Commuting mode choice and work from home in the later stages of COVID-19: Consolidating a future focussed prediction tool to inform transport and land use planning

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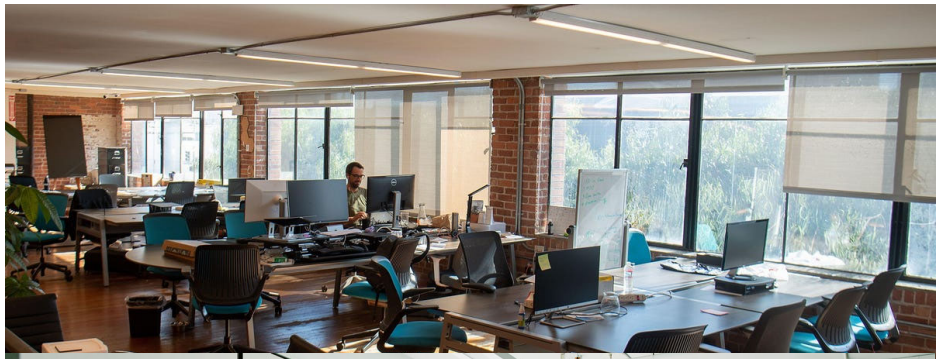
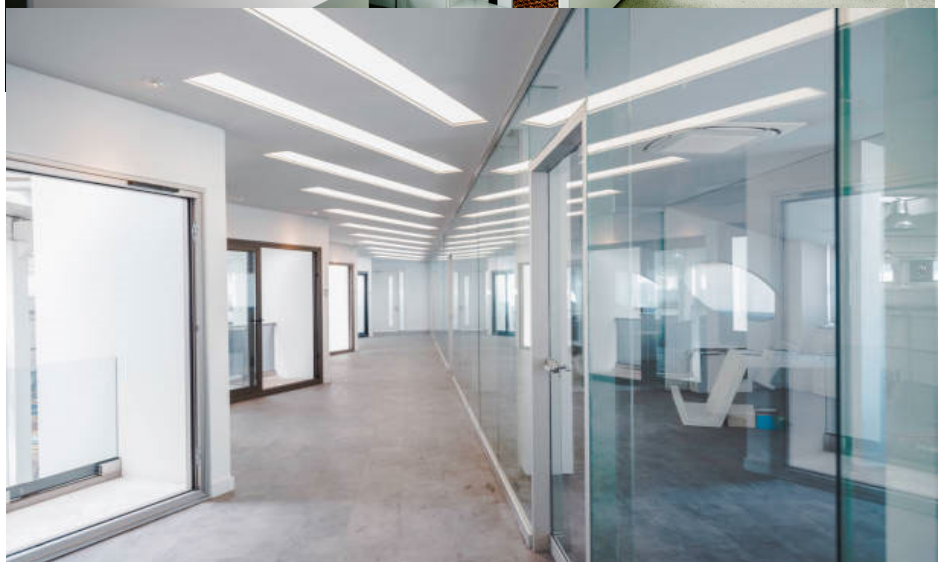
Department of Transport
Queensland Government





WFH and Hybrid Work Location Still Very Relevant: Hybrid: Coordination – office benefits are being with co-workers

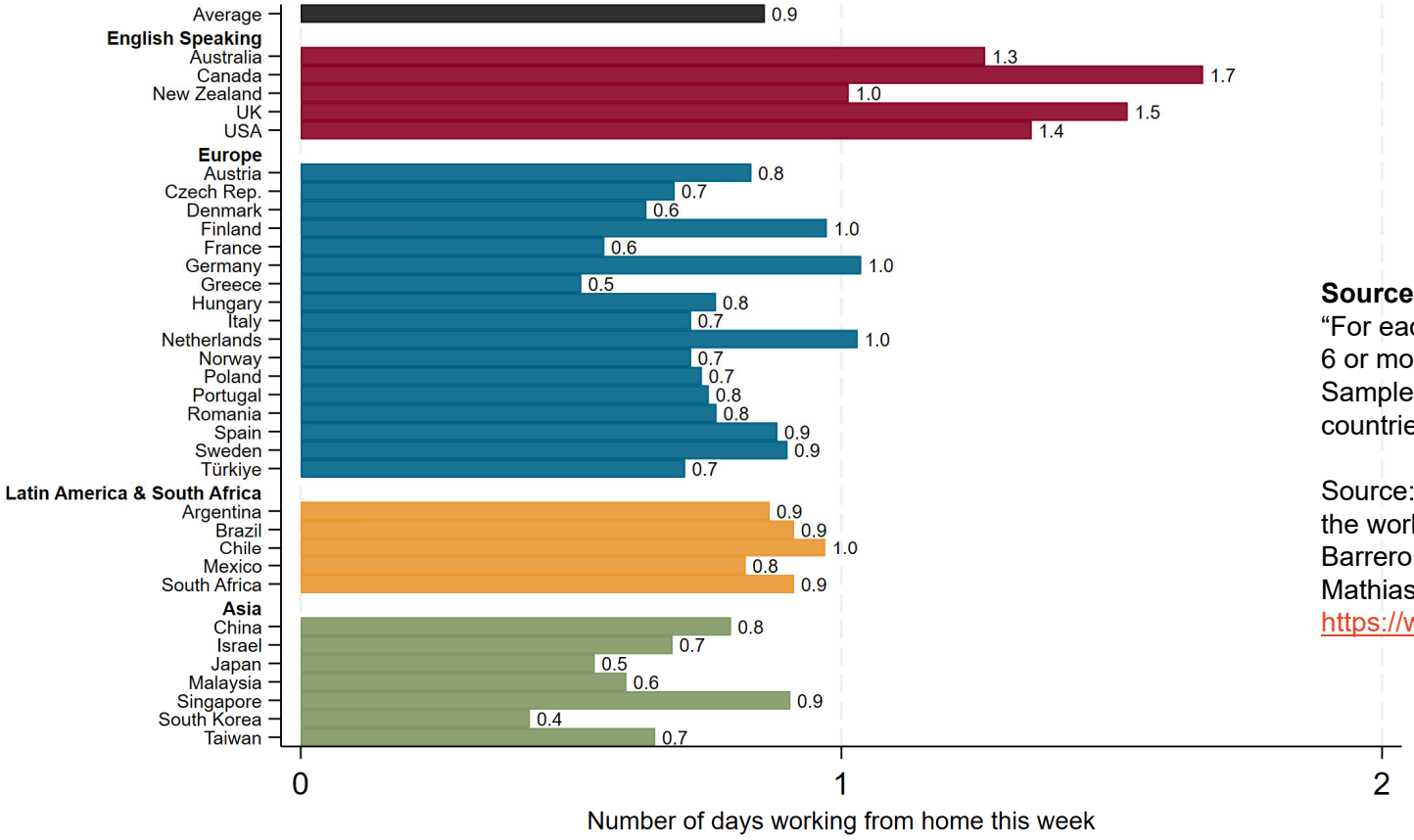
WFH/Remote working possibly the greatest transport policy lever we have had for many years

WFH is no longer stigmatised

We must continue to recognise this post-COVID-19

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

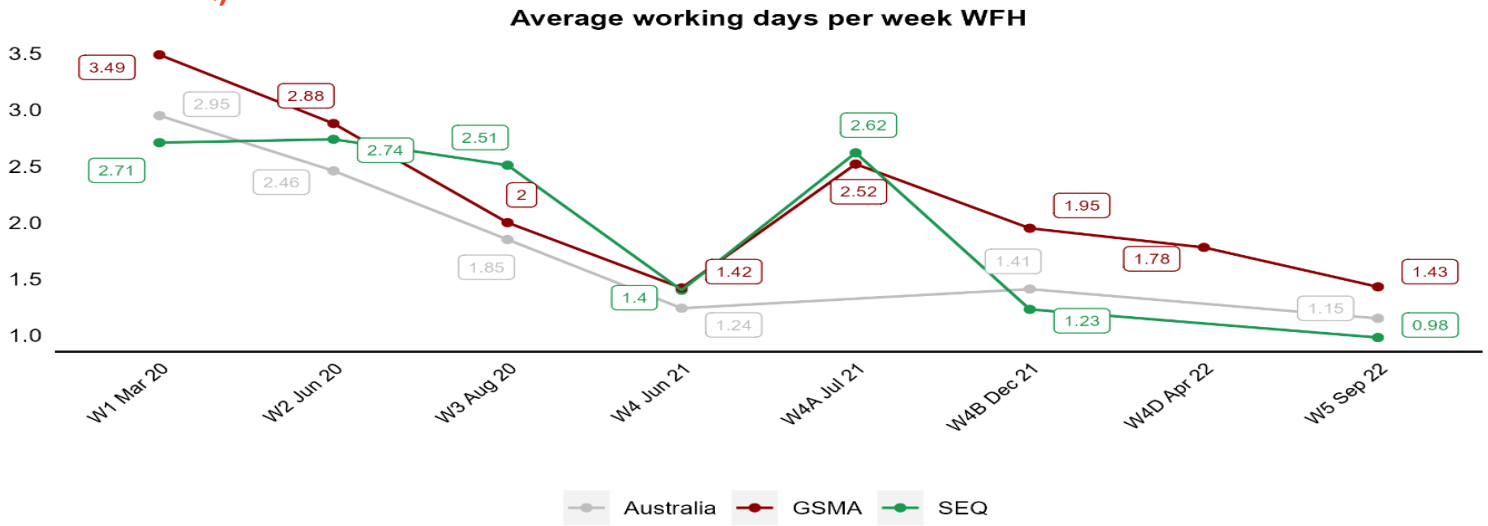
Globally: Highest in North America, UK and Australasia, then Europe, Latin America and South Africa, and then Asia (April-May 2023)



Source: Responses to the question "For each day last week, did you work 6 or more hours, and if so where?". Sample of N=42,426 workers in 34 countries surveyed in April-June 2023.

