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COVID-19 and its influence on the propensity to Work from Home between March 2020 and June 2021

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ABSTRACT: The COVID-19 pandemic has had a significant impact on the world of work. With growing support and preference revelation from both employees and employers, we might anticipate a settling in of working from home around one to two days a week, varying by occupation depending on the ability to work remotely. Although there are a growing number of studies that have analysed data collected at a point in time or over time during the pandemic, there is now sufficient time and data to treat the waves of collected data as a repeated cross section that is jointly modelled to assess systematically, the changing roles of various influences on the proportion of working days that are worked from home. This paper estimates random effects regression models for the Greater Sydney Metropolitan Area and South East Queensland over four waves of data collected in 2020 and 2021, where this last one represents a period with almost full vaccinations and minimum restrictions (i.e., 'new normal'). By jointly estimating four waves of data within a single modelling framework, we are able to track the changing roles of the influences found to be statistically significant across the waves. The elasticity outputs reveal how these influences impact on the propensity to WFH, giving clues on whether we were starting to see a stabilisation of WFH activity mid-way in the pandemic period that can be reflective of a 'new normal'. Results are very supportive of employees' preferences, suggesting that those that feel the same or more productive when WFH relative to going to the office, are more likely to WFH relative to those that feel less productive.

KEY WORDS: ***COVID-19, working from home, Australian metropolitan experience, four waves, elasticities, random effects regression, new normal***

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presented as Report in Working from Home Final Report according to the following link: https://imoveaustralia.com/wp-content/uploads/2023/02/Working-from-Home-and-implications-for-revision-of-Metropolitan-Strategic-Transport-Models.pdf

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1. Introduction and Key Insights to Date

The interest in the impact that COVID-19 is having, and will likely continue to have, is unabated. Zhang and Hayashi (2022) reviewed the numerous papers that have been published in the first two years of the pandemic (up to March 11, 2022), and synthesised the key contributions, where the focus was on the impact on passenger transport, immediate measures taken to cope with the pandemic, how individuals and organisations adapted their travel activity in particular, and what this might mean from a policy position going forward in the future for all stakeholders. At the centre of much of the growing number of contributions is the changing nature of a real-world experiment which has turned out to have many unintended positive consequences for both employees and employers and has resulted in what may be the greatest transport policy level for desirable change we have seen for many years.

This change is especially noticeable in terms of benefits experienced by many (but not all) workers who have been able to work from home (WFH). There is a ground swell of evidence emanating from numerous studies in many countries suggesting that flexibility is here to stay, and that employers who offer a balance between WFH and in-office work will attract more high-quality employees (Hensher et al. 2023). There is a noticeable increase in support from employers for work/leisure life balance of employees. About 75% of the increase in WFH will likely be permanent, with one in five workdays being from home post-COVID-19[1]. One of the most striking takeaways from the increase in WFH over the last two years is its persistence, without stigma.

We also see continuing nervousness about using public transport (Beck et al. 2021)[2], and more generally, any shared form of transport with strangers, which has resulted in part at least, in increased ownership of private cars (often as a first-time purchase of a car). This has increased car use, but noticeably with a flattening of the traditional peaks and growth in off-peak road traffic, in part linked to greater flexibility in when non-commuter travel can occur. With reduced commuting activity by each worker, the cost and time outlays in commuting take on a new set of values in terms of sensitivity to outlays that were previously over five days a week and are now distributed over less number of days a week. Consequently, there is an expectation that commuters will be less sensitive to parking and fuel/toll prices. In addition, some of the retained commuting activity where an employer has reduced their office space footprint (saving on lease and other costs), might be translated into the growth of work in satellite offices located closer to home, although the extent of this is unknown. This is a nice association with the idea of a 15-20 min city, where much of previous activity that denied this outcome was commuting-related. Furthermore, the reduction in anticipated office space capacity is resulting in many employers rethinking when staff need to be in the office on the commuting days, which spills over to staggered working hours leading to a possible increase in single-occupant car use where car sharing was previously much more feasible for common spans of working hours.

The land use implications are also quite striking, with WFH possibly driving a future 'suburbanisation effect'. With more time spent working at home, activities outside of the house are more likely to occur

[1] https://www.bloomberg.com/news/articles/2022-02-28/remote-work-seen-more-persistent-than-u-s-city-planners-expect, 28 February 2021.

[2] Car and freight travel have reached pre-pandemic levels, but public transit and passenger rail are not expected to recover fully. Americans' preferred means of travel were shifting away from public transit before the pandemic, and these changes accelerated during the pandemic and afterwards. Americans prefer the flexibility and safety of cars rather than group travel, where they risk catching COVID. TomTom, which provides traffic information and navigation systems, estimates that traffic is higher midday than before the pandemic, and slightly lower during peak hours. See https://www.forbes.com/sites/dianafurchtgott-roth/2022/03/31/out-with-buses-in-with-rideshare/?sh=2a0dea23328d

at the local level. With reduced commuting, suburbs will become more popular as activity centres, but the downtown centres will still remain important locations for not just business but entertainment and accommodation, which we refer to as downtown activity precincts (in contrast to reference to a central business district) (Hensher et al. 2023c).

Figure 1, based on data collected in late 2021[3], shows how the time reallocated from reduced commuting is used on work and leisure-related activities. For South East Queensland (SEQ) in Queensland (Qld), Australia, 23% of all time saved is associated with leisure activities undertaken in the home, 18% household tasks (i.e., chores), and 9% is associated to leisure outside of the home, i.e., a total of 50% of the saved time is allocated to leisure activities plus household tasks. The equivalent percentages for the Greater Sydney Metropolitan Area (GSMA) in New South Wales (NSW), Australia are 17.5% for leisure activities in home, 19% for household tasks, and 11% for leisure activities outside home, i.e., 47.5% of all saved time is allocated to leisure plus household tasks in SEQ. The out-of-home activity adds additional traffic onto the road network in particular, although some of this travel is local, can often be done outside the peak hour, and is increasingly made by active modes.

[3] This data was collected after waves 1-4 but is sufficiently relevant telling the story on activities undertaken as a result of reduced commuting activity that we have included it in this paper. See Beck and Hensher (2024) for analysis of data collected after Wave 4.

