tasks and activities could be done remotely. Ability to work remotely tends to be highest across white-collar sectors and occupations. If these employees were able to work remotely, when possible, we estimate that this could reduce weekday commute travel by car by 12-17 per cent and by public transport by 22-31 per cent across large urban areas. Reductions in travel are likely to be greatest on Mondays and Fridays, and for commute trips made to workplaces in CBD locations. Remote working arrangements could additionally move roughly 5 per cent of commute trips outside the morning peak period, and 10-20 per cent of commute trips outside the evening peak period.

1. Introduction

Remote working, telecommuting, work from home and other flexible working arrangements have been used as travel demand management strategies for over three decades now (e.g., Mokhtarian, 1991; Salomon, 1990). The transport benefits of these alternative working arrangements are many, through their impacts on congestion, emissions, energy use, etc. For example, “small reductions in the number of cars travelling at peak times can lead to big improvements in traffic flow... the NRMA estimates that when traffic on congested roads [in Australian cities] reduces by 5 per cent, traffic speeds increase by 50 per cent” (Kelly and Donegan, 2015). Similarly, in their review of thirty studies that have examined the impacts of telecommuting on transport, O’Brien and Aliabadi (2020) found that twenty-six studies predicted a decrease in travel distance, energy use, and emissions.

Despite these benefits, historic uptake of remote working arrangements has been low. In a 2012 study of remote working arrangements across Australia, DAE (2012) found that only 13 - 16 per cent of employees have a formalised arrangement with their employer to work from home on a regular basis, and an additional 18 - 32 per cent have an ad hoc arrangement based on requesting permission from their employer. In terms of actual take-up, DAE (2012) found that only 24 - 33 per cent chose to work from home at least once a week or more. Based on our own analysis of data from the 2016 Australian Census, we estimate that on average, roughly 2-8 per cent of the workforce in major Australian cities were working remotely on Census day.

As a consequence of the COVID-19 pandemic, there has been an unprecedented upsurge in the adoption of remote working practices. For example, based on surveys conducted by the Australian Bureau of Statistics during the pandemic, at least 40 per cent of the Australian workforce reported working remotely one or more times a week during the peak of the pandemic, and 30 per cent reported working remotely most days (ABS, 2020). Employers have had to develop the necessary infrastructure, protocols and processes to support these changes; employees have had to adapt their work practices to manage these changes. Despite these challenges, the pandemic has offered a unique opportunity to test the viability of remote working practices across different jobs and industries, and to assess their economic, social and environmental impacts. Cities across the world have reported significant improvements in environmental quality due to reduced private car use (Arora et al., 2020; Lian et al., 2020). In some cases, worker productivity has increased during the pandemic as a direct result of working from home (Etheridge et al., 2020; Galanti et al., 2021). Many employees report greater overall work and life satisfaction, and are eager to continue these practices after the pandemic (Ipsen et al., 2021; Shao et al., 2021). Many employers too have had positive experiences with remote working, and hybrid workplaces that offer a mix of on-site and remote working arrangements are likely to be the norm even after the pandemic (Fayard et al., 2021; Kane et al., 2021).

The objectives of this study are three-fold: (1) to assess the viability of remote working across different industries and occupations; (2) to measure potential impacts of remote working on commute patterns, in terms of days and hours spent at the workplace; and (3) to identify implications of changes in transport demand for the supply of transport infrastructure in urban areas.

We surveyed 2,694 Australian employees in 2020-21 drawn from the 17 largest urban areas in the country. Survey participants were asked about their current job, their ability to work remotely given the characteristics of their job, and potential impacts on commute travel if they were offered the opportunity to work remotely whenever possible. This study reports some of the key findings that emerged from the survey.

The remainder of the paper is structured as follows. Section 2 reviews previous studies that have examined the viability of remote working arrangements, and their implications for travel demand management strategies. Section 3 describes the survey instrument that we used for data collection, and Section 4 describes the sample for our analysis. Section 5 uses this data to assess the viability of remote working as a function of different employer, employee and employment characteristics. Sections 6 and 7 examine potential impacts on commute days and times, respectively. Section 8 concludes with a summary of the key findings, and their implications for transport policy and practice.

2. Literature review

Multiple studies have examined the feasibility of remote working arrangements across different occupations. For example, Dingel and Neiman (2020) classify the possibility of working from home for various occupations using data from the United States (US). Data for their analysis comes from the O*NET program sponsored by the US Department of Labour on the nature of work and the workforce. The database contains responses from employees across almost 1,000 occupations, with the median occupation having 26 respondents. Based on their analysis, Dingel and Neiman (2020) estimate that 37 percent of jobs in the US can be performed from home, with significant variation by location and industry. We combine results from Dingel and Neiman (2020) with Australian Census distributions across different occupation types to calculate the shares of jobs that can be completed from home in Australia, following the approach taken by Stratton (2020). Based on this methodology, we estimate that 41 percent of the jobs in Australia can be done from home. Adams-Prassl et al. (2020) provide an alternative

estimate, based on a different methodology from Dingel and Neimann (2020), where they also account for heterogeneity due to worker and firm differences. Their data was collected over three waves of surveys conducted in the US and the UK in March, April and May 2020, with approximately 25,000 total respondents. The study estimates that on average 42 percent of the work tasks of the respondents could be done from home in the US, while the same figure is 39 percent in the UK. Despite differences in methodologies, other studies too report similar estimates (c.f. Bick et al., 2021; Garrote-Sanchez et al., 2021; Gottlieb et al., 2020), and in summary, we conclude that roughly 40 per cent of current jobs in developed countries can be done remotely. Furthermore, most studies find that higher income jobs that require more educated workers, typically in white-collar sectors and occupations, are more amenable to being done remotely.