Source: "Working from home around the world" by Cevat Aksoy, Jose Barrero, Nick Bloom, Steve Davis, Mathias Dolls and Pablo Zarate. https://wfhresearch.com/gswadata/

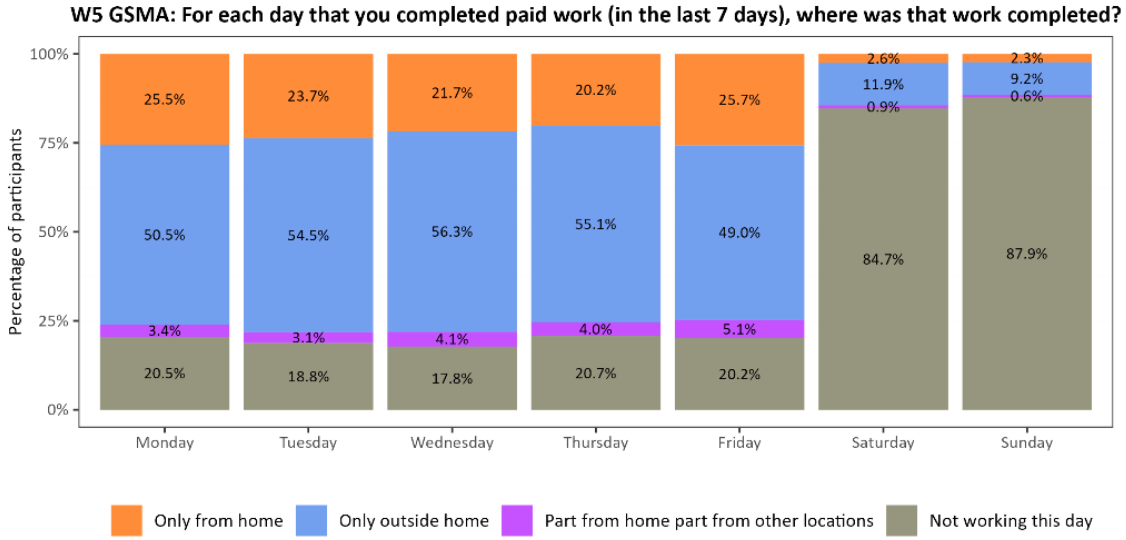
The number and proportion of working days that are working from home at some point (Mainly GSMA and SEQ)

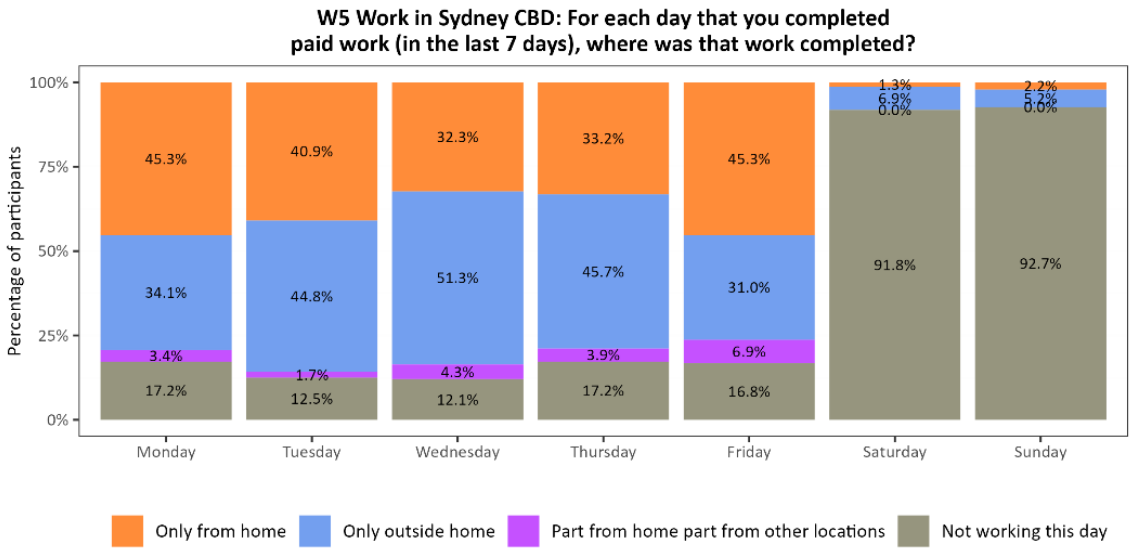


GSMA over 7 days as a weighted average is 1.04

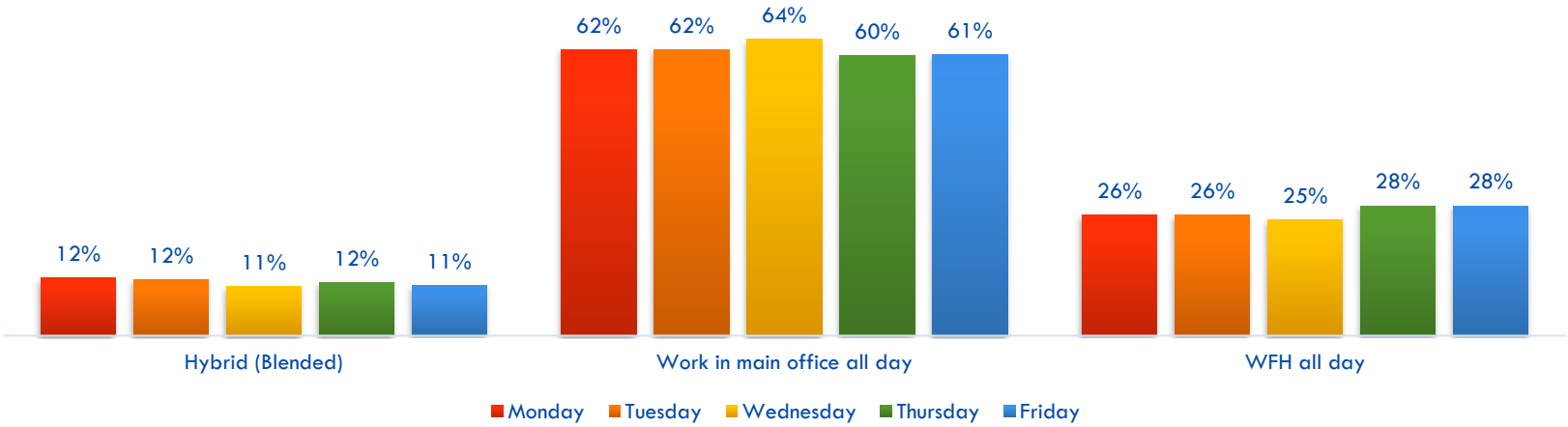
Aug-Sept 2022	GSMA	Rural NSW	Sydney CBD	SEQ	Rural QLD	BNE CBD
Average days worked	4.30 (1.34)	4.45 (1.53)	4.39 (1.32)	4.44 (1.23)	4.69 (1.24)	4.55 (1.30)
Weekdays	4.02 (1.42)	3.94 (1.43)	4.24 (1.37)	4.07 (1.31)	4.29 (1.19)	4.27 (1.29)
Weekends	0.27 (0.60)	0.50 (0.81)	0.16 (0.50)	0.37 (0.69)	0.40 (0.70)	0.28 (0.61)
Average days WFH at some point	1.43 (1.86)	0.82 (1.65)	2.20 (1.91)	0.98 (1.66)	0.86 (1.70)	1.62 (1.90)
Weekdays	**1.43 (1.82)**	**0.73 (1.47)**	**2.16 (1.87)**	**0.98 (1.57)**	**0.80 (1.57)**	**1.55 (1.84)**
Weekends	0.06 (0.32)	0.09 (0.37)	0.03 (0.23)	0.06 (0.31)	0.06 (0.32)	0.07 (0.32)
Average days WFH only	1.21 (1.76)	0.62 (1.49)	2.00 (1.90)	0.77 (1.44)	0.66 (1.54)	1.40 (1.75)
Weekdays	1.17 (1.72)	0.55 (1.33)	1.96 (1.86)	0.72 (1.39)	0.62 (1.41)	1.35 (1.73)
Weekends	0.05 (0.28)	0.06 (0.32)	0.03 (0.23)	0.05 (0.27)	0.04 (0.28)	0.06 (0.28)
Proportion of days WFH only	0.27 (0.38)	0.14 (0.31)	0.43 (0.39)	0.18 (0.32)	0.14 (0.31)	0.32 (0.38)
Weekdays	0.27 (0.38)	0.14 (0.31)	0.43 (0.39)	0.17 (0.32)	0.14 (0.31)	0.31 (0.38)
Weekends	0.03 (0.17)	0.04 (0.19)	0.02 (0.15)	0.03 (0.17)	0.03 (0.16)	0.04 (0.19)
Sample size	1135	232	231	874	270	163

Profile of Location of worked hours by DoW for GSMA & GSMA-CBD Wave 5 (Aug-Sep 2022)

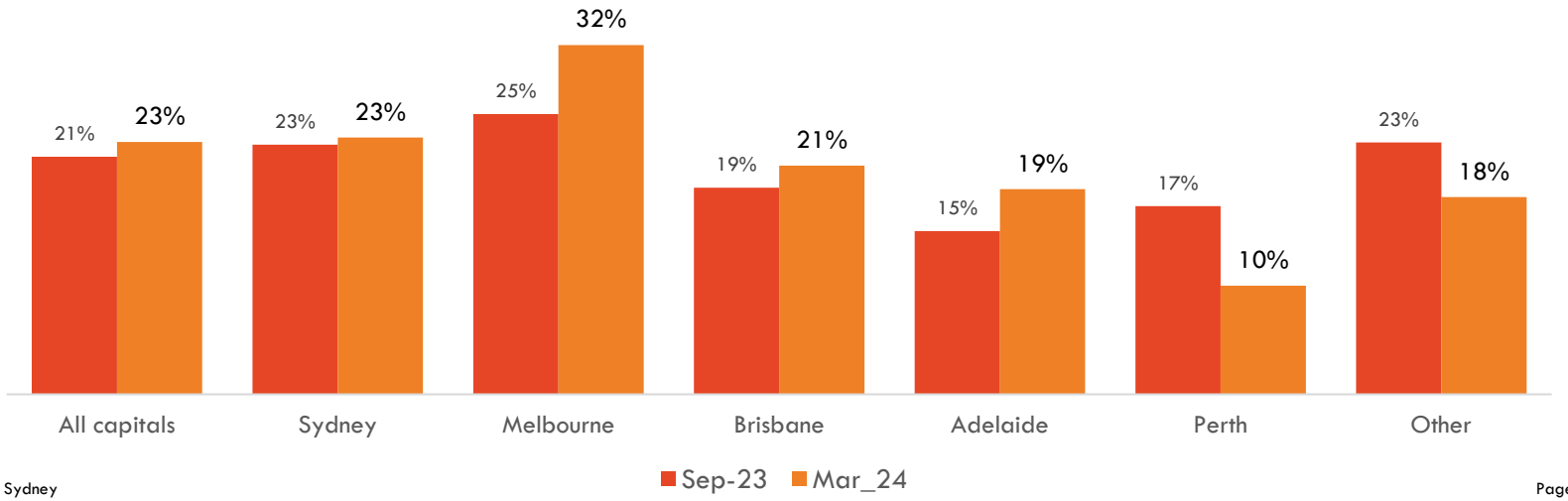




Moving on to March 2024: Composition of Work location by DoW: Office, Blended and WFH, Australia Wide