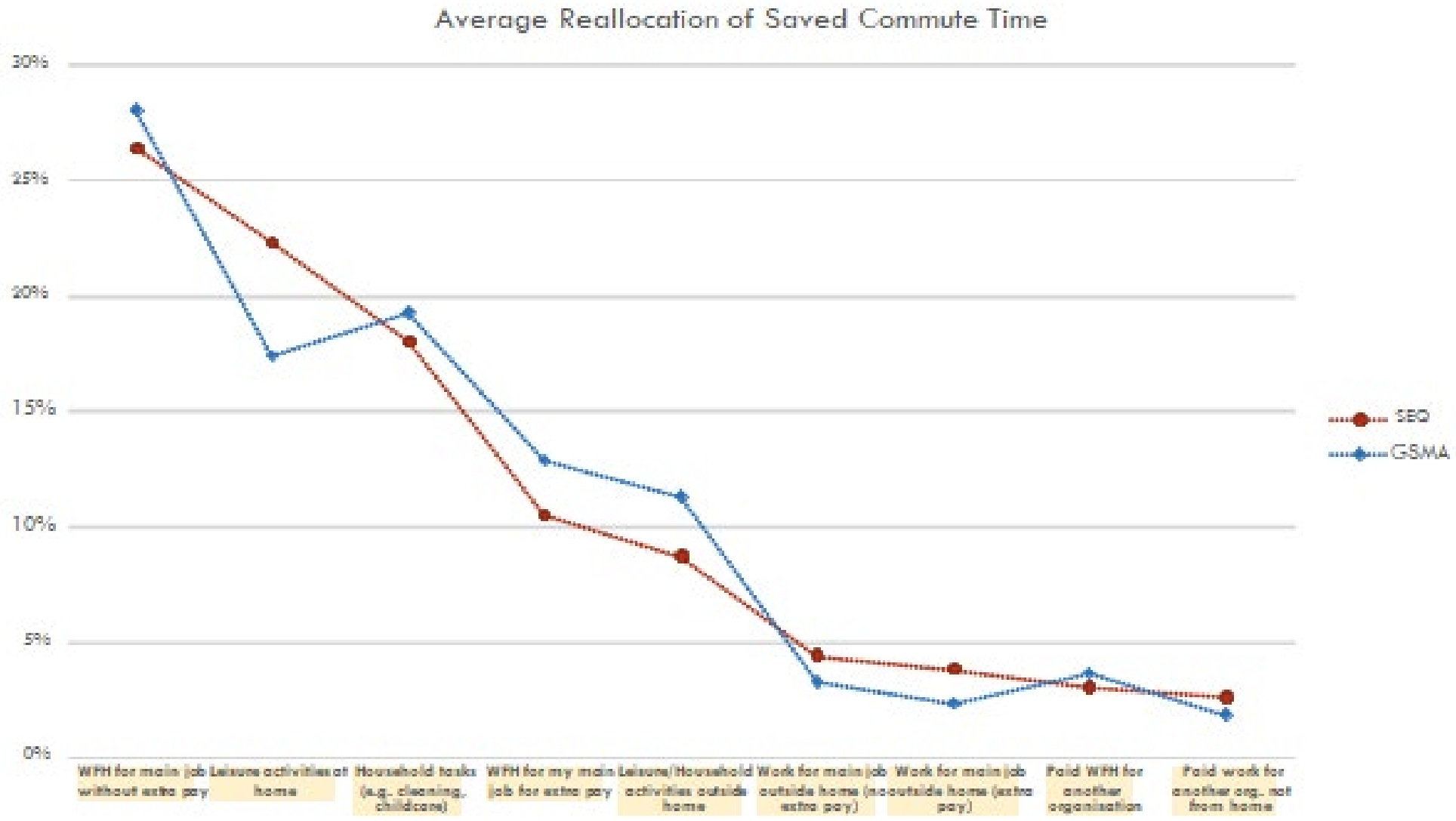

Figure 1. The breakdown of the allocation of saved commuting time within leisure and work in the GSMA and SEQ, late 2021

Ramani and Bloom (2021) find that in dense US cities, households, businesses, and real estate demand have moved from central business districts towards lower density suburban areas, labelling the phenomenon the "Donut Effect" reflecting the movement of activity out of city centres to the suburban ring. While many have speculated that WFH might result in people moving out of cities altogether, this US study does not find evidence for large-scale movement of activity from large US cities to smaller regional cities or towns. This might be explained by the growing evidence that working patterns will increasingly be hybrid, with workers commuting to their business premises typically three days per week.

Delventhal and Parkhomenko (2022) suggest that there are at least four views on WFH now and in the future. The first view is that WFH during the pandemic is a transitory phenomenon, and that once people are allowed to and feel safe, they will return back to the office. The second view is that individuals have experienced through WFH, a shock to preferences. Citing Barrero et al. (2021), they suggest that working from home was always great, but that social norms and stigma limited it; and that we now observe a positive change in attitude by the average worker towards WFH after having actual experience with it. The third view suggests that events of the past recent years may amount to a technology shock, with the early months after March 2020 seeing a burst of innovation directed at making remote work, work. Digital software was widely adopted, new policies and procedures were put in place, and individuals and organisations did a great deal of learning by doing, all on top of a sizeable investment in remote-complementary physical capital. The fourth view suggests that the in-office work model is a coordination game with multiple equilibria if everyone is in the office, but if enough people go remote, workers prefer to WFH. They suggest that the most feasible explanation of increased and continued WFH is due to a preference shock, something we also find in the modelling undertaken in this paper.

The traditional thinking, highly associated with predict and provide, is now aligned with different thinking, often referred to as vision and validate, since not only are the new opportunities preferred and supported by most areas of society, they come on top of the broader environment challenges that are looming large in climate change, which has resulted in changes in weather patterns accompanied by increased periods and severity of drought and floods. Hensher et al. (2022) show in an integrated transport and land use model system that the levels of WFH observed in the GSMA in mid-2021 in the absence of restrictions or stay-at-home orders have resulted in a 10 percent reduction in CO_2 emissions from land transport, both passenger and freight. This is significant and unlikely to be achieved by any single transport initiative, with the possible exception of road pricing reform (Hensher et al, 2021c, 2023b).

One of the key contributions of this paper is to fill the gap in the literature between the flurry of (important) academic activity during the initial stages of the pandemic, and the emergent literature that seeks to now understand the "new normal" or current state of transport and commuting activity patterns. There are very few studies globally that track the progression of pandemic related changes and can trace the line between the extreme states of the COVID-19 pandemic. Noting that Australia has experienced a remarkably different experience to other comparable economies (given border closures, multiple extended lockdowns, slow vaccination rollouts followed by dramatic rates of vaccination take-up in the population), Australia has ultimately arrived at a present state where working from home is still a significant component of working behaviour, and as discussed in this paper, evidence is such that WFH will continue to play a significant role for some time yet. This paper makes an important contribution in that helps fill the gap between the start of the pandemic and the current state and gives important context for understanding how we got to the "now" that exists in Australia.

Specifically, this paper explores behaviour at a very unique time, where after a swift and an initial 6-week lockdown in the early stages of the pandemic (with a much longer lockdown limited to the state of Victoria and in Melbourne especially) and up until the most recent point of data collection used in this paper, Australians had largely thought they had weathered the brunt of COVID-19, and had experienced an extended run of relative normality and single-digit levels of COVID-19 cases across the country. Despite the relative brevity of the experience with COVID-19, this paper will provide evidence that experiences with WFH had been positive, to the point that the seed of what would be a substantive change in work and commuting, was planted during this period. We believe that recording the insights from this period of time, is an important part of telling the full story of COVID-19, and is required in order to be able to understand the trajectory of the pandemic within Australia, and such history is likely to be useful should another pandemic play out at some point in the future.

The paper is structured as follows. The next section provides a brief literature review on the impact that WFH is having on travel activity, noting that we and others have covered much of this material extensively in many other publications. This is followed by a descriptive overview of the four wave data sources collected from March 2020 to May 2021, and then we propose a model framework centred on a random effects regression model. The findings from model estimation for the two geographical jurisdictions of our focus, the Greater Sydney Metropolitan Area (GSMA) and South East Queensland (SEQ), are presented and discussed together with the informative elasticity estimates. The paper concludes with a synthesis of the main findings and future research themes.