As mentioned previously, remote working and other flexible working arrangements have been used previously as travel demand management strategies. Multiple studies have examined their potential impacts on commute travel behaviour, and subsequent implications for the supply of transport infrastructure (e.g. Shabhanpour et al., 2018; Kim et al., 2015; Mokhtarian, 1991; Pendyala et al., 1991; Salomon, 1990). However, most of these studies were conducted before the COVID-19 pandemic, when remote working arrangements was less widespread. While these studies can still offer valuable insights on the impacts of remote working arrangements on commute travel at an individual level, they offer limited insights on potential system-wide impacts. For example, Shabhanpour et al. (2018) find that “compared to the current baseline situation where almost 12% of workers in Chicago region have flexible working time schedule, in the case when 50% of workers have flexible working time, telecommuting can reduce total daily vehicle miles traveled (VMT) and vehicle hours traveled (VHT) up to 0.69% and 2.09%, respectively.” These impacts are significantly lower than those observed during the COVID-19 pandemic, as well as future estimates developed during the COVID-19 pandemic based on worker surveys. For example, Beck and Hensher (2021) “anticipate at least a 10–15 per cent improvement in metropolitan transport networks due to reduced traffic congestion on the roads and crowding on public transport [post-pandemic].”

Relatedly, numerous studies have examined changes in commute patterns during the pandemic (e.g. Awad-Núñez et al., 2021; Eisenmann et al., 2021; Kolarova et al., 2021; Beck and Hensher, 2020; Beck et al., 2020). However, these studies are not able to control for the confounding effect of lockdown measures and other factors specific to the pandemic, and consequently, they too offer limited insights on the long-term post-pandemic impacts of remote working arrangements on travel patterns and transport system use.

Given that significant proportions of the workforce have had a chance to trial remote working arrangements during the pandemic, and worker surveys indicate that many employees are eager to continue these arrangements post-pandemic (Ipsen et al., 2021; Shao et al., 2021), more research is needed to understand potential long-term post-pandemic impacts on commute travel patterns, and consequent implications for the provision of road and public transport infrastructure in urban areas.

3. Survey instrument

The survey instrument was designed as part of a broader study on attitudes, perceptions and preferences towards remote working, from the perspective of employees, managers and businesses. We designed the instrument following a three-stage process. First, we reviewed the existing literature to identify relevant determinants of remote working viability and uptake, and perceived benefits, challenges and impacts from the perspective of different actors, based on which we formulated a first draft of the instrument. Second, we undertook three rounds of consultations with project stakeholders from the Australian Commonwealth Department of

Infrastructure, Transport, Regional Development and Communications (DITRDC), Transport for New South Wales (TfNSW) and iMOVE Cooperative Research Centre (CRC), where we amended the instrument to reflect their insights and experiences. Third, we piloted the survey instrument with a sample of 109 respondents. Following analysis of this data, the survey instrument was revised a final time.

The final instrument comprised five broad sections:

1. **Employment:** Respondents were asked about the nature of their current employment, and their employment pre-pandemic, such as occupation, industry, firm size, income, etc. Respondents that have direct reports were identified as managers.
2. **Commute patterns:** Respondents with an on-site that they report to regularly for work were asked about their commute before and during the pandemic, such as days spent on-site, arrival and departure time at work, travel mode, and travel time. These respondents were also asked to indicate how these patterns are likely to change, if their employer offered them the flexibility to work remotely, when possible.
3. **Remote working preferences:** Respondents were asked about their ability to perform their job tasks and activities remotely, and their preferences to work remotely.
4. **Remote working attitudes and perceptions:** Respondents are asked about their attitudes towards and perceptions of the impacts of remote working on productivity, health and wellbeing, and transport, land and energy use.
5. **Demographics:** Respondents are asked about their age, gender, education, place of residence, household size and structure, and income.

For this paper, we limit attention to employment characteristics and commute patterns (Sections 1 and 2 of the survey), with the objectives of examining the viability of remote working arrangements, and their potential impacts on extant commute patterns. In other papers presently under preparation, we intend to focus on remote working preferences, attitudes and perceptions from the perspective of employees, managers and businesses (Sections 3, 4 and 5).

4. Sample composition

The sample was recruited through the market research company Dynata. Our sample was limited to individuals with a minimum age of 18 years, living in one of the 17 largest Australian cities, that were employed before the onset of the COVID-19 pandemic. The study was co-funded by the Commonwealth government and the New South Wales (NSW) state government. Consequently, by design, roughly half our sample was drawn from the state of NSW, and roughly half from the remainder of Australia.

The survey was launched on Dec 11. Data collection was paused from Dec 14 to Jan 11, to allow for the holiday break. Data collection resumed on Jan 11, and concluded on May 4. We surveyed roughly 150 employees and 50 managers each week. Data collection was deliberately staggered over a five-month period, to allow us to observe how preferences for different WfH arrangements evolve over time, as a function of concurrent changes in contextual factors relating to the spread and containment of the pandemic, and as a function of employee and manager experiences with different arrangements in practice over extended periods of time.

After quality checks based on survey response times, responses from 3,853 individuals were deemed usable (of the 4,087 that were surveyed in total). Of these 3,853 respondents, 2,694 respondents were asked about their attitudes, perceptions and preferences towards remote working from the perspective of an *employee*. In particular, these respondents were asked about

their ability to do some of their job tasks and activities remotely, and their commute patterns. These 2,694 respondents comprise our sample throughout this paper.