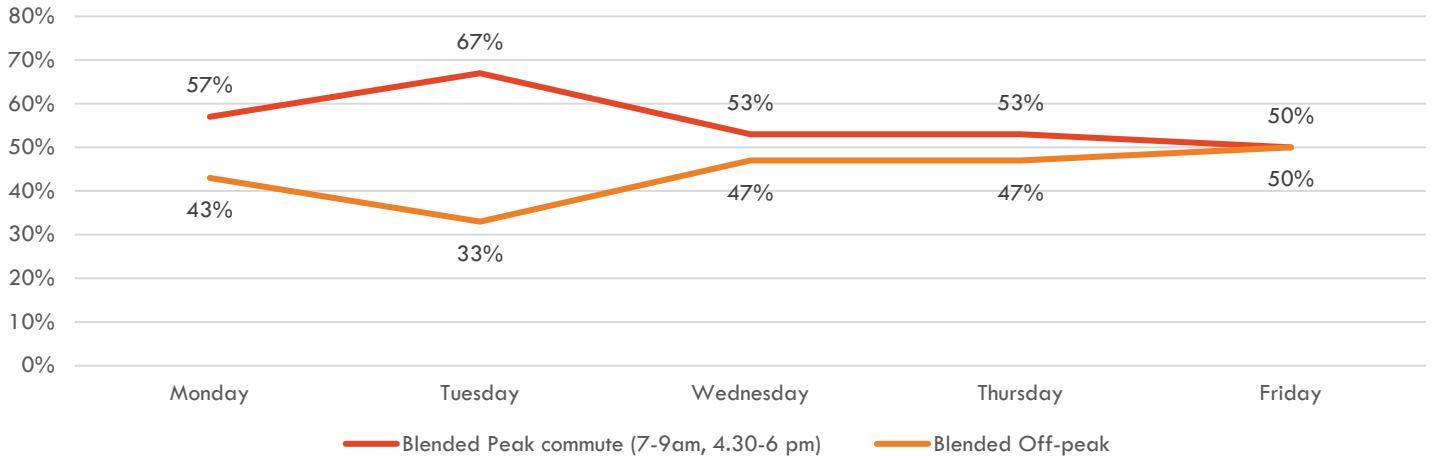


Average % of working time WFH - Capital Cities Sept 23 vs March 2024

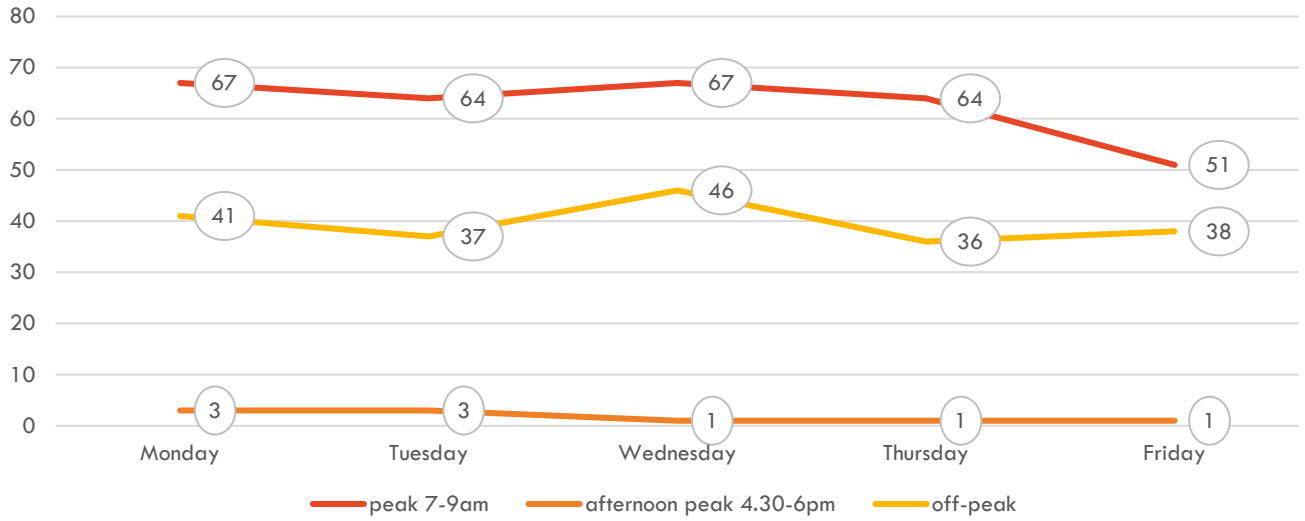


Time of Day Commuter Profile by Day of Week (All Modes)

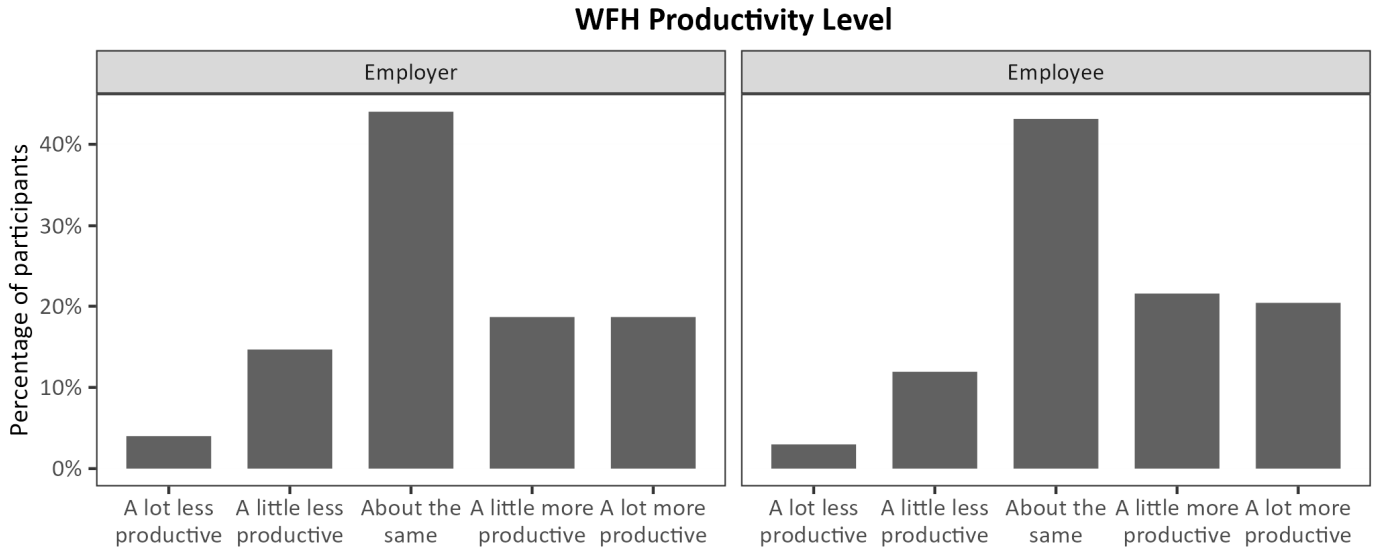
Time of Day Departure for Commuters who undertake Blended work locations in each DoW, **March 2024 GSMA**

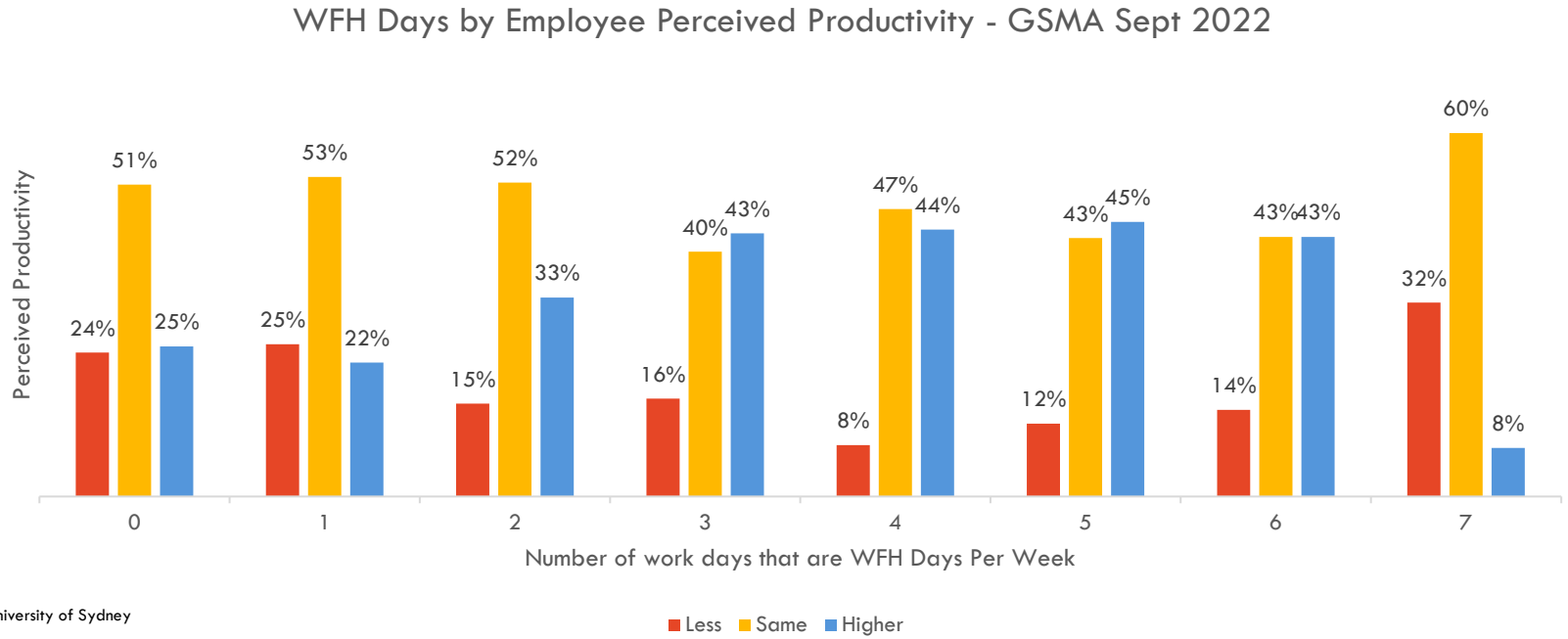


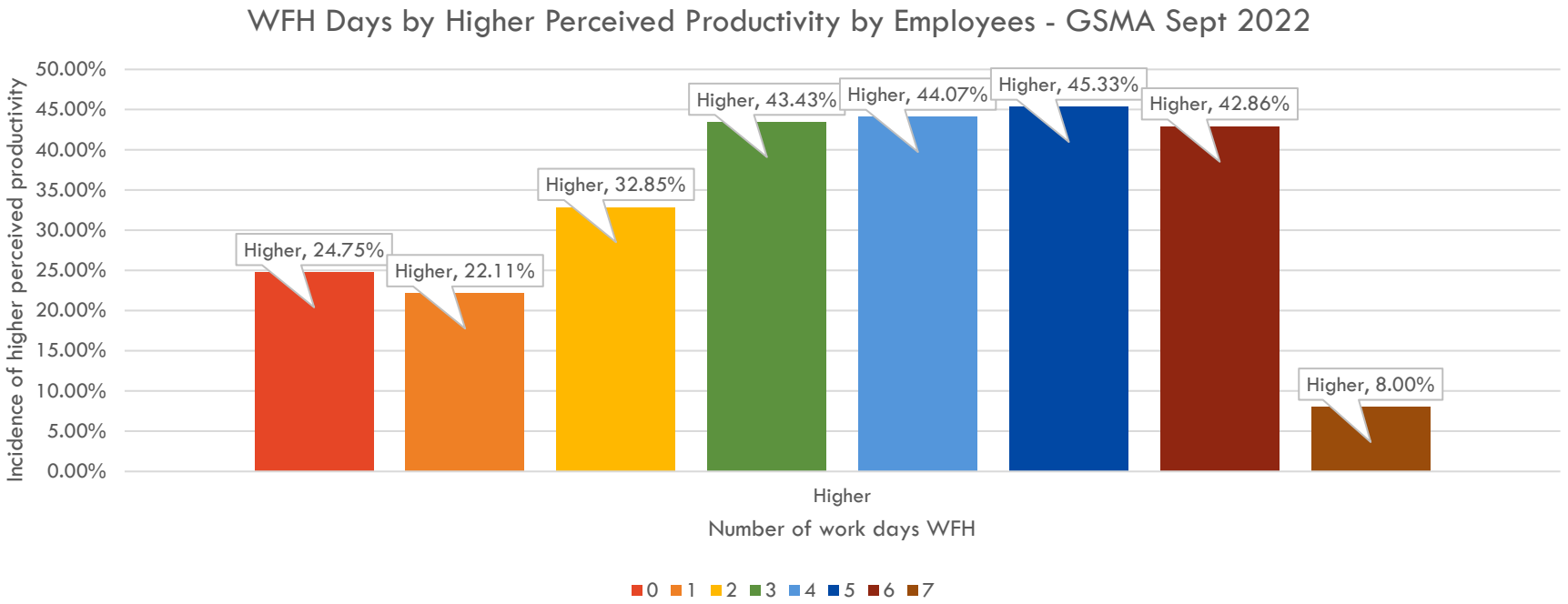
Commuting to work by **Public Transport** GSMA, March 2024 TOPS survey of ITLS: Time of day shares by Day of Week