2. Descriptive Overview of the Data

The data has been collected throughout Australia at four points in time since the pandemic took hold in March 2020 (Figure 2). Data was collected via an online survey provider PureProfile. The sample characteristics align well with those from the most recently available published Australian Bureau of Statistics census data; where we extracted data for the sample of the working age population from which the sample was drawn. Although there is some gender imbalance within each sample, the overall ratio of male to female is as per the population in Waves 2-4. We also note that the samples are repeated cross-sectional in nature. In analysing the data, the points of comparison over time are limited to the GSMA and SEQ regions. The four waves are associated with periods of lockdown and easing of lockdown, enabling us to capture the influence that degrees of severity of restrictions had on the propensity to work from home, either under a compulsory mandate of government or by choice. Wave 1 was collected in late March 2020 when much of Australia was in lockdown, with restrictions being eased from late April onwards into May with dates varying by State. When we commenced Wave 2 in the middle of May most restrictions had eased (with nationally only 100 deaths from COVID-19, heavily linked to cruise ships) with schools reopening and limits of the number of people that could gather in public places, restaurants, religious locations, and parties. Beck and Hensher (2020, 2020a) discuss the impacts on work productivity, support from employers for WFH where it is possible, and a large number of other responses related to bio-security concerns in using public transport and other shared modes such as ride share, and attitudes towards working from home in the future after these new forced experiences.

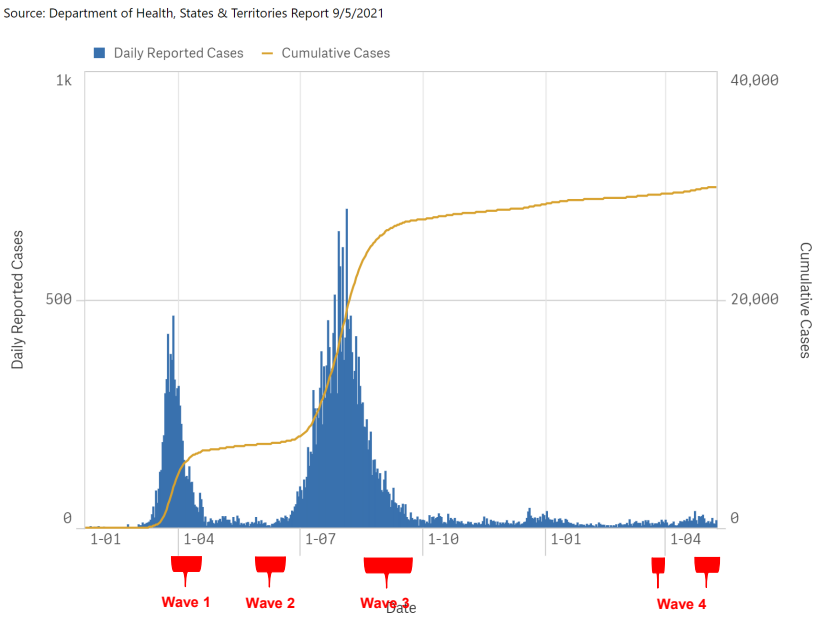

Figure 2. The timing of the four waves of data collection in 2020 and 2021.

Wave 3 was collected between early August and mid-October 2020 where we witnessed state border closures, a severe lockdown in Victoria but increasing easing of restrictions in other States. Full details are provided in Beck and Hensher (2021, 2021a), Hensher et al. (2022) proposed a new way of integrating the choice between WFH and commuting into a strategic transport model system with a mapping equation to identify the influences on the probability of WFH at an origin-destination level for both the Greater Sydney Metropolitan Area (GSMA) and Southeast Queensland (SEQ). Wave 4 was in the field during April-May 2021, during a period where we had started to see most restrictions removed, except for State border closures and international travel only by exception, just prior to an extended lockdown in NSW and Victoria when the Delta virus took hold. We had anticipated that the data from Wave 4 would represent a period of accumulated experience with lockdowns and easing of restrictions and a period of reflection on experience with WFH (see Hensher et al. 2023q). While this was indeed a period of significantly reduced restrictions, in the latter half of 2021 the Delta variant meant much of the Australia population was placed back under restrictions (of varying severity), following high rate of vaccinations restrictions were eased, but an unexpected growth in people catching COVID as a result of the Omicron strain meant that the 2020/2021 new year period meant many individuals reverted to "voluntary" lockdown behaviours in absence of any government mandates (Beck and Hensher 2024).

A descriptive profile of the data over the four waves is summarised in Table 1 for the two geographical jurisdictions we are investigating in this paper, namely the Greater Sydney Metropolitan Area (GSMA) and Southeast Queensland (SEQ). We limit the table to those variables that we have found to have a statistically significant impact on the incidence of WFH in one or more waves of data in each location. Some data items were not collected across all four waves, due in part to the journey of exploration and identifying some new data items as we progressed through the waves. Employer perceived productivity of their staff in Wave 4 was asked, but unfortunately, a coding error resulted in this data item being ignored by too many eligible respondents who should have answered it. Results across waves and jurisdictions show that employees' perceived productivity levels are somewhat aligned with employers' perceived productivity of their staff, particularly if we consider the same and more productivity together. In many cases, employees perceive their level of productivity has improved, while their employers perceive it to be the same. However, results suggest that employees and

employers are more or less aligned in what they perceive as productivity levels compared to pre-COVID levels.

Table 1. Descriptive profile of key data items across Waves 1 to 4 for the GSMA and SEQ (n/a=not available)

	Wave 1		Wave 2		Wave 3		Wave 4	
	GSMA	SEQ	GSMA	SEQ	GSMA	SEQ	GSMA	SEQ
Survey period	**30 March – 15 April 2020**		**23 May-15 June 2020**		**4 August-10 October 2020**		**April-May 2021**	
Number of workers	82	63	120	44	413	332	421	334
Proportion of Workdays that are WFH	0.595 (σ=0.463)	0.644 (σ=0.467)	0.591 (σ=0.469)	0.417 (σ=0.476)	0.410 (σ=0.442)	0.368 (σ=0.434)	0.313 (σ=0.421)	0.271 (σ=0.405)
Age	44.5 (σ=14.2)	46.4 (σ=11.5)	42.3 (σ=13.3)	42.1 (σ=11.7)	40.4 (σ=13.5)	40.5 (σ=13.8)	41.5 (σ=14.7)	42.7 (σ=13.9)
Male	74.4%	38.1%	30%	31.8%	41.1%	30.1%	47.3%	42.2%
Manager	3.7%	0%	1.7%	4.5%	16.2%	12.3%	19.2%	12.3%
Professional	54.8%	49.2%	45%	27.3%	30.8%	31.6%	28.7%	27.8%
Like to WFH more in future	43.9	55.6%	42.5%	27.2%	39.5%	37.9%	n/a	n/a
Number of days WFH in future	1.89 (σ=1.8)	2.04 (σ=1.9)	2.29 (σ=2.0)	1.95 (σ=2.0)	1.74 (σ=1.9)	1.9 (σ=2.0)	1.51 (σ=2.1)	1.31 (σ=2.1)
My work cannot be done from home	n/a	n/a	n/a	n/a	14.8%	16.6%	46.7%	52.1%
Total weekly one-way commuting trips	5.69 (σ=4.6)	4.39 (σ=5.8)	6.84 (σ=7.1)	5.48 (σ=5.2)	5.32 (σ=8.6)	5.29 (σ=6.0)	5.92 (σ=7.3)	5.98 (σ=6.4)
Distance to work from home	n/a	n/a	n/a	n/a	18.4km (σ=19.4)	16.9 km (σ=17.4)	19.8km (σ=19.6)	20.9 km (σ=20.5)
Employee perceived more productive	33.3%	35.7%	38.7%	35%	39.3%	39.8%	43.0%	33.0%
Employee perceived same productivity	35.3%	33.3%	34.7%	35%	37.5%	42.7%	37.3%	54.3%
Employer perceived staff more productive	21.5%	38.7%	18.3%	20.45%	27.8%	31.9%	n/a	n/a
Employer perceived staff same productivity	36.7%	32.3%	47.0%	50%	42.1%	40.1%	n/a	n/a