For the sake of brevity, we do not include descriptive statistics of our sample. In general, we have good coverage across different income groups, employed across a mix of white-collar and blue-collar industry sectors and occupation types. However, some white-collar industry sectors and occupation types are overrepresented in our sample when compared to the target population. Any differences between our sample and the target population have been controlled for in our subsequent analysis through reweighting.

5. Viability and uptake of remote working arrangements

On average, across our sample of 2,694 employees, 1,525 employees, or 57 per cent, indicated that some of their jobs tasks and activities could be done remotely. However, once we reweight our sample to account for differences with the target population, we find that roughly 51 per cent of employees believe that some of their jobs tasks and activities could be done remotely.

Figure 1 plots self-reported ability to work remotely across different 1-digit ANZSCO occupation types. Employees in white collar jobs, such as Professionals, Managers, Clerical and Administrative Workers report the greatest ability to work remotely. Conversely, employees in blue collar jobs, such as Labourers, Machinery Operators and Drivers report the lowest ability to work remotely. Community and Personal Service Workers, Sales Workers, and Technicians and Trades Workers too report low abilities to work remotely. For the sake of brevity, we do not include analogous plots for industry sectors, but the results were consistent: ability to work remotely is typically strongest in white collar sectors.

Figure 2 shows uptake of remote working before and during the pandemic, and the week before each respondent was surveyed, and willingness to continue remote working arrangements post-pandemic. Based on our analysis, we estimate that the average employee was doing 17 per cent of their job tasks and activities remotely before the pandemic, 25 per cent during the peak of the pandemic, and 20 per cent in the week before they were surveyed. Looking forward, we estimate that the average employee would like to continue doing 25 per cent of their job tasks and activities remotely post-pandemic. In general, there seems to significant correlation between uptake in the week before respondents were surveyed and desired uptake post-pandemic, indicating that current WfH uptake might be a good indicator of future uptake in a post-pandemic world, at least in the short term. However, it also appears to be the case that current uptake is slightly less than desired future uptake, indicating that the provision of remote working arrangements to employees is potentially lagging their own desire to work remotely.

Figure 3 compares uptake across different 1-digit ANZSIC industry sectors. Before the pandemic, uptake was highest across white-collar sectors, such as information, media and telecommunications; financial and insurance services; and professional, scientific and technical services. High uptake continued across these sectors during the pandemic, and employees in these sectors indicated a high willingness to continue these arrangements into the future.

Interestingly, uptake was also high before the pandemic across some blue-collar sectors, such as agriculture, forestry and fishing; electricity, gas, water and waste services; and mining. However, uptake during the peak of the pandemic across these sectors was comparatively lower than the white-collar sectors mentioned previously, indicating that there are likely limitations to the amount of work that can feasibly be done remotely in these sectors, as also reflected by the lower capabilities reported for these sectors.

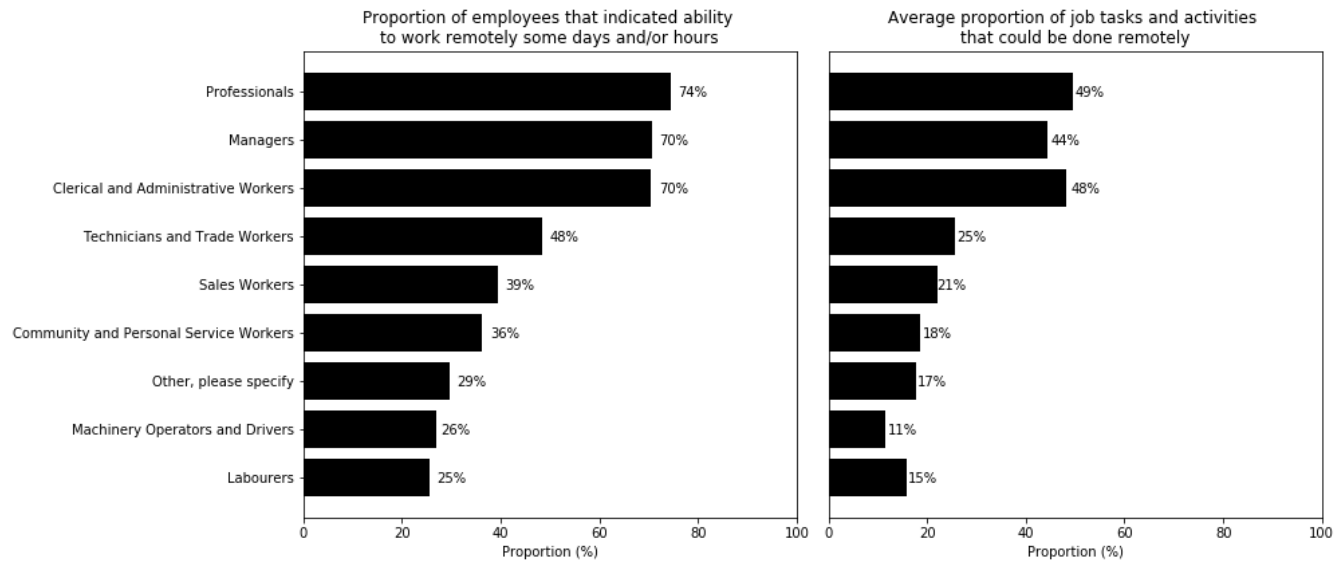


Figure 1: Self-reported employee ability to do some job tasks and activities remotely as a function of their 1-digit ANZSCO occupation type