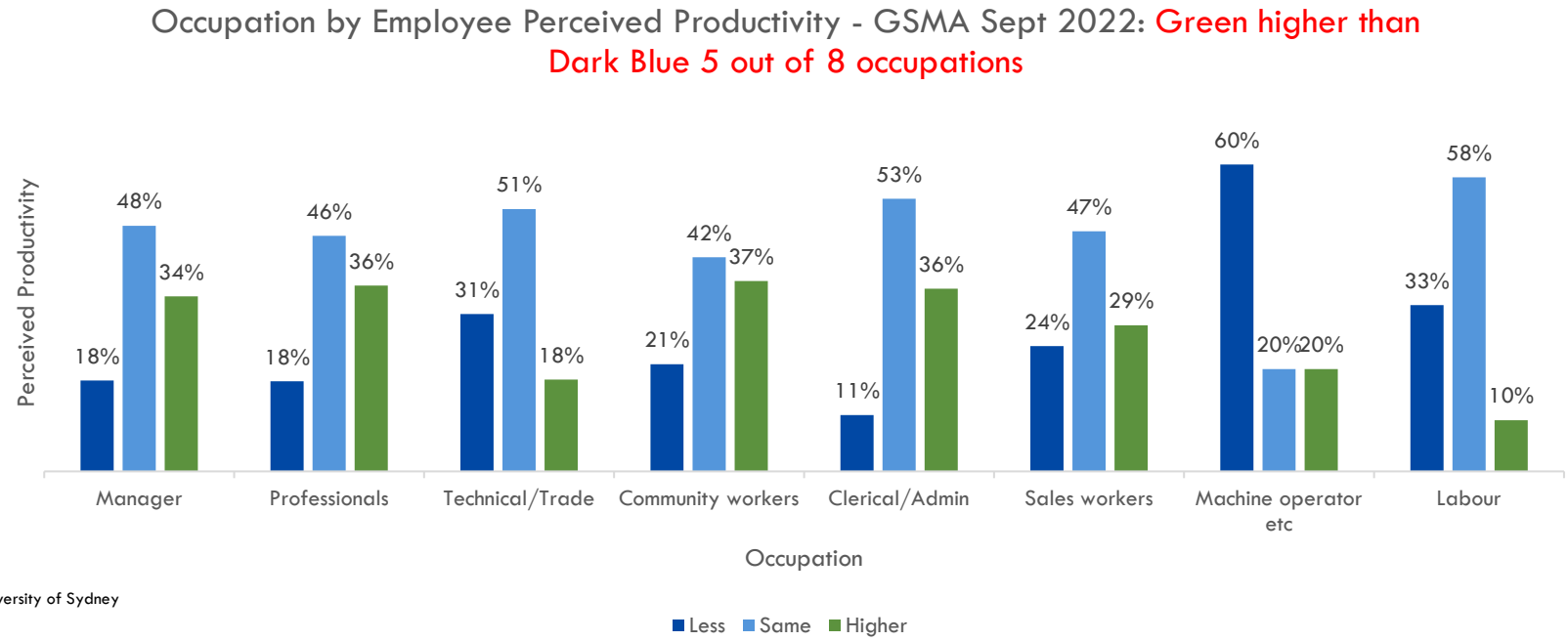


Productivity WFH – Employer and Employee Perceptions Wave 5 (Aug-Sep 2022)






WFH Days by Higher Perceived Productivity by Employees - GSMA Sept 2022
Incidence of higher perceived productivity
50.00%
45.00%
40.00%
35.00%
30.00%
25.00%
20.00%
15.00%
10.00%
5.00%
0.00%
Higher, 24.75%
Higher, 22.11%
Higher, 32.85%
Higher, 43.43%
Higher, 44.07%
Higher, 45.33%
Higher, 42.86%
Higher, 8.00%
Higher
Number of work days WFH
0 1 2 3 4 5 6 7


Occupation by Employee Perceived Productivity - GSMA Sept 2022: Green higher than Dark Blue 5 out of 8 occupations
Perceived Productivity
18%
48%
34%
18%
46%
36%
31%
51%
18%
21%
42%
37%
11%
53%
36%
24%
47%
29%
60%
20%
20%
33%
58%
10%
Manager
Professionals
Technical/Trade
Community workers
Clerical/Admin
Sales workers
Machine operator etc
Labour
Occupation
Less Same Higher

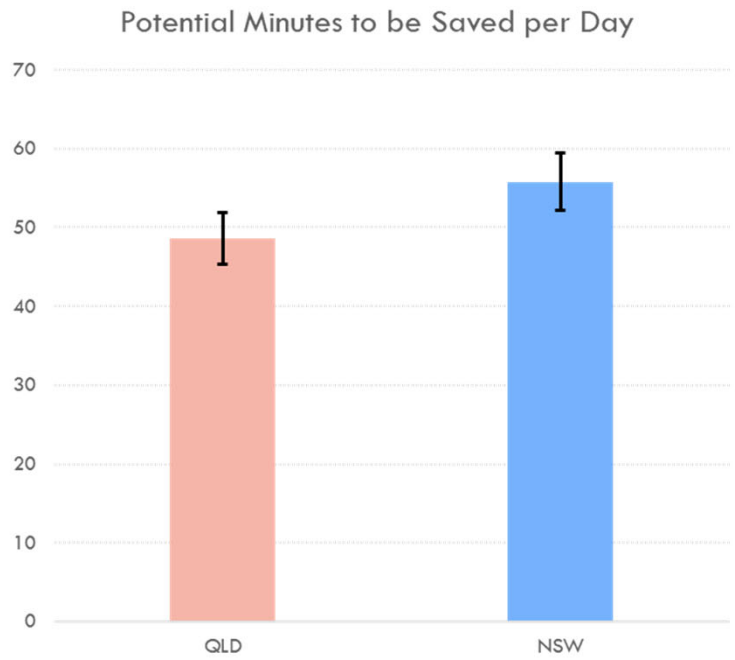
Productivity Boost - USA

- The productivity boost came from two sources (USA evidence).
  - First, remote employees worked 9 percent more in minutes per day. They were rarely late to work, spent less time gossiping and chatting with colleagues, and took shorter lunch breaks and fewer sick days.
  - Remote employees also had 4 percent more output per minute. They told us it's quieter at home. The office was so noisy many of them struggled to concentrate.
- The macro evidence also suggests, or at least is consistent with, work from home working:
- In the five years before the pandemic, U.S. labor productivity growth was 1.2 percent; since 2020, this picked up to 1.5 percent. Given the state of the world, that acceleration was miraculous.
- **Ref:** Working from Home Around the Globe: 2023 Report, Cevat Giray Aksoy, Jose Maria Barrero, Nicholas Bloom, Steven J. Davis, Mathias Dolls and Pablo Zarate

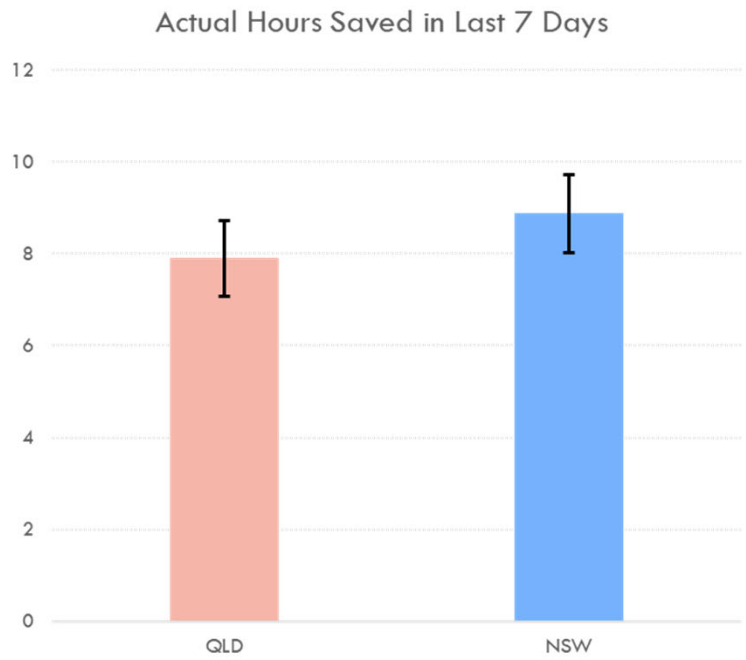
Time Saving and Reallocation due to WFH in Australia

In QLD respondents saved an average of 7.9 hours in the last week by not commuting, those in NSW saved an average of 8.9 hours. In QLD there is an average of 100 extra minutes per week being spent on additional unpaid work, 120 minutes on household tasks, and 100 minutes reallocated to home-based leisure activities. It is roughly the same in NSW.