The proportion of working days that are worked from home in the GSMA vary from a high average of 0.595 in Wave 1 to a low average of 0.313 in Wave 4, with the range for SEQ being greater from a high of 0.644 in Wave 1 and a low of 0.271 in Wave 4. The distributions are shown in Figures 3 and 4. There is a clear trend towards a reduced number of days WFH from the beginning of 2020 until mid-2021, which is an important finding, but one that raises the question as to whether we have arrived at a level of WFH that is likely to become the 'next normal', showing an average of 1.3 to 1.5 days per week in Wave 4 for the two locations. This is a question for ongoing research to see if the evidence in mid-2021 is reinforced in 2022 after a period of severe lockdowns in late 2021.

The average number of one-way weekly commuting trips is relatively stable over time, in a range from 6.84 to 4.39 which is typically of an average of two to three days commuting per week, although the standard deviations suggest a noticeable spread across the samples for each wave and location.

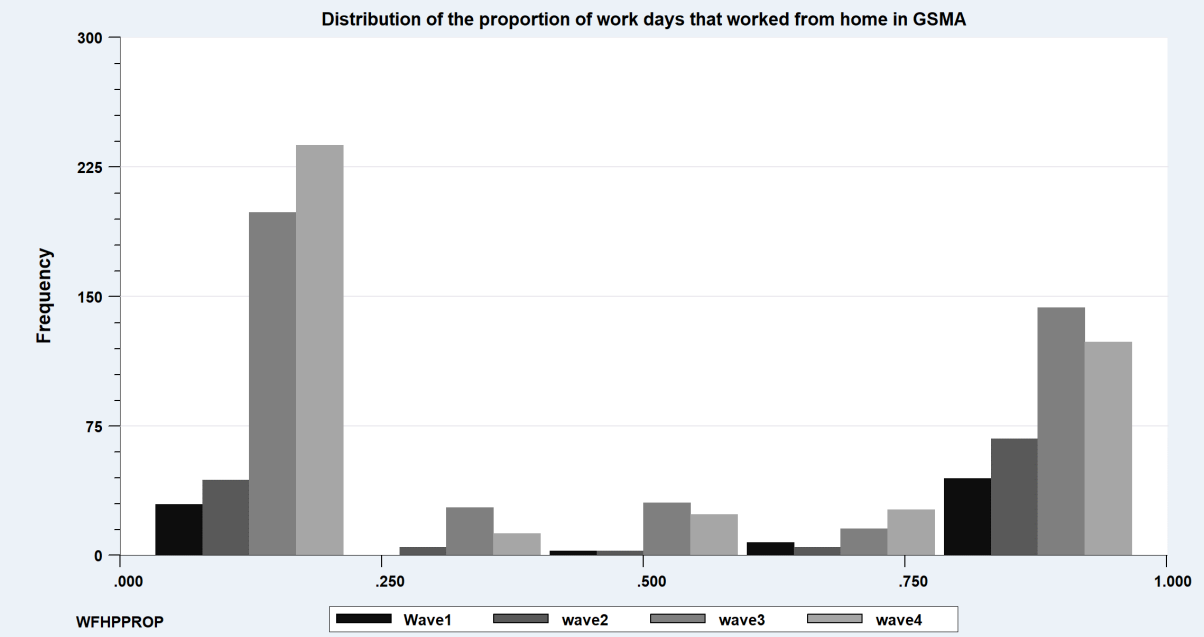

Figure 3. The distribution, by Wave, of the proportion of workdays that were worked from home in the GSMA

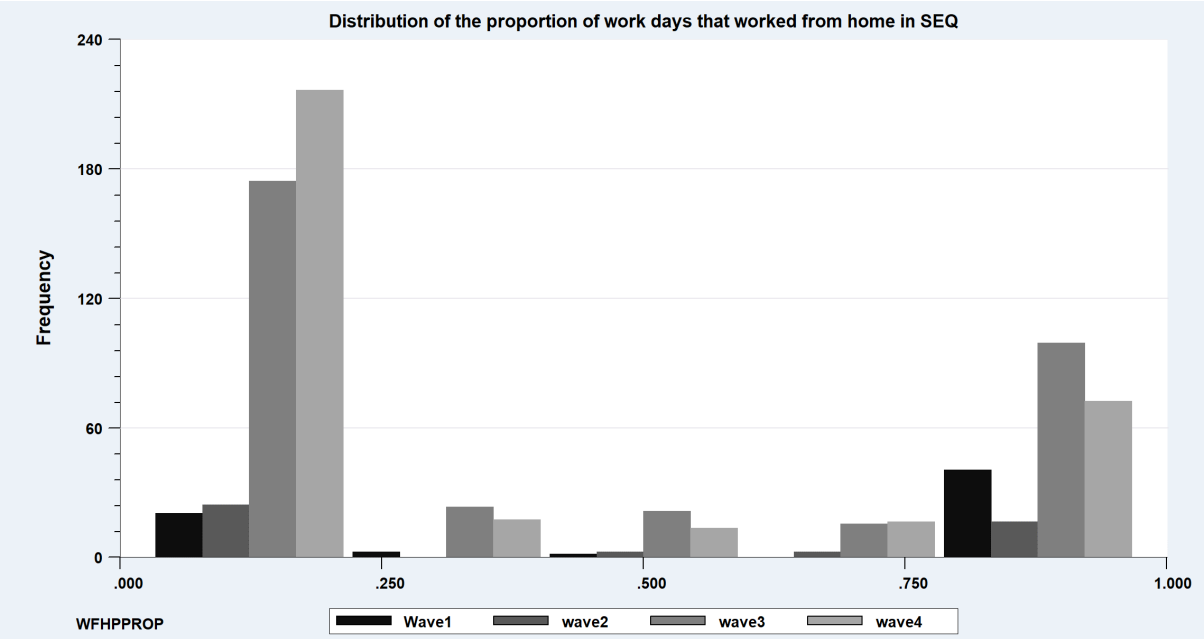

Figure 4. The distribution, by Wave, of the proportion of workdays that were worked from home in the SEQ

We know from this data, summed across all waves and data reported elsewhere (Hensher et al. 2023), that employers who were not supportive of WFH prior to COVID-19 were surprised and pleased to see that WFH was increasingly associated with greater employee productivity. This evidence has contributed to a growing view that WFH, to some extent, is here to stay as a significant structural change. This will require a major rethink by government and industry on what policies should be put in place to support a significant unintended positive consequence of the pandemic. Correlated with this, is the potential redesign of organisations to accommodate a situation where people are seen as more than workers but as people with lives that can creatively benefit organisations who start to reflect of this.