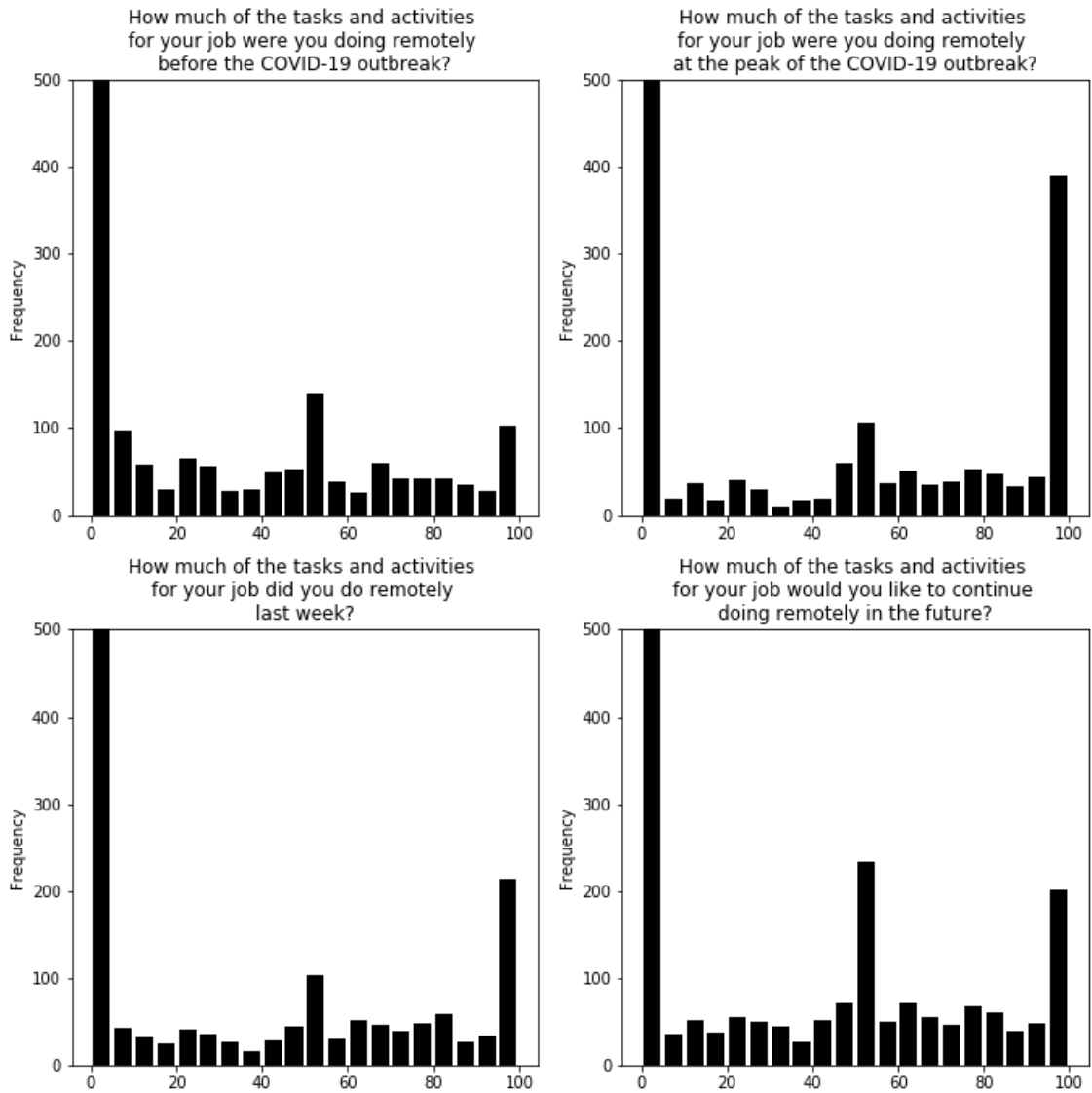


Figure 2: Uptake of remote working arrangements before and during the pandemic, and willingness to continue remote working arrangements post-pandemic

Some sectors, such as education and training; rental, hiring and real estate services; and arts and recreation services, demonstrate a fluctuating trend. These sectors had comparatively low uptake before the pandemic. Uptake surged during the peak of the pandemic, with the average employee across these sectors doing more than 30 per cent of their job tasks and activities remotely. However, in the week before they were surveyed, employees in the sector reported doing less than 20 per cent of their job tasks and activities remotely, significantly lower than how much they would ideally like to work remotely. Together, these findings suggest that while these sectors have the capability to adopt greater remote working arrangements, and employees working in these sectors would be supportive of expanding remote working arrangements, employers in these sectors have preferred to return to pre-pandemic practices.

Finally, as one would expect, sectors such as health care and social assistance; transport, postal and warehousing; and retail trade have had the lowest uptake both before and during the pandemic, due to lower capabilities, as also reported in the previous section.