- **Potential minutes** saved per day by not commuting and WFH

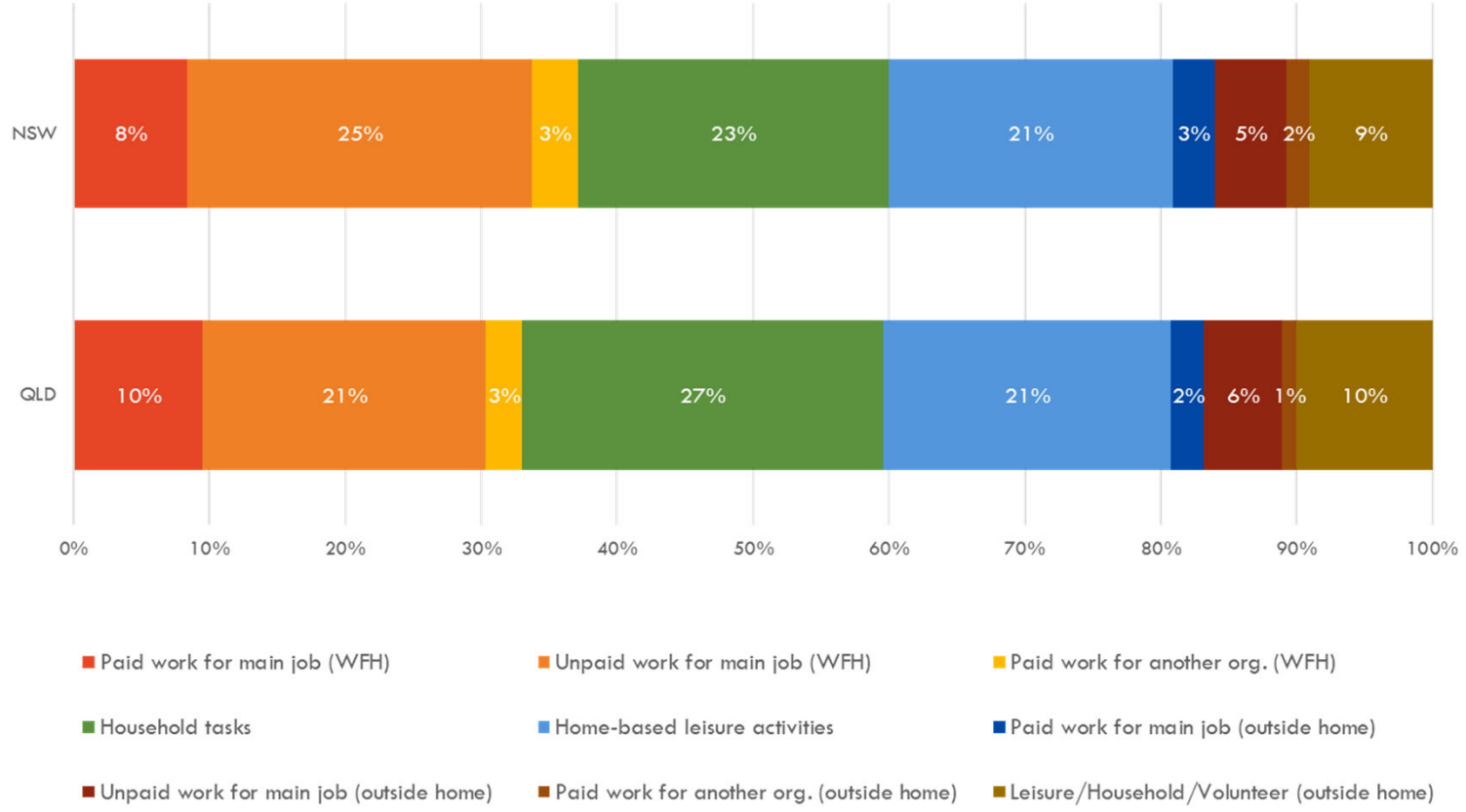


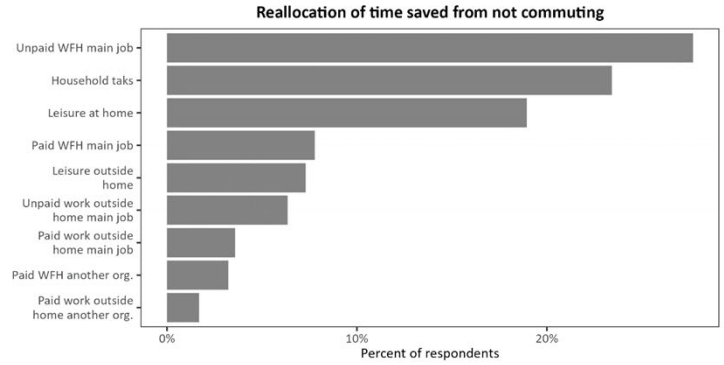
- **Actual hours** saved in the last 7 days by WFH and not commuting



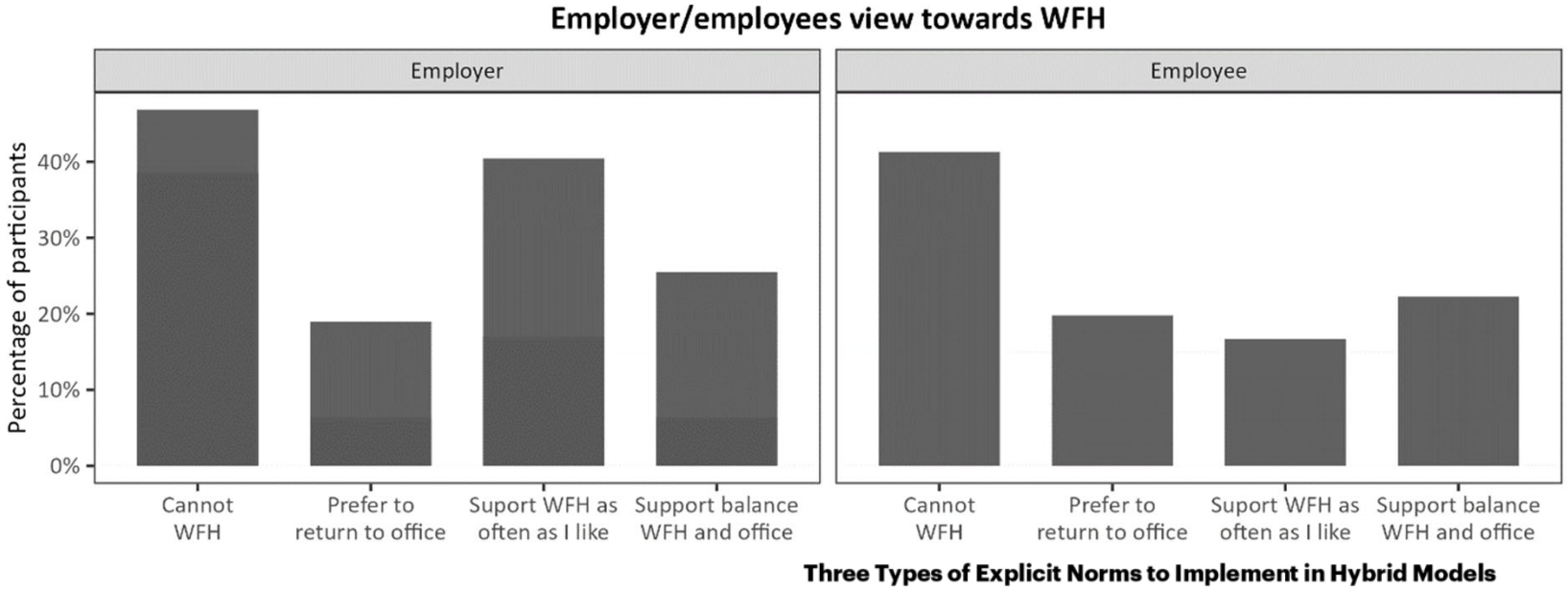
Hensher, D.A., Beck, M. and Balbontin, C. (2022) Time allocation of reduced commuting time during COVID-19 under working from home, *Journal of Transport Economics and Policy (#4013)*, 56 (4), October, 399-428.

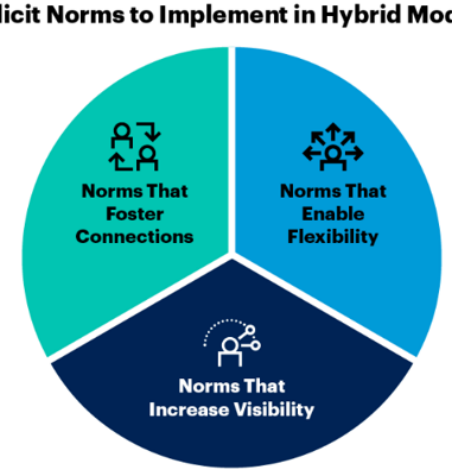
Reallocation of Saved Time NSW and QLD (~20% is outside home) Reallocation of Saved Time NSW and QLD (~20% is outside home): September 2022





Wave 5: GSMA September 2022 Employer and employee views on WFH
(Support WFH as often as like big difference ER and EE)

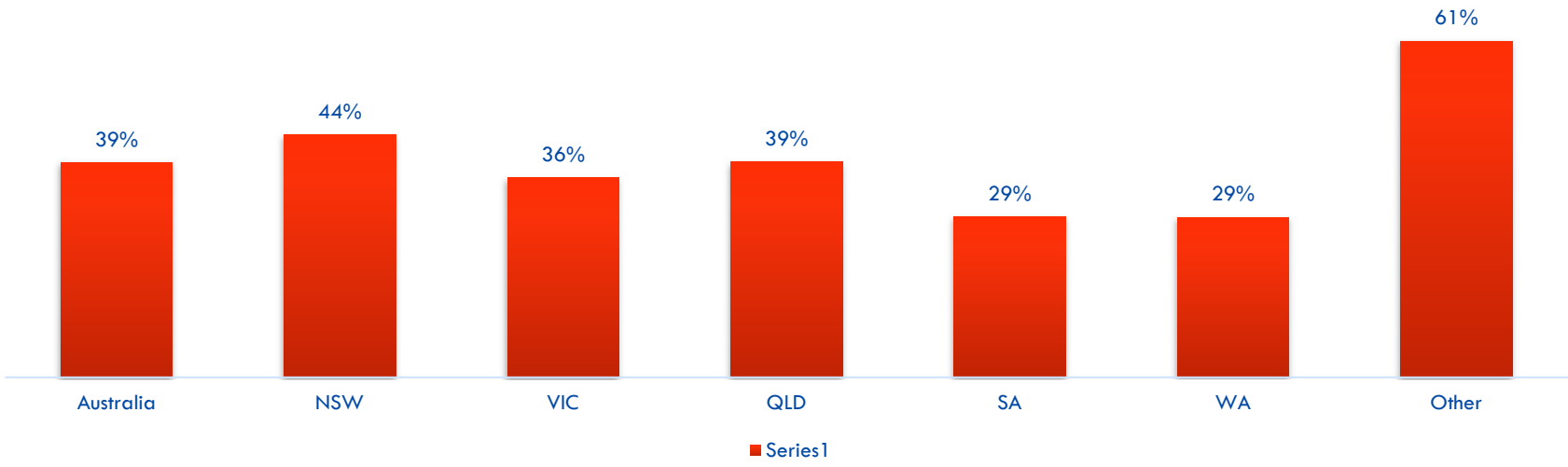




Frequent remote workdays and meeting-free days have emerged as hybrid work norms that contribute to improved employee productivity and performance.

https://www.gartner.com/en/newsroom/press-releases/04-17-23-gartner-says-employees-are-twelve-percent-more-likely-to-leave-their-workplaces-if-employers-dont-establish-explicit-hybrid-work-norms

Employer stipulated that workers must return to the office a particular number of days each week? March 2024



Relationship between Office Space Capacity, Working from Home and Remote Working at a Satellite Office: Pre-COVID, now (April 2022) and 2023

A survey undertaken in April 2022 for the Greater Sydney Metropolitan Area (GSMA)
Survey 4D (focus on the Firm)
459 organisations

Hensher, D.A., Wei, E. and Beck, M.J. (2022) The Impact of COVID-19 and working from home on the main location office space retained and the future use of satellite offices *Transport Policy*, 130, 184-195. Paper #30.