Another data item of particular interest is respondent preferences for days to WFH going forward (Figures 5 and 6). This includes all workers, including those who are not able to work from home, as it is the aggregate behaviour that will ultimately determine level of work-based travel activity on any particular day. This was at high when asked in Wave 1 and slowly reduced to an average of 1.51 days per week for the GSMA and 1.31 days per week for SEQ. This evidence aligns well with what is the average of 1.3 to 1.5 days per week in Wave 4 for the two locations. This may be suggesting that we are close to identifying the incidence of WFH in the 'next normal' as workers process their accumulated experiences and settle on a regular WFH profile. Interestingly, we also observe some desire to complete work on weekend days, previous work suggesting that employees enjoy the flexibility to move work into days (or times) that better suit them, to free up what would otherwise be work time for use on other purposes.

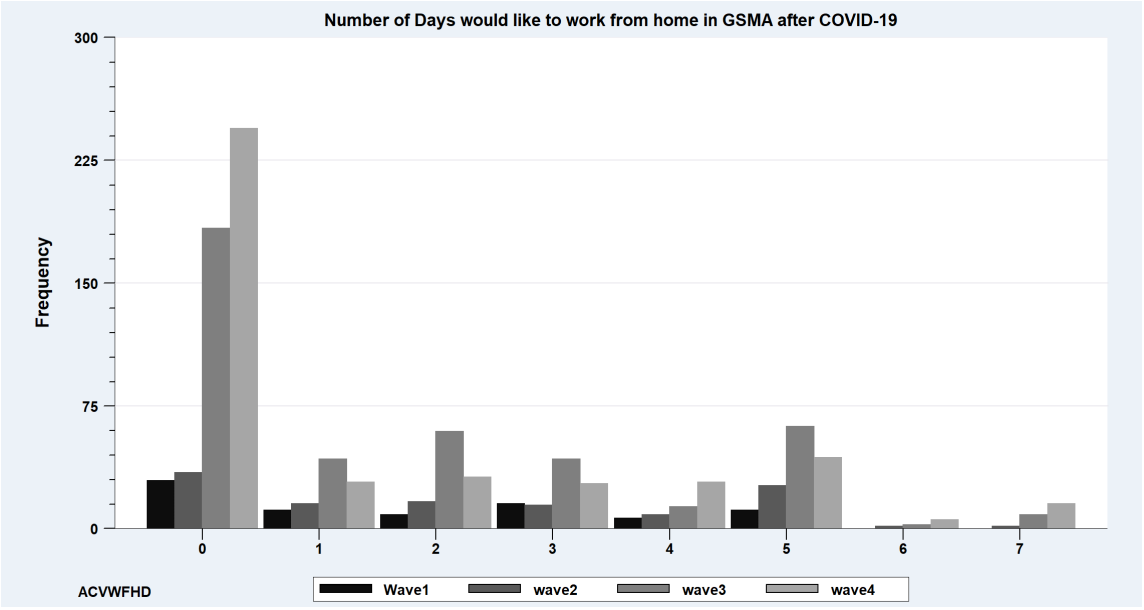

Figure 5. The preferred number of days working from home in the future in the Greater Sydney Metropolitan Area

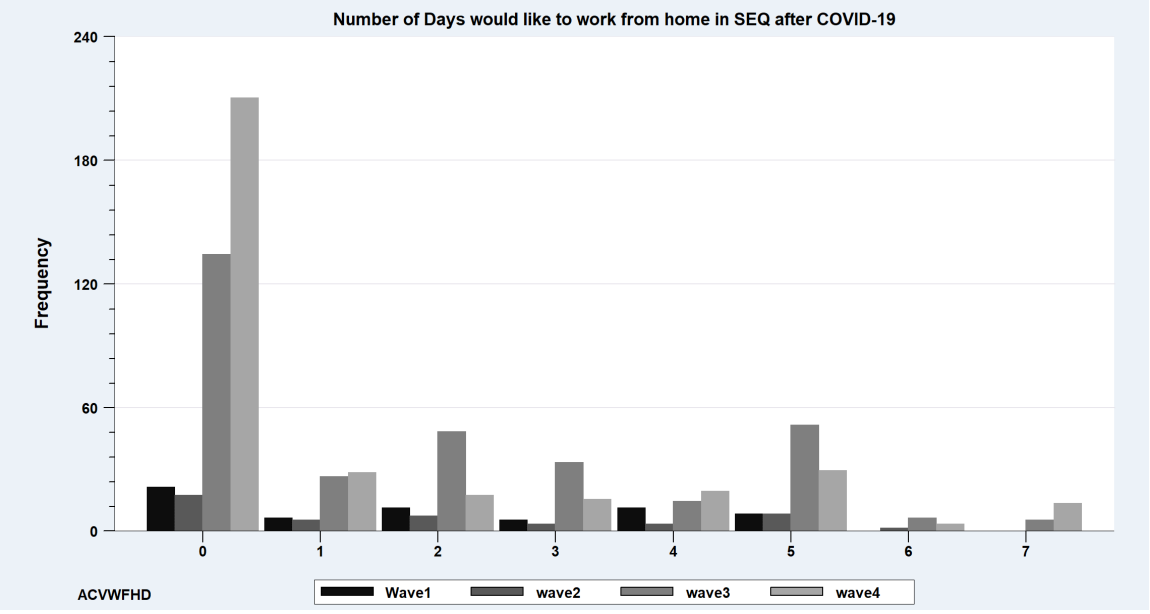

Figure 6. The preferred number of days working from home in the future in South East Queensland

3. Methodology

In exploring changes in the proportion of work completed from home, we use a random effects regression model to account for data obtained from four waves of repeated cross-section surveys, assumed to be random in order to account for random effects. Random effects are useful when we have uneven sampling across our four waves, something that is potentially problematic when using only ordinary least squares regression. We have a set of candidate explanatory variables to identify what role they might play in influencing the proportion of workdays that are worked from home in each of the four waves of data. To allow the parameter estimates associated with these explanatory variables vary across periods, we interact these variables with period dummy variables. The standard one-way random effects model (REM) is given in equation (1).

$$y_{it} = \alpha + \boldsymbol{\beta}'\mathbf{x}_{it} + \varepsilon_{it} + u_i + w_t \qquad (1)$$

The variation across groups (individuals) or time (i.e., data waves) is captured in simple shifts of the regression function – i.e., changes in the intercepts. These models are the random effects models characterised by u and w being uncorrelated with x. Under this assumption, the model can be estimated consistently by ordinary least squares. The fundamental part of the random effects model is a one-way common effects specification,

$$y_{it} = \alpha + \boldsymbol{\beta}'\mathbf{x}_{it} + \varepsilon_{it} + u_i \qquad (2)$$

where $Cov(u_i, x_{it}) = 0$ for all t, and $E[u_i \mid x_{it}] = 0$, $Var[u_i \mid x_{it}] = \sigma_\mu^2$, $Cov(\varepsilon_{it}, u_i \mid x_{it}) = 0$. The random effects model is a generalised regression model. It is homoscedastic, as all disturbances have variance $Var[\varepsilon_{it} + u_i] = \sigma^2 = \sigma_\varepsilon^2 + \sigma_u^2$. But, for a given *i*, the disturbances in different periods are correlated because of their common component, u_i, $Corr[\varepsilon_{it} + u_i, \varepsilon_{is} + u_i] = \rho = \sigma_\mu^2 / \sigma^2$. The efficient estimator is generalised least squares.