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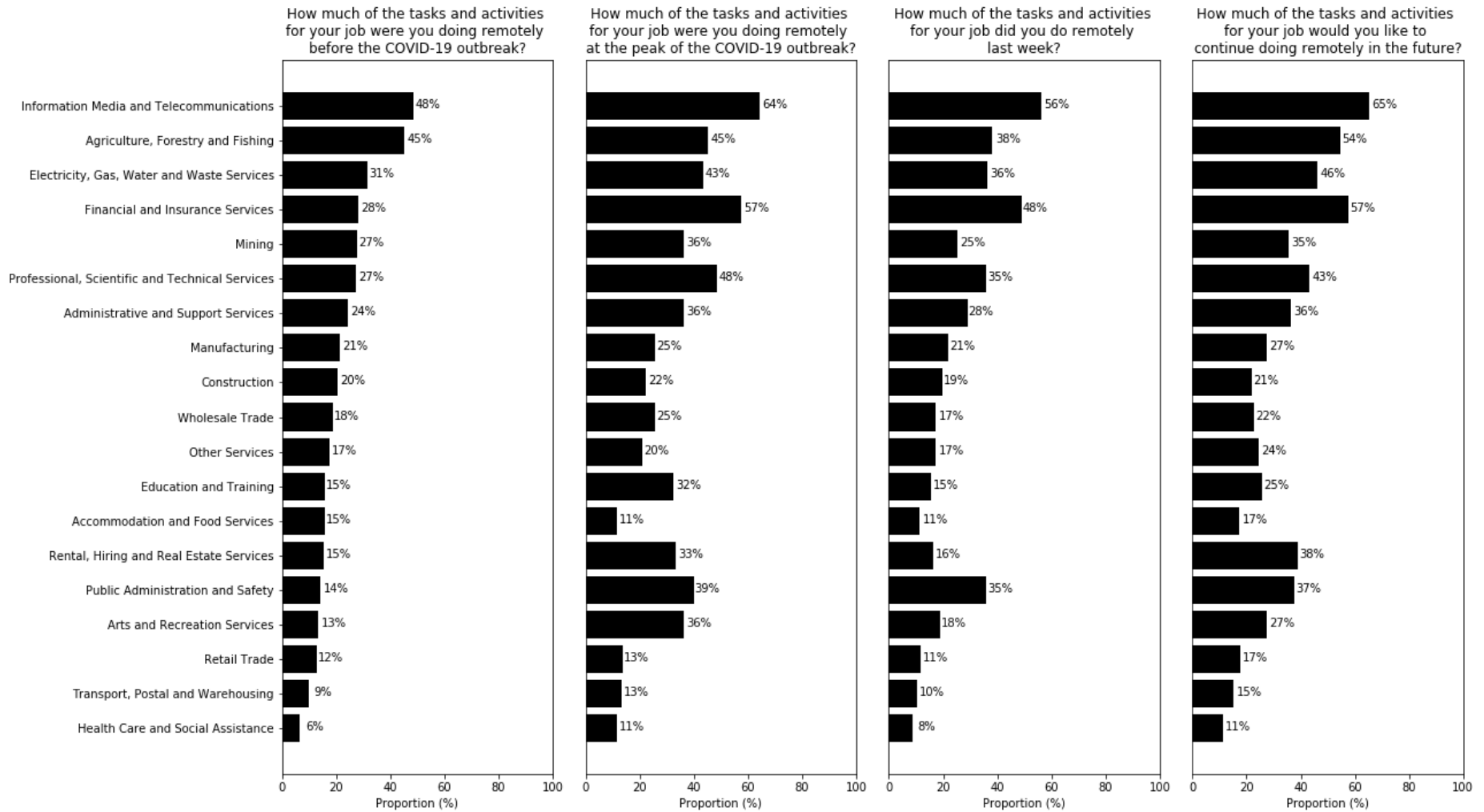


Figure 3: Uptake of remote working arrangements before and during the COVID-19 pandemic, and willingness to continue remote working arrangements post-pandemic, across different 1-digit ANZSIC industry sectors

6. Potential impact on commute behaviour

Of the 2,694 employees in our sample, 1,879 employees reported having a designated workplace that they work from or report to (e.g., office, co-working space, warehouse, factory floor). These employees were asked about their commute patterns before and during the pandemic, as well as the week before they were surveyed. Of these 1,879 employees, 1,113 employees indicated that some of their jobs tasks and activities could be done remotely. These 1,113 employees were further asked how they would change their commute patterns (days and times spent on-site during a typical work week), if their employer offered them the flexibility to work remotely when possible. All findings in this section have been reweighted to adjust for differences between our sample and the general Australian population.

Figure 4 plots the distribution in terms of the days that employees worked on-site before the pandemic, and the days that they would work on-site if allowed to work remotely when possible. Note that the figure includes *all* employees with a designated workplace, including those who do not have the ability to work remotely. On average, there is a 15-20 per cent reduction in commute travel across weekdays for these employees.

Figure 5 plots the same information in terms of number of days spent on-site under the two scenarios across employees that have the ability to work remotely. The greatest change is the increase in the number of employees that would work remotely all workdays, and the corresponding decline in the number of employees that are on-site 5 days a week. However, in absolute terms, the strongest preference appears to be for hybrid working arrangements, where employees are on-site 2 or 3 days a week.