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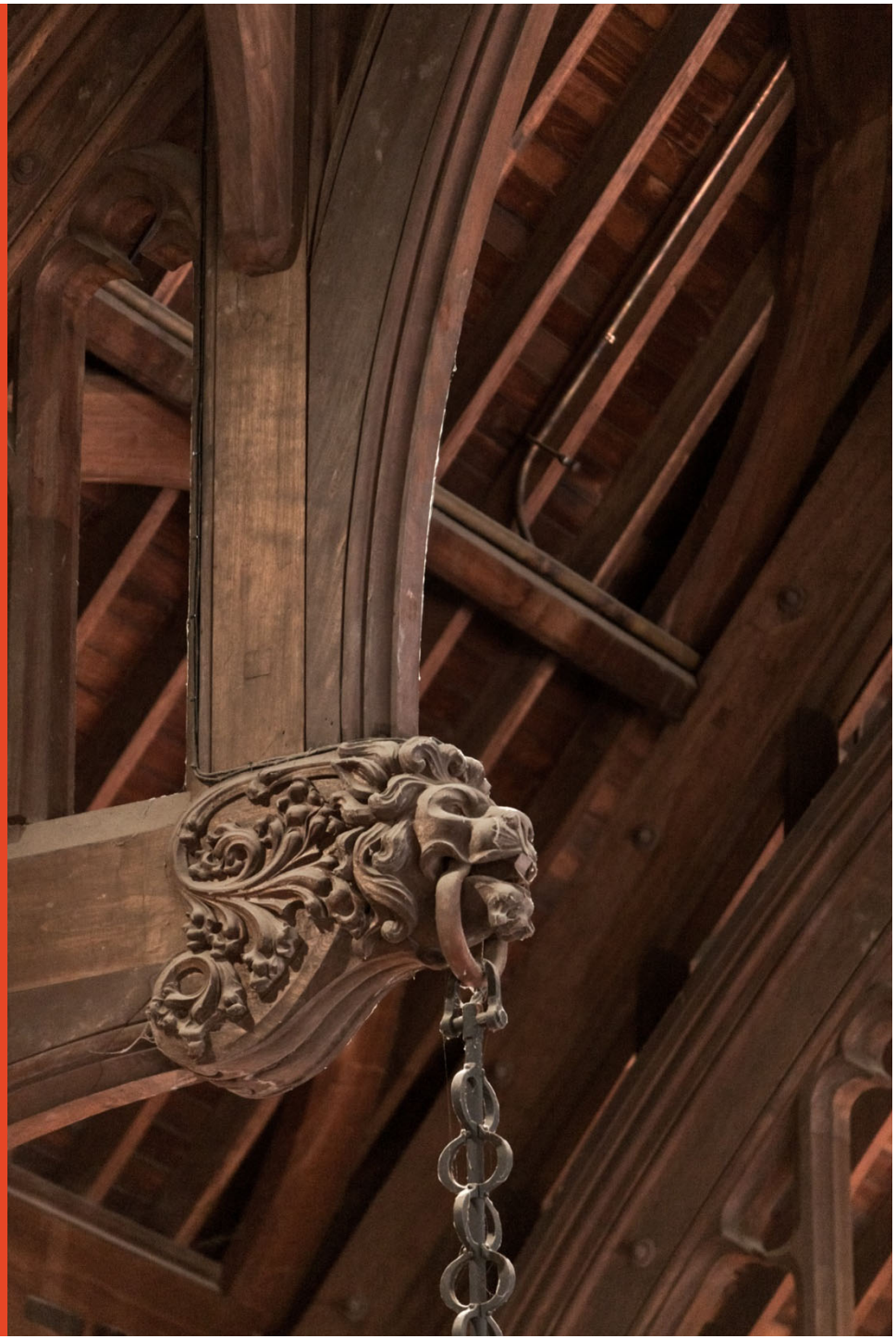
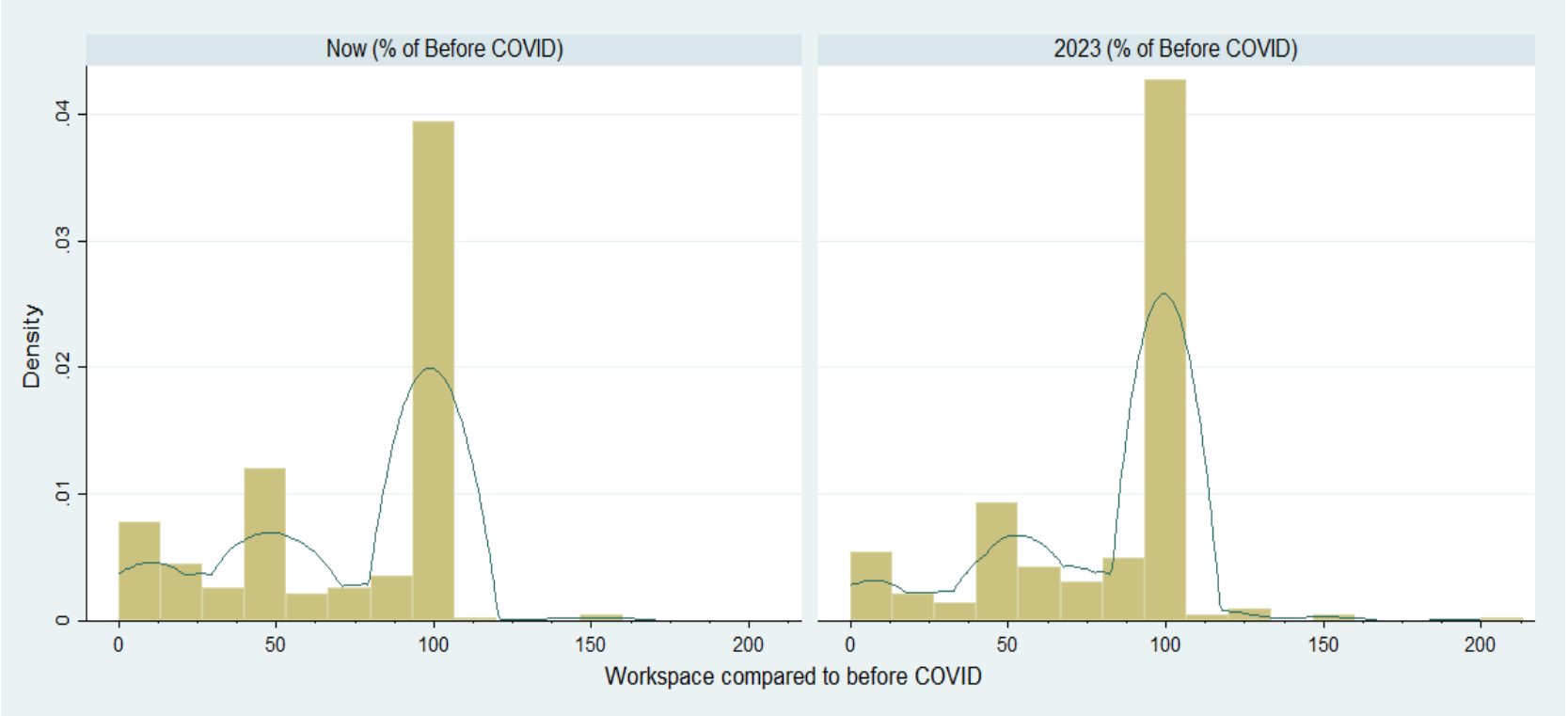
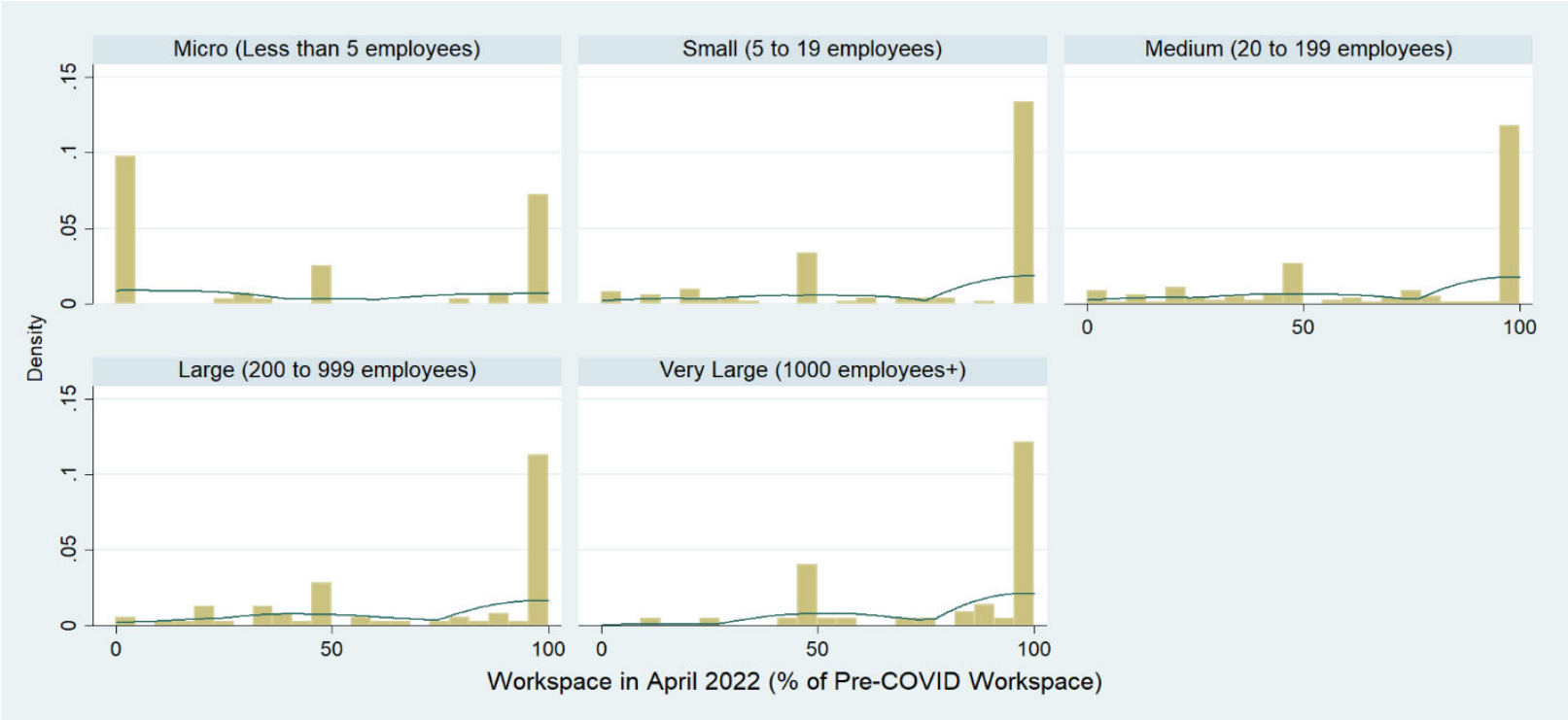


Percentage of Work-Space (relative to Pre-COVID) in April 2022 and Sept 2023 (100% is no change): GSMA



Y axis: probability density is the probability per unit on the x-axis;
X axis is the number of firms

The distribution of main location office space in 2022 compared to Pre-COVID-19 by organisation size: GSMA (459 organisations)
Note: 100% means same as pre-COVID-19