4. Model Results

Separate models developed for GSMA (1036 respondents) and SEQ (773 respondents) are summarised in Table 2[4], where the dependent variable is the proportion of days worked per week that are worked from home. These models were selected after an extensive assessment of numerous socioeconomic, attitudinal and travel-related variables.

Table 2 Summary of GSMA and SEQ random effects models for all waves of data
n/s = not statistically significant

Variable	Acronym	Units	Parameter estimate (t-value)		95% confidence interval	
			GSMA	SEQ	GSMA	SEQ
Wave 2	Wave2	1,0	0.0928 (5.71)	0.4579 (3.1)	0.3478-0.7115	0.1685-0.7473
Wave 3	Wave3	1,0	0.0755 (3.44)	-0.0104 (0.23)	0.0325-0.1184	-0.0986-0.779
Wave 4	Wave4	1,0	0.1913 (2.2)	0.0571 (0.90)	0.0293-0.3532	-0.0673-0.1815
Wave 1:						
Age of respondent	Age1	years	0.0038 (3.98)	0.0044 (4.42)	0.0019-0.0056	0.0024-0.0063
Professional	Dprof1	1,0	0.3065 (5.18)	0.1582 (2.57)	0.1905-0.4224	0.0375-0.2790
Like to WFH more often in future	WFHFrag1	1,0	0.5345 (8.84)	0.6442 (9.79)	0.4160-0.6530	0.5152-0.7732
Wave 2:						
Age of respondent	Age2	years	-0.0049 (-2.62)	-0.0075 (-2.18)	-0.0086-0.0012	-0.0141-|0.0008
Professional	Dprof2	1,0	n/s	0.2725 (3.07)	n/s	0.0984-0.4466

[4] A combined model with a GSMA dummy variable associated with each wave was far less informative than separate models for SEQ and the GSMA.

Like to WFH more often in future	WFHFrag2	1,0	0.5866 (11.7)	0.7166 (8.29)	0.4880-0.6852	0.5472-0.8859
Wave 3:						
Age of respondent	Age1	years	n/s	0.0024 (2.35)	n/s	0.0004-0.0044
Professional	Dprof3	1,0	0.1122 (3.94)	n/s	0.0564-0.1680	n/s
Manager	DMngr3	1,0		-0.0805 (-1.88)		-0.1642-0.0033
Work cannot be done at home	EMVRet3	1,0	-0.0946 (-2.56)	n/s	-0.1671-0.0220	n/s
Employee productivity much more than pre-COVID-19	ProdMor3	1,0	0.2750 (5.66)	0.3110 (6.53)	0.179800.3702	0.2177-0.4043
Employee productivity same as pre-COVID-19	ProdSam3	1,0	0.3613 (8.63)	0.3922 (9.21)	0.2793-0.4434	0.3087-0.4756
Like to WFH more often in future	WFHFrag3	1,0	0.4503 (10.9)	0.3876 (9.59)	0.3692-0.5314	0.3083-0.4668
Wave 4:						
Male respondent	DMale4	1,0	n/s	0.0631 (2.28)	n/s	0.0090-0.1173
Distance from home to regular office	DistHmW4	kms	-0.0007 (-11.2)	-0.0008 (-10.4)	-0.0009-0.0006	-0.0009-0.0006
Work cannot be done at home	EMVRet4	1,0	-0.1604 (-4.87)	-0.0621 (-1.95)	-0.2249-0.0958	-0.1324-0.0082
Employee productivity much more than pre-COVID-19	ProdMor4	1,0	0.49021 (11.5)	0.4568 (8.05)	0.4066-0.5736	0.3467-0.5580
Employee productivity same as pre-COVID-19	ProdSam4	1,0	0.5293 (12.0)	0.5449 (11.8)	0.4429-0.6157	0.4544-0.6355
After COVID-19, preferred # days WFH per week	ACvWFHD4	days	0.0376 (4.69)	0.0435 (4.58)	0.0219-0.0534	0.0249-0.0621

Random effects*:	**GSMA**	**SEQ**
Var (ε)	0.0664	0.0618
SD (ε)	0.2577	0.2486
Var (μ)	0.0060	0.0029
SD (μ)	0.0774	0.0539
Corr [v(i,t),v(i,s)]	0.0828	0.0449
R-squared	***0.649***	***0.671***
Lagrange Multiplier Test vs. RE Model:	***0.43***	***0.33***
1 degrees of freedom, prob. value	***0.512772***	***0.562839***

* Variances computed using ordinary least squares (OLS) and least squares dummy variable (LSDV)

We have endeavoured to account for all variables that are available from all waves, but a few variables are only available from waves 3 and 4 (as the survey and associated questions evolved over time and our understanding of the impact of the pandemic grew). For example, employee perceived productivity is only collected in waves 3 and 4. We did obtain employer perceived productivity of employees in all Waves but struggled to find any statistical significance except in waves 1 and 3; however, employee perceived productivity is a good proxy given that employees and employers are well aligned.

The estimated random effects model suggests that the gains in statistical efficiency are very small compared to the traditional ordinary least squares regression model[5]. The most insightful output supporting this position is the Correlations (Corr[v(i,t),v(i,s)]) for the GSMA and SEQ of 0.0828 and 0.0449 respectively, which suggests that the waves are unlikely to impact on each other. This might be expected given we have a repeated cross-section sample of unequal sizes and we have included wave-specific dummy variables to control for differences, at the mean and in unobserved influences, which clearly matter in the GSMA across all waves and less so for SEQ. The two models have overall explanatory power as reflected in the linear R^2 of 64.9% and 67.1% respectively, for the GSMA and SEQ.

[5] Available on request but most parameters are very similar to the random effects model.

Specifically, we found few occupation dummy variables to be statistically significant, with professionals being the main significant occupation category, with manager status appearing only in wave 3 for SEQ. Age of the respondent is an important influence on the incidence of WFH, with a statistically significant presence in waves 1 and 2 for the GSMA and SEQ, and wave 3 for SEQ. The sign, however, changes between the waves, with increasing age tending to increase the incidence of WFH in waves 1 and 3 and the reverse in wave 2. This is likely associated to the higher health risks of COVID-19 for older people, and the increase in daily cases in waves 1 and 3, whereas in wave 2 the daily cases were much lower (Figure 1) motivating older people - probably fatigued of being confined – to go to the office more often. Interestingly, in wave 4 age does not seem to have a statistically significant influence in either jurisdiction, suggesting that once initial perceptions and risks towards COVID-19 were overcome, age did not seem to turn the scales as to WFH.