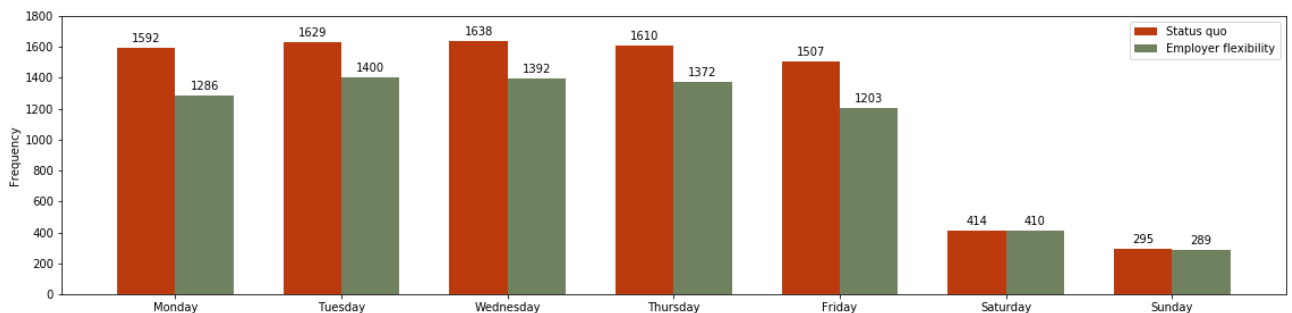


Figure 4: Days spent on-site before the pandemic, and days they would spend on-site post-pandemic if allowed to work remotely when possible, for all employees with a regular on-site

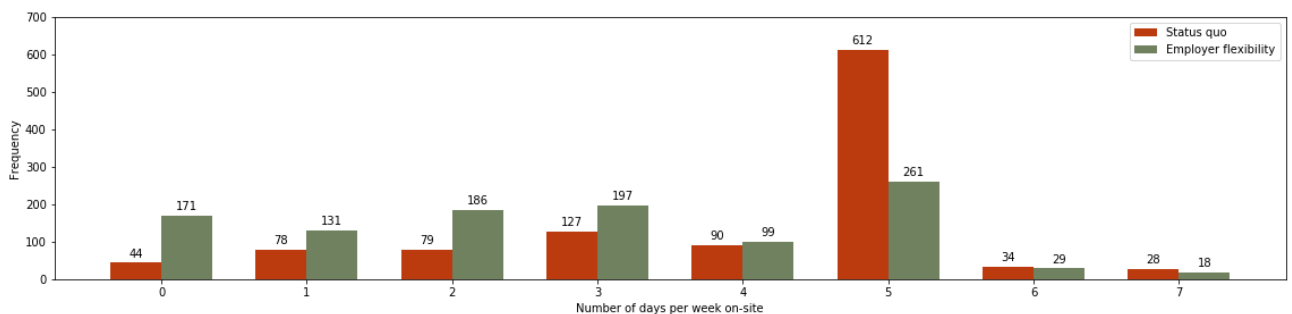


Figure 5: Number of days spent on-site before the pandemic, and number of days they would spend on-site post-pandemic if allowed to work remotely, for employees that have the ability to work remotely

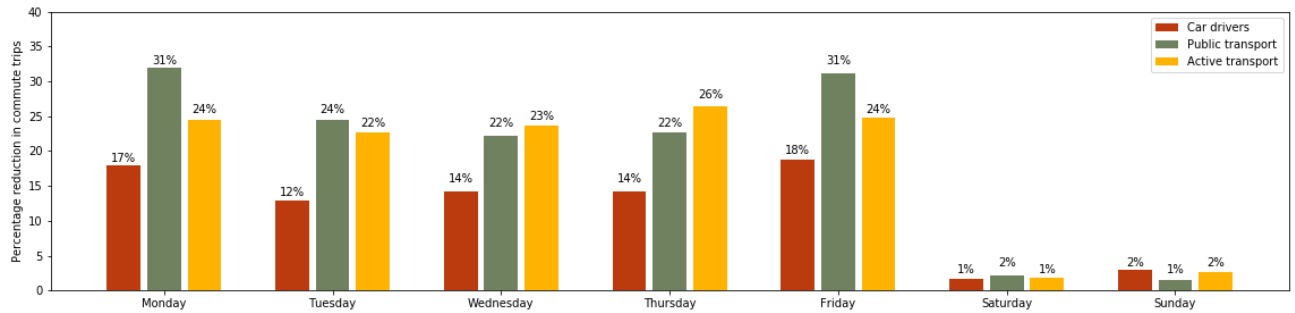


Figure 6: Percentage reduction in commute travel across different transport modes and across different days of the week, if employees were allowed to work remotely when possible

Figure 6 plots the percentage shift in commute trips made using different transport modes, as a function of the day of the week. In general, reduction in car travel is lower than the corresponding reduction in public and active transport travel. This indicates that remote working arrangements appeal more to individuals that commute using public or active transport. The widespread adoption of remote working arrangements could reduce commute travel on the public transport network by 22-31 per cent on a given weekday, compared to 12-18 per cent for private cars. Across all modes, the plots have a U-shape, where the greatest reduction in trips is on Mondays and Fridays.

Figure 7 compares the reduction in car and public transport commute trips across employees living in the five largest urban areas (i.e. Sydney, Melbourne, Brisbane, Perth and Adelaide) and the twelve smaller urban areas in our sample. In general, the reduction in both car and public transport travel appears to be consistent across large and small urban areas, and there are no clear points of difference between large and small cities.

Similarly, Figure 8 compares the reduction in car and public transport commute trips across employees working in the CBD and non-CBD areas within the Sydney metropolitan region in our sample. In general, the reduction in both car and public transport travel is much greater for employees commuting to workplaces in the CBD. For example, commute trips to the CBD could decline by up to 23 per cent for car and 39 per cent for public transport. In contrast, commute trips to non-CBD areas could decline by up to 18 per cent for car and 24 per cent for public transport.