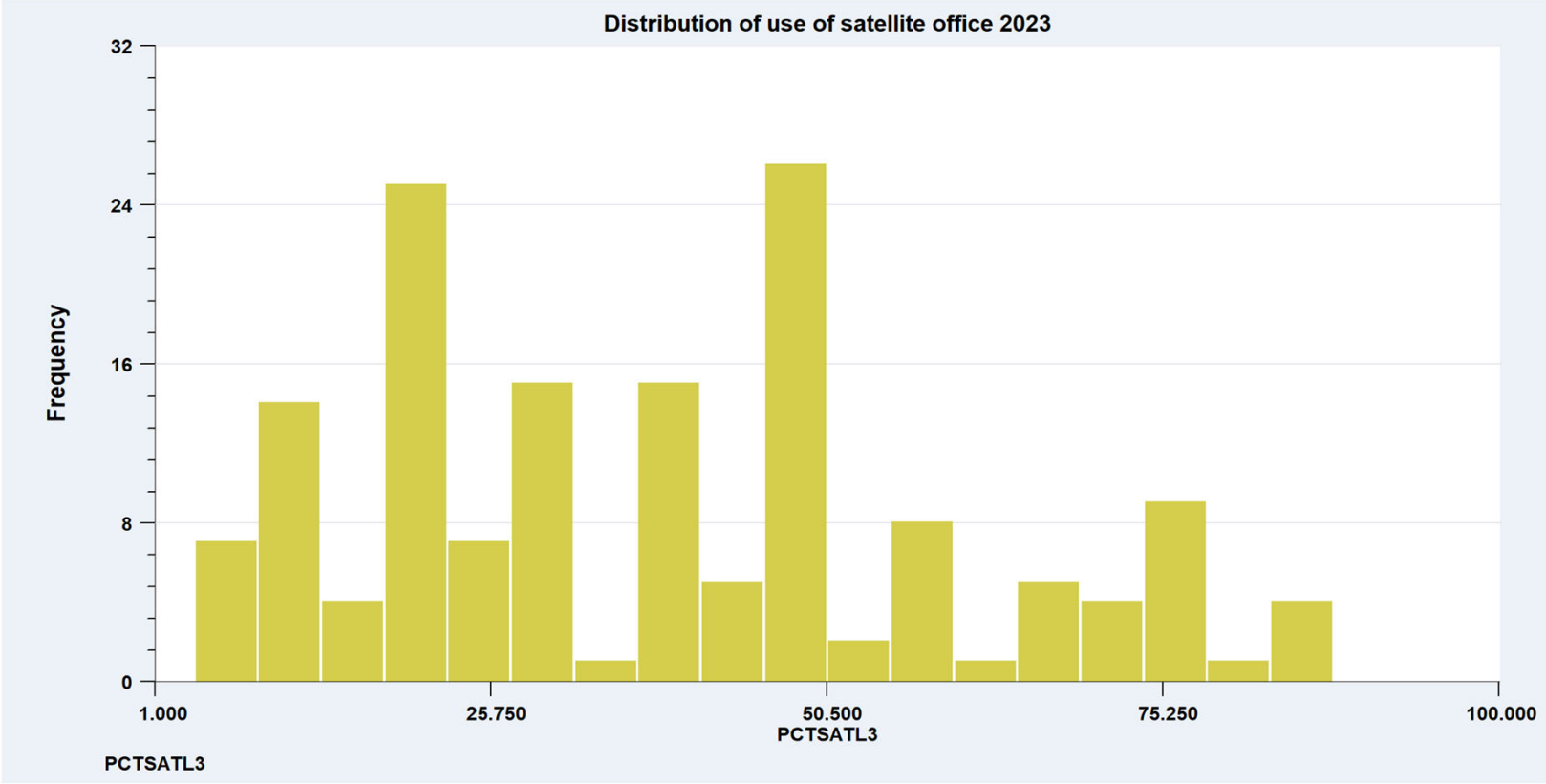
Y axis: probability density is the probability per unit on the x-axis; X axis is the number of firms

Some Key Descriptive Statistics: 459 organisations in GSMA, April 2022 and Sept 2023. Note workspace change (72%-80% cf. pre-COVID-19)

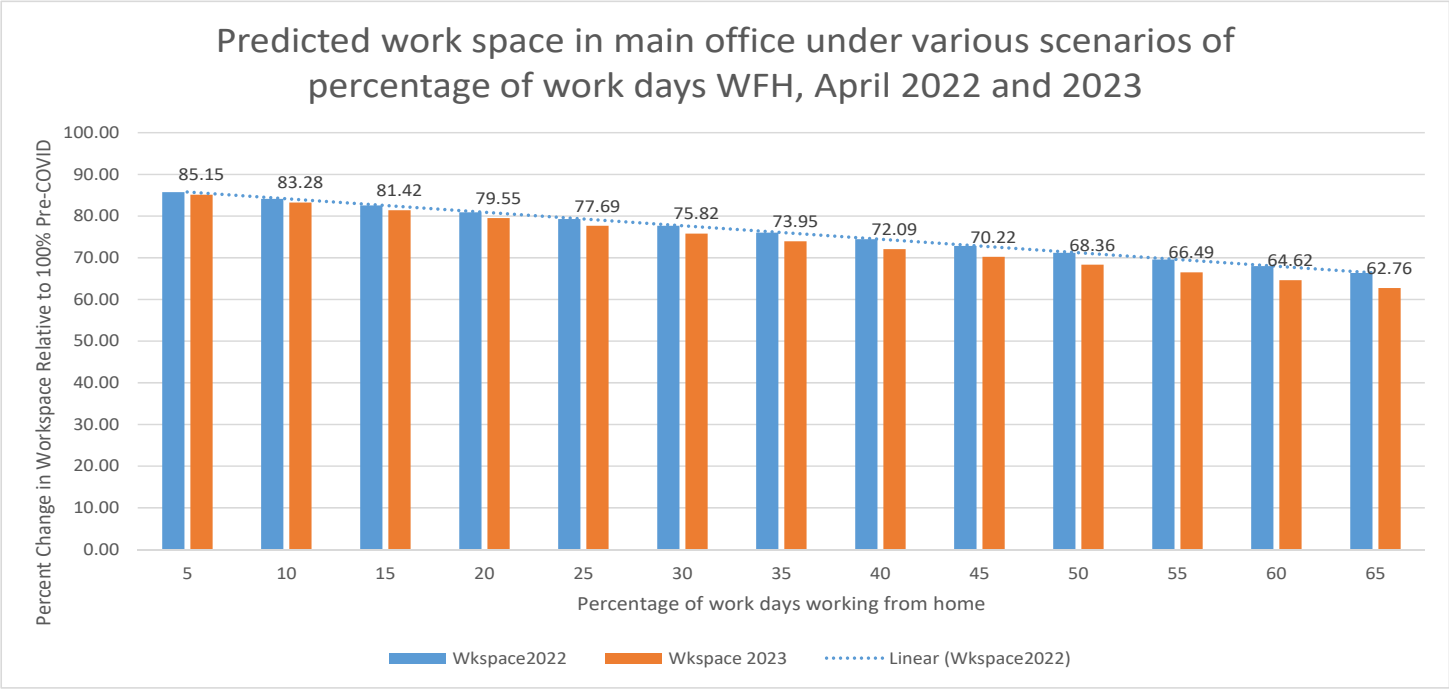
Before COVID	Mean	STD	Median	Min	Max
Number of working days	4.4	1.3	5	0	7
WFH Proportion (to some extent)	20.5	32.5	0	0	100
Employer supported WFH days	1.3	1.7	1	0	5
Employee Numbers	847	4081	50	0	50000
Commuting time in minute	35	25	30	0	180
April 2022	Mean	STD	Median	Min	Max
Number of working days	4.1	1.4	5	0	7
WFH Proportion (1-2 days per week)	35.5	37.5	20	0	100
Employer supported WFH days	2.8	1.4	3	0	5
Employee Numbers	711	3654	50	0	45000
Workspace (cf 100% pre-COVID)	72	36	100	0	150
Commuting time in minute	31	23	30	0	150
In Sept 2023	Mean	STD	Median	Min	Max
Number of working days	4.1	1.4	5	0	7
WFH Proportion	35.2	35.7	25	0	100
Employer supported WFH days	2.5	1.5	2	0	5
Employee Numbers	728	3643	50	0	45000
Workspace (cf 100% pre-COVID)	80	32	100	0	200
Commuting time in minute	31	23	30	0	150

Satellite Office Impact (distributed spatial work): GSMA.

34.72% of the sampled organisations (Figure below) indicated that they will use satellite offices to some extent, which represents an average 14.34% of staff in the future working in a satellite office or, on average one in 6.7.



The expected influence of WFH levels on required office space in the main location in April 2022 and 2023: GSMA Scenario Analysis



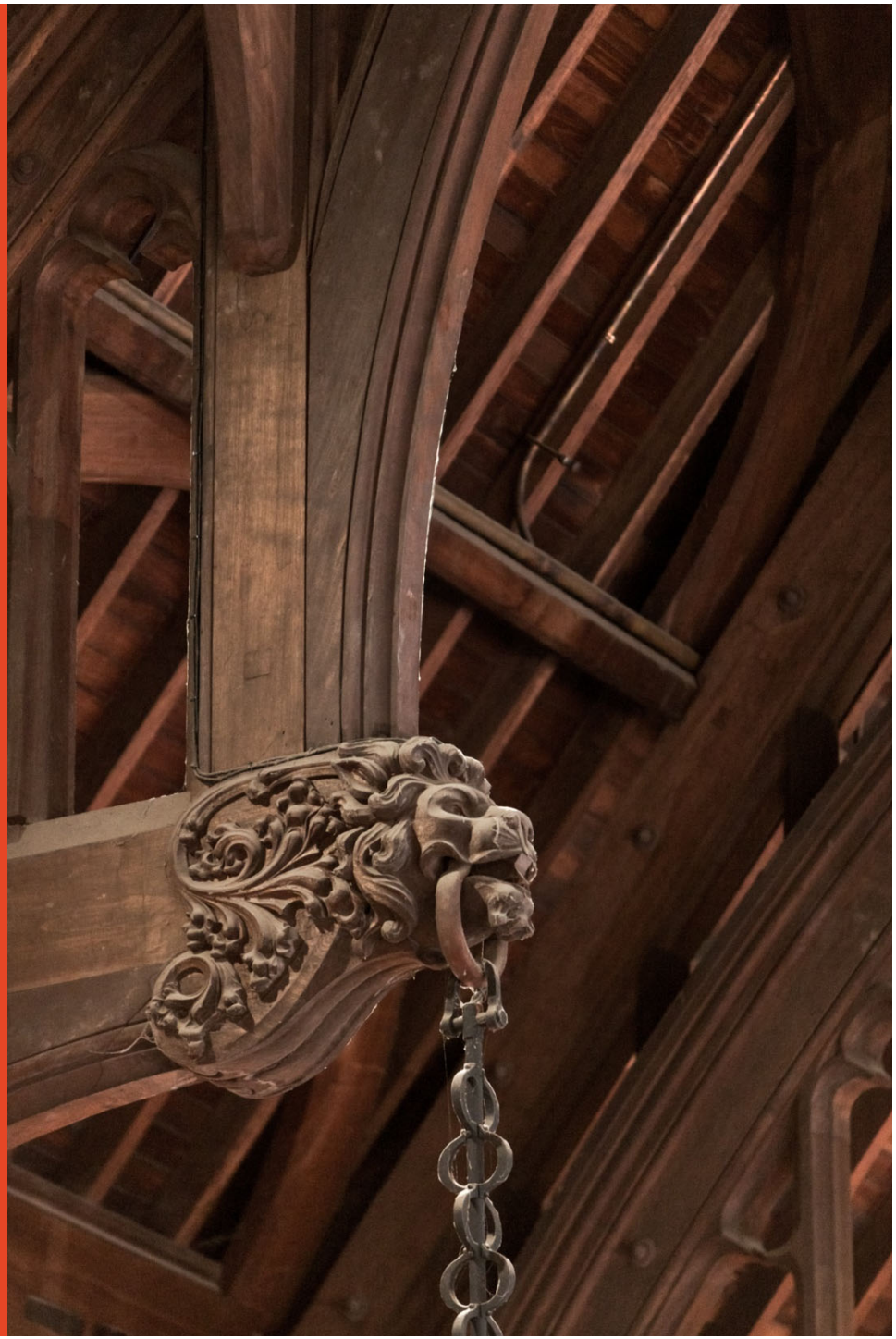
If we work with what appears to be the most likely scenario of one to two days WFH per week for many occupations:

Our model predicts a reduction in the percentage of office space compared to pre-COVID-19 to 79.6% for an average of one day WFH and 72.1% for an average of two days WFH.

The decline of 20% to 28% in 2023 relates reasonably well to an occupancy rate in 2022 of 18% for the Sydney metropolitan area.