Employee perceived productivity is a statistically significant influence in waves 3 and 4 for more productivity as well as the same productivity relative to pre-COVID-19, and we anticipate that this would also be significant in waves 1 and 2 if it had been collected. The other influence of significance is their future preference for working from home. We have two specifications, one related to a desire to work from home more often in the future, as a dummy variable ($WFHFrag_t$), and the number of days a respondent would like to work from home in the future (ACvWFHD4). We had to consider ACvWFHD4 on wave 4 since there was a coding error in the reference to the question for $WFHFrag_t$ which resulted it being avoided by many workers. We did, however, include ACvWFHD4 in waves 1-3 but found that $WFHFrag_t$ was statistically superior. A variable representing the dummy variable response that work cannot be done at home was available in waves 3 and 4 and was found to be statistically significant and of the expected negative sign for the GSMA in wave 3, and both locations in wave 4.

Commenting on the differences in parameter estimates is not behaviourally informative compared to the set of elasticities that can obtained. The direct elasticities calculated for each respondent and averaged are summarised in Table 3. We report the results for all the explanatory variables whose standard errors on a Delta test result in a statistically significant t-value at 95% confidence level or better. They are either point or arc direct elasticities depending on whether the explanatory variable is continuous or discrete, and are defined as the relationship between the percentage change in an explanatory variable and the percentage change in the proportion of work days that are WFH, *ceteris paribus*. As unitless metrics, they are directly comparable, and offer a preferred way to identify the greatest influences on changes in WFH.

There are interesting differences of influences between each wave as well as within the GSMA and within SEQ. We present the results in two ways: a ranking from the lowest (least elastic) to highest (most elastic) (column 2), and by the specific explanatory variable appearing in each wave and geographical jurisdiction (column 4). We also present this evidence in Figures 7 and 8.

Table 3 Summary of mean point and arc elasticity estimates

Ranked from lowest to highest elasticity	
Influence	**Elasticity**
Emvret3 GSMA	-0.193
Age 2 GSMA	-0.065
Age1 SEQ	0.039
ACVWFH4 GSMA	0.0411
Prof3 GSMA	0.647
Prodmor3 GSMA	0.855

Ranked by explanatory variable name and jurisdiction	
Influence	**Elasticity**
ACVWFH4 GSMA	0.0411
Age 2 GSMA	-0.065
Age1 SEQ	0.039
Emvret3 GSMA	-0.193
Prodmor3 GSMA	0.855
Prodsam3 GSMA	0.957

Ranked from lowest to highest elasticity	
Influence	**Elasticity**
Prof1 GSMA	0.888
Prodsam3 GSMA	0.957
Prof2 SEQ	1.018
WFHFrag3 GSMA	1.06
Prodmor4 GSMA	1.063
Prodmor3 SEQ	1.068
WFHFrag1 GSMA	1.074
Prodsam4 GSMA	1.086
WFHFrag2 GSMA	1.113
Prodsam3 SEQ	1.145
WFHFrag3 SEQ	1.157
Prodmor4 SEQ	1.173
Prodsam4 SEQ	1.25
WFHFrag1 SEQ	1.274
WFHFrag2 SEQ	1.292

Ranked by explanatory variable name and jurisdiction	
Influence	**Elasticity**
Prodmor3 SEQ	1.068
Prodmor4 GSMA	1.063
Prodmor4 SEQ	1.173
Prodsam3 SEQ	1.145
Prodsam4 GSMA	1.086
Prodsam4 SEQ	1.25
Prof1 GSMA	0.888
Prof2 SEQ	1.018
Prof3 GSMA	0.647
WFHFrag1 GSMA	1.074
WFHFrag1 SEQ	1.274
WFHFrag2 GSMA	1.113
WFHFrag3 GSMA	1.06
WFHFrag2 SEQ	1.292
WFHFrag3 SEQ	1.157

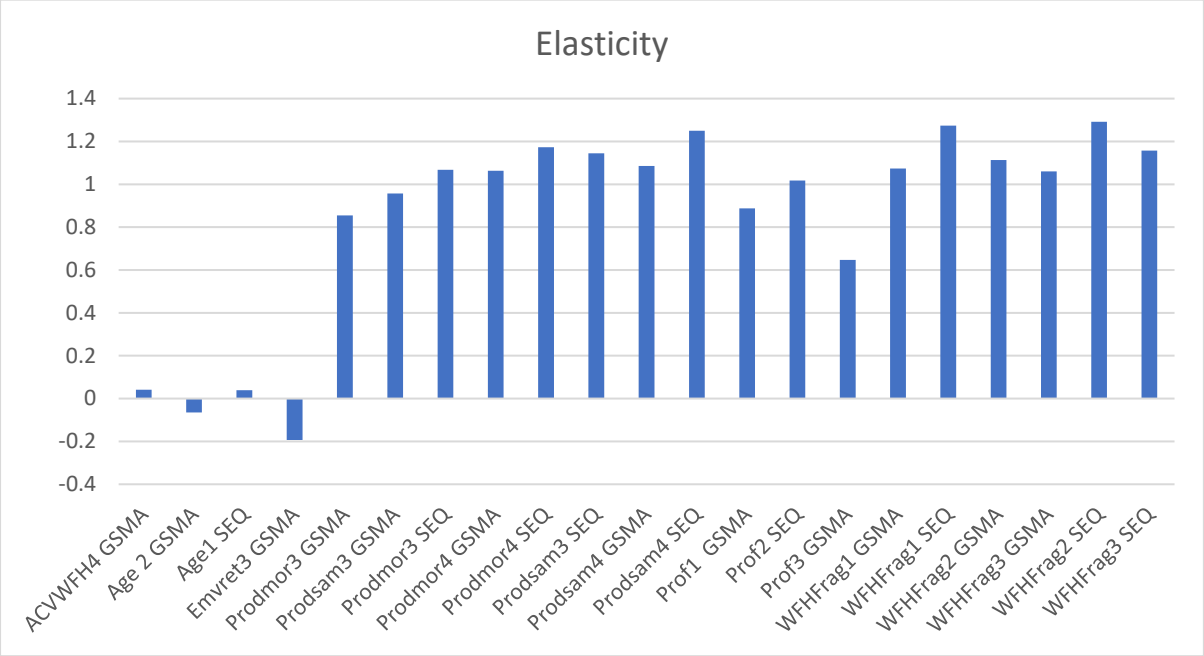

Figure 7. Direct point and arc mean elasticity estimates by variable-specific grouping