Figure 9 plots the distribution of employees that have the ability to work remotely in terms of their arrival time at work before the pandemic, and their preferred arrival if allowed to work remotely when possible. Figure 10 plots the corresponding distributions for departure time from work. For the morning commute, after accounting for the remaining employees who have a designated workplace but do not have the ability to work remotely, there is roughly a 5 per cent shift across the network away from the peak window between 8:00 AM and 9:00 AM, and towards 10 AM. For the evening, there is a larger shift in magnitude of roughly 10-20 per cent away from the peak window between 5:00 PM and 6:00 PM, and towards 2:00 to 4:00 PM. Together, the plots indicate that peak spreading could reduce commute travel during peak hours by an additional 5 per cent during the morning period, and an additional 10-20 per cent during the evening period.

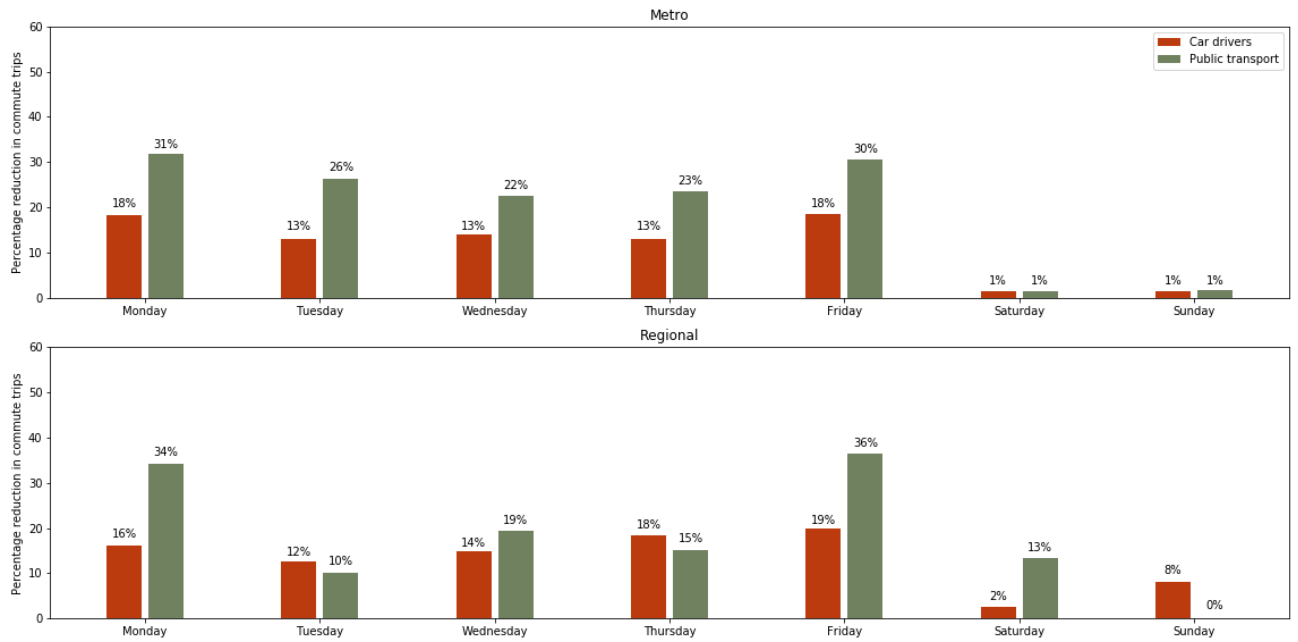


Figure 7: Percentage reduction in car and public transport commute travel across different days of the week for employees living in the five major metropolitan centres and the twelve smaller regional centres, if employees were allowed to work remotely when possible

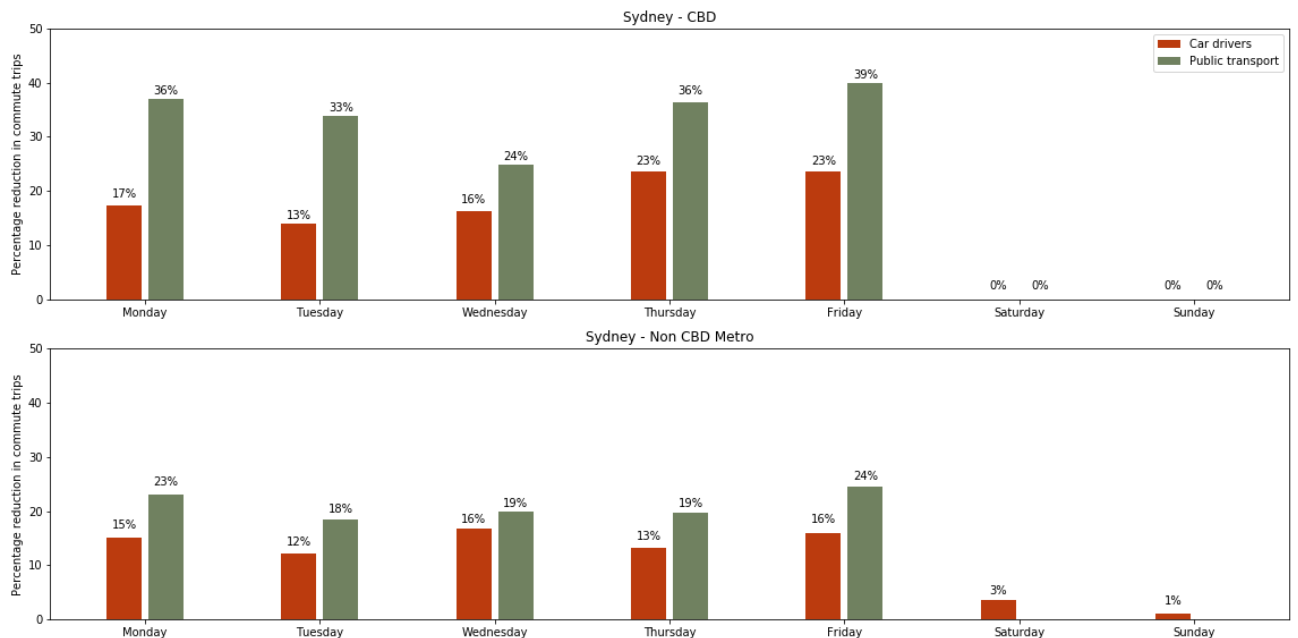


Figure 8: Percentage reduction in car and public transport commute travel across different days of the week for employees working in CBD and non-CBD areas within the Sydney metropolitan region, if employees were allowed to work remotely when possible