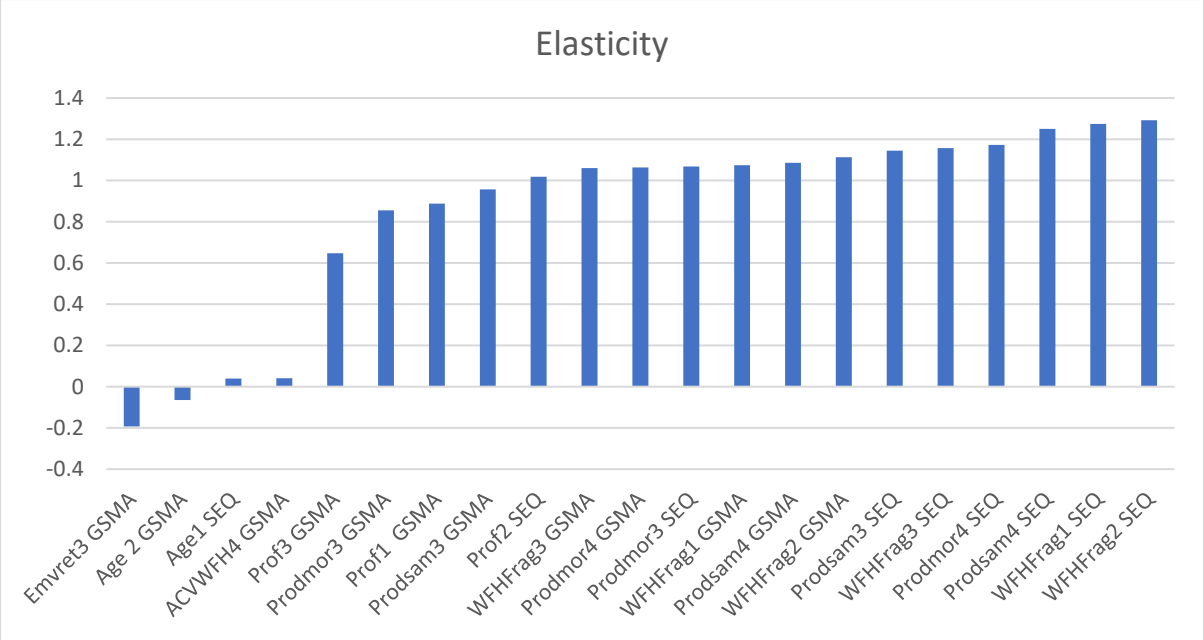

Figure 8. Direct point and arc mean elasticity estimates ranked by numerical value

A most interesting finding is that the direct elasticity of the proportion of weekly workdays that are WFH with respect to employee perceived productivity is in the range of 0.855 to 1.173 for being more productive and between 0.957 and 1.25 for the same level of productivity. These elasticities span a wide range of relative inelastic to relative elastic. For example, if the average number of days WFH weekly (considering total worked days) is 1.5, then the high-end elasticity response of 1.173 in the SEQ (wave 4) will result in an average number of days WFH weekly increasing to 1.76. Clearly, there is a statistically significant and plausible behavioural link between the propensity to perceive a greater or same level of productivity when WFH compared to back in the regular office. Using the arc elasticities results we see that when a worker moves from a level of perceived productivity worse than pre-COVID to better, we obtain a 0.855% to 1.173% increase in the proportion of working days that are worked from home. As far as we know, these are the first elasticity empirics on this link. Interestingly, the relative elasticity for being more productive goes up between waves 3 and 4 for SEQ (from 1.068 to 1.173) and GSMA (from 0.855 to 1.063). This is relevant, as it suggests that people seem to be conscious of their productivity levels, and this is significantly influencing their decision to go to the office or WFH – which is even more pronounced in the last wave, which represents a period without any lockdowns or restrictions. These results are encouraging and supportive of employees' preferences of where to work, particularly in a situation with no restrictions ("new normal") – suggesting that those who want to WFH are, at least, as productive as they are when going to the office (i.e., pre-COVID-19).

We have a similar relative elastic finding for 'I would like to work from home more often in the future' ($WFHFrag_t$), which is in the range of 1.06 to 1.292. This is statistically significant in waves 1, 2and 3 (there was a data error in wave 4 as explained earlier) . We see that when a worker indicates that they would like to work from home more often in the future, we obtain a 1.06% to 1.292% increase in the proportion of working days that are worked from home. This preference has more or less flattened between waves 1 and 3 for both the GSMA and SEQ. An alternative metric is the number of days 'after COVID-19' that an individual would like to WFH (ACVWFH). This was not found to be statistically significant in most waves and both locations with one exception, the GSMA in wave 4 with a mean

elasticity of 0.041. As a continuous variable that indicates, for example, that if we have a 10% increase in the number of days someone would like to WFH after COVID, we see a 0.41% increase in the proportion of weekly days working that are WFH.

In summary, the evidence across the waves suggests, *ceteris paribus*, that the improved perceived productivity of employees , which aligns well with employers' views on employee productivity, is a very strong indicator of the success and desire to WFH more often than pre-COVID-19, although employees are more harsh on themselves than what employers believe - at least for W3. We should suggest that this influence, together with a limited number of socioeconomic effects, provides rich support for a future with WFH, to some extent, that is, on average 1 to 2 days a week, but even greater for some workers.

5. Conclusions

There is enough accumulating evidence in this study and indeed many other studies listed in the references, that working from home will be embedded at the centre of the 'next' or 'new' normal. While the timing of this is not clear, in the sense of a stable level that can be used in future planning and proofing, there are signs that adjustments made through experience, often without choice, and through outcomes that have proven on balance to be very attractive to both employees and employers where working all of the time on-site is not necessary or valuable, will reinforce a regular pattern of WFH that is significantly greater than pre-COVID-19 levels. The often suggested metric of 1 to 2 days a week on average, seems to be reinforced by almost all studies (see a summary in Hensher et al. 2023c). As hybrid working becomes more structured, and technologies and work patterns better support the mix between WFH and work "on-site", we can expect productivity gains to be enforced as workers and workplaces gain the benefits of better flexibility, but also better face-to-face contact.

This study has investigated how the move between waves of data as society has learnt to live with and adjust to COVID-19, and all of its associated health risks (in an almost fully vaccinated society such as Australia since November 2021), offers signals as to what are important drivers of a desire to work from home. As long as productivity is seen as a positive outcome of working from home, especially by employers, who also recognise the lifestyle and wellbeing benefits to their employees (something that will inevitably be built in to employments contracts going forward), and that a preference of workers to continue to work from home remains, given the many benefits on balance that have been recognised, the next normal will almost certainly be linked to the delivery of structural change centred around WFH. Our results suggest that employers who feel the same or higher level of productivity from home than when going to the office (i.e., pre-COVID) are more likely to WFH, suggesting that employees are aware and concerned about their productivity levels which drives their preferences.

There are many ongoing challenges to governments, to the broad base of employers, and even to households as they work out how best to encapsulate the non-stigmatised WFH future. The implications for funding of infrastructure, re-prioritising land use plans, growing new office settings which include satellite offices referred to as working near home (WNH), and what the future office environment might be are profound. Individuals commuting less often may translate into a shrinking local revenue base and contribute to long-term fiscal challenges for local and State governments. Philadelphia, for example, assumed a permanent loss of 15% of the non-resident wage tax base in its projections, according to an analysis by the Philadelphia Office of the Controller in July

2022. San Francisco, in a five-year financial plan published in January, estimates that office workers will permanently telecommute about 15% of the time in the fiscal year 2025-2026[6].

Ongoing research will investigate how the WFH profiling emerging for society as a whole might be embedded in the way organisations will see the need for a revised value proposition. The challenge is to identify the key characteristics of a future setting for work and transport practices that aligns with a desire to build an effective workplace environment that promotes a culture of collaboration, connecting with peers and to foster company loyalty while retaining the flexibility benefits of WFH. Better understanding the WFH environment will give more insight into potential spillover effects on home design, urban design, and transport systems. Five distinct models seem to be emerging from our descriptive and modelling findings and the broader literature on WFH: (1) Office frequency and days fixed, a model that mandates certain days all employees are expected to be at the office; (2) Office frequency fixed but days of attendance flexible where companies require employees to attend the office for a specific number of days each week, but choose when those days are; (3) Workers' choice which is the most flexible with employees having autonomy to choose where (and when) work is done; (4) Remote work only; and (5) Office work only.

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