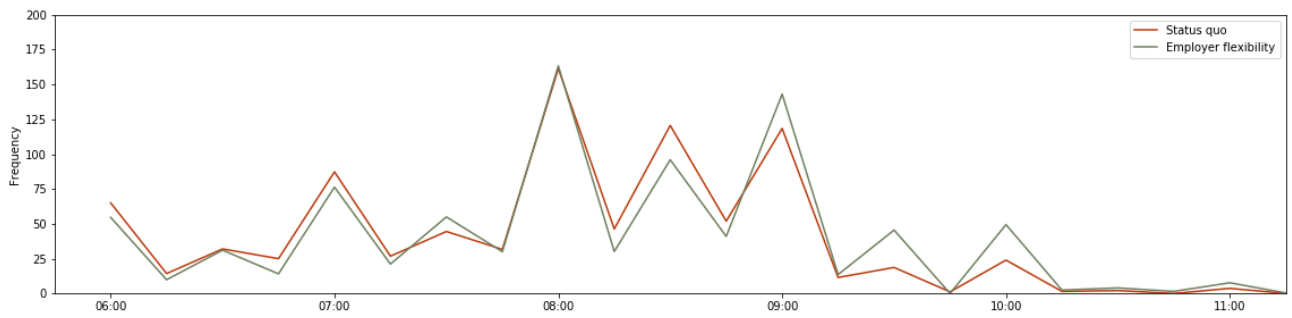


Figure 9: Arrival time at work before the pandemic, and preferred arrival time if employees were allowed to work remotely when possible

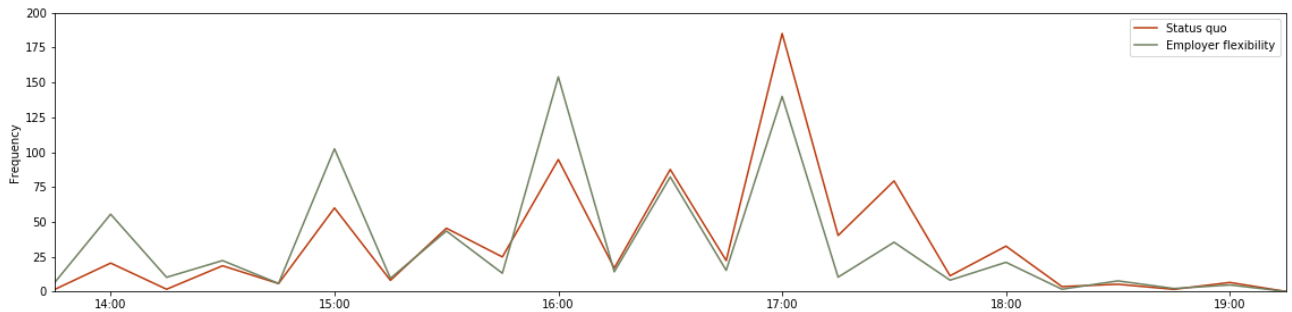


Figure 10: Departure time from work before the pandemic, and preferred departure time if employees were allowed to work remotely when possible

7. Conclusions

The continuation and potential expansion of remote working arrangements after the pandemic could have profound implications for existing patterns of commute travel, with consequent impacts for the supply of transport infrastructure. The capacity of most transport systems is designed to serve peak demand, which typically coincides with peak commute hours. If commute travel during peak hours can be reduced and/or spread to other hours of the day, transport systems can serve this demand more efficiently and cost-effectively, and this can help achieve wider societal benefits in terms of reduced network congestion, improved air quality, etc. (Thorhauge et al., 2020; Hess et al., 2007).

Based on a survey of 2,694 Australian employees in 2020-21 living in one of the 17 largest urban areas in the country, we estimate that roughly 38 per cent of employees in these urban areas believe that some of their jobs tasks and activities could be done remotely. If these employees were able to work remotely, when possible, we estimate that this could reduce weekday commute travel by car by 12-17 per cent and by public transport by 22-31 per cent across large urban areas. Reductions in travel are likely to be greatest on Mondays and Fridays, and for commute trips made to workplaces in CBD locations. Remote working arrangements could additionally move roughly 5 per cent of commute trips outside the morning peak period, and 10-20 per cent of commute trips outside the evening peak period.

The primary objective of this paper was to estimate potential long-term post-pandemic system-wide impacts of remote working on commute travel patterns. In the immediate, future research could examine how the adoption of remote working arrangements and their impacts on commute travel are likely to vary as a function of employee, employer and employment characteristics. Such analyses could help identify segments in the population that are likely to be most responsive to travel demand management strategies that leverage remote working arrangements. In the long-term, more ongoing research is needed to understand how attitudes and preferences towards remote working evolve over time, and how these changes are likely to impact transport patterns.

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