The Modelling Approach and Wave 5: GSMA

"What Modelling does is give you good direction and good vision."
Premier of NSW, 6 September 2021



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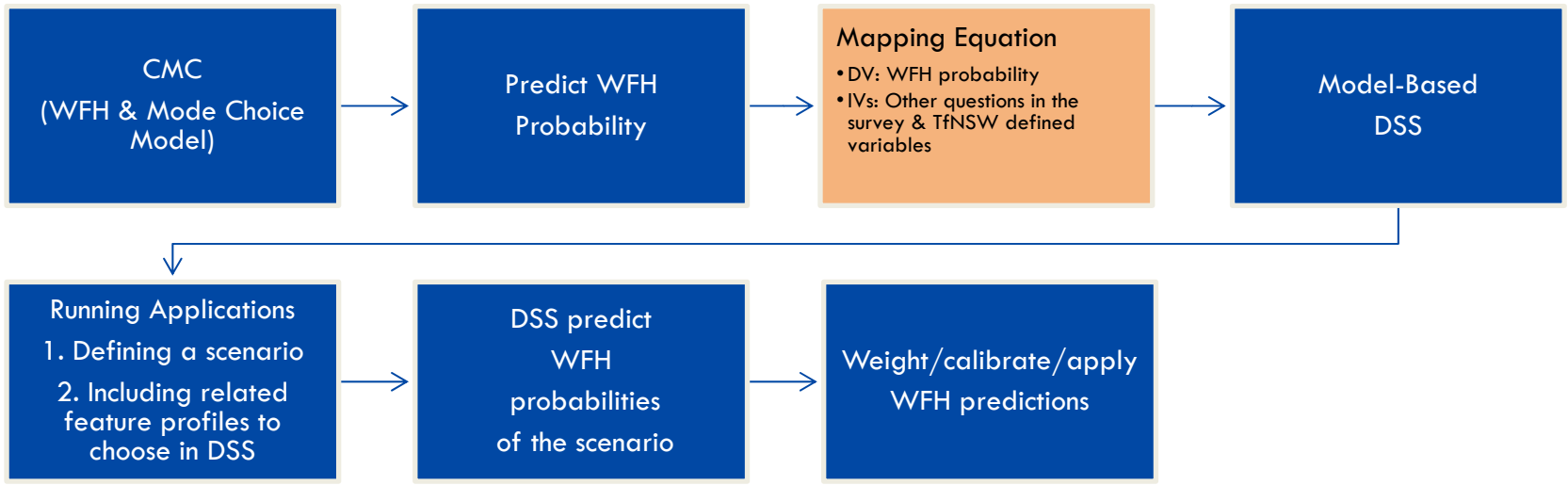
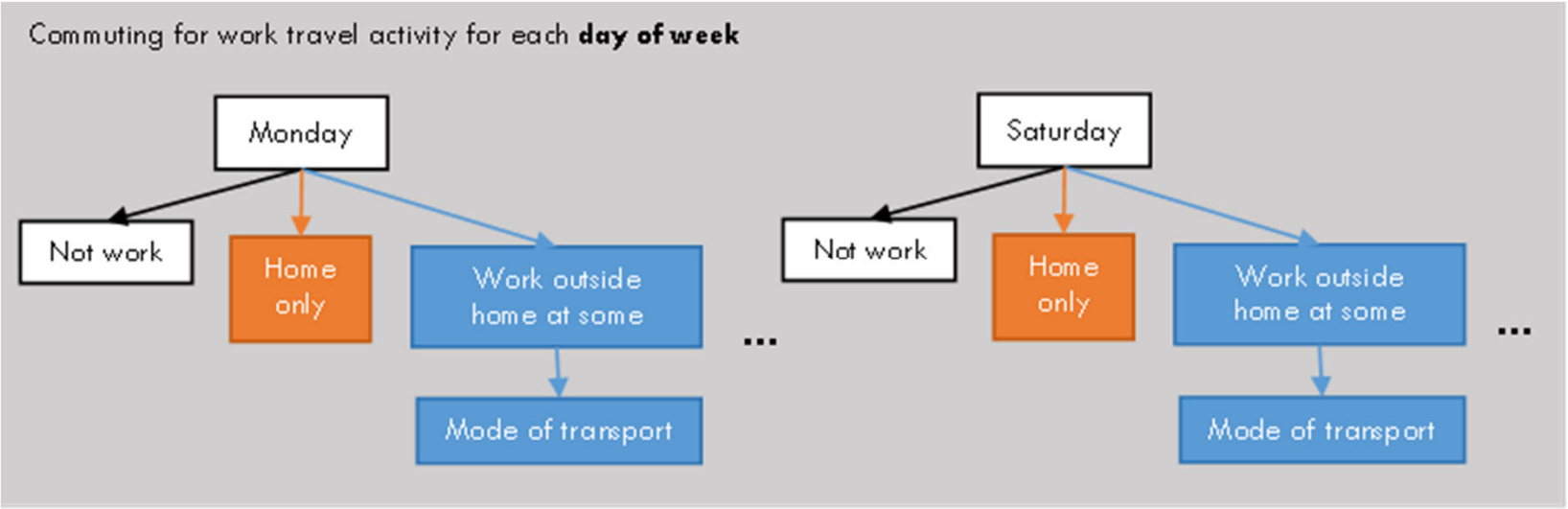
ITLS Models & DSS and Data & Statistics



METHODOLOGY: Wave 5



Monday - Sunday	
Altij	Description
1	Not work
2	Work from home only
3	Work outside home - car driver
4	Work outside home - car passenger
5	Work outside home - taxi/rideshare
6	Work outside home - train
7	Work outside home - bus
8	Work outside home - light rail
9	Work outside home - ferry
10	Work outside home - walk
11	Work outside home - bicycle
12	Work outside home - motorcycle

Utility Exprressions

$$U_{NoWork} = ASC_{NoWork} + \sum_{n} \beta_{NoWork,n} \cdot z_n$$

$$U_{WFH} = ASC_{WFH} + \sum_{n} \beta_{WFH,n} \cdot z_n + \sum_{n} \beta_{WFH,d} \cdot day_d$$

$$U^{PT}_{Mode_m} = ASC_{Mode_m} + \beta_{Mode_m,TT} \cdot TT_{Mode_m} + \beta_{Mode_m,Cost} \cdot Fare_{Mode_m} + \beta_{Mode_m,AEWT} \cdot \left(AcT_{Mode_m} + EgT_{Mode_m} + WT_{Mode_m} \right)$$

$$U^{Car/moto}_{Mode_m} = ASC_{Mode_m} + \beta_{Mode_m,TT} \cdot TT_{Mode_m} + \beta_{Mode_m,Cost} \cdot \left(Fuel_{Mode_m} + Park_{Mode_m} + Toll_{Mode_m} \right) + \sum_{n} \beta_{Mode_m,n} \cdot z_n + \beta_{WFH,Dist} \cdot Dist_{Home-work}$$

$$U^{Active}_{Mode_m} = ASC_{Mode_m} + \beta_{Mode_m,TT} \cdot TT_{Mode_m}$$

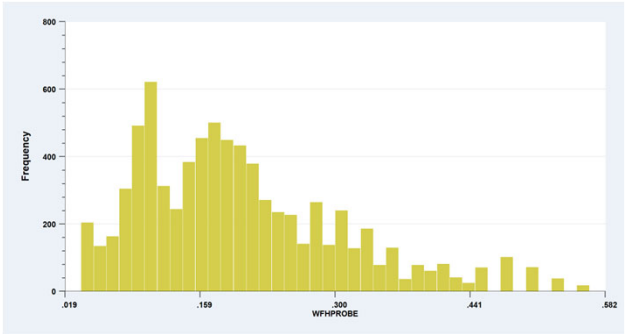
Wave 5 (Aug-Sep 2022) GSMA

```
Random Parameters Multinom. Logit Model
Dependent variable                CHOICE12
Log likelihood function       -8324.05148
Restricted log likelihood    -19168.56990
Chi squared [ 20](P= .000)    21689.03684
Significance level                .00000
McFadden Pseudo R-squared       .5657448
Estimation based on N =    7714, K =  20
Inf.Cr.AIC  =   16688.1 AIC/N =    2.163
---------------------------------------
            Log likelihood R-sqrd R2Adj
No coefficients **********   .5657 .5653
At start values -8328.3718   .0005-.0004
Note: R-sqrd = 1 - logL/Logl(constants)
---------------------------------------
Response data are given as ind. choices
Replications for simulated probs. = 100
Used Halton sequences in simulations.
Number of obs.=  7714, skipped    0 obs
```

Monday - Sunday	
Alti j	Description
1	Not work
2	Work from home only
3	Work outside home - car driver
4	Work outside home - car passenger
5	Work outside home - taxi/rideshare
6	Work outside home - train
7	Work outside home - bus
8	Work outside home - light rail
9	Work outside home - ferry
10	Work outside home - walk
11	Work outside home - bicycle
12	Work outside home - motorcycle

VOT:$21.22/person Hr

CHOICE12	Coefficient	Standard Error	z	Prob. |z|>Z*	95% Confidence Interval	
|Random parameters in utility functions.....						
All mode alts except walk and bicycle:						
BTT	-.00940**	.00368	-2.55	.0107	-.01662	-.00218 Travel time (mins
CD and CP alt:						
BDISTC	.00983***	.00356	2.76	.0058	.00285	.01681 Distance (km)
All modes except CP, Walk, Bicycle:						
BCST	-.02658***	.00550	-4.84	.0000	-.03735	-.01581 Travel cost ($)
|Nonrandom parameters in utility functions.....						
No Work Alt:						
BAGENW	.02540***	.00112	22.70	.0000	.02320	.02759 Age (years)
WFH alt:						
BBLCOWK	-1.20109***	.14041	-8.55	.0000	-1.47628	-.92590 Blue collar (1,0)
BDMON	.90010***	.08617	10.45	.0000	.73121	1.06898 Monday (1,0)
BDTUES	.77406***	.08781	8.81	.0000	.60195	.94617 Tuesday (1,0)
BDTHUR	.54462***	.09109	5.98	.0000	.36608	.72315 Thursday (1,0)
BFRI	.90306***	.08591	10.51	.0000	.73468	1.07144 Friday (1,0)
CD and motorbike alt:						
BASCCD	.53595***	.12943	4.14	.0000	.28228	.78963 CDASC
CD alt:						
BPINCCD	.00036	.00057	.64	.5222	-.00075	.00148 Pers inc pa /1000
BHCARS	.00375	.04852	.08	.9384	-.09136	.09885 # cars in hhld
BPCVDRVC	1.46657***	.08940	16.41	.0000	1.29136	1.64179 Drive pre COVID(1,0)
CP alt:						
BASCP	-.76123***	.12926	-5.89	.0000	-1.01458	-.50788 CPASC
Ride Share alt:						
BASCRSH	-1.22087***	.26739	-4.57	.0000	-1.74494	-.69681 RSASC
PT mode alts:						
BASCPT	1.23916***	.14063	8.81	.0000	.96354	1.51478 PTASC
BAEW	-.01081***	.00239	-4.51	.0000	-.01550	-.00612 Access-egress time
Walk and Bicycle alts:						
BASCWKBK	1.11419***	.16448	6.77	.0000	.79181	1.43657 Walk-Bike ASC
Walk alt:						
BTTWK	-.00820	.00509	-1.61	.1070	-.01816	.00177 Walk time (mins)
Bicycle alt:						
BTTBK	-.03174***	.00902	-3.52	.0004	-.04942	-.01406 Bicycle time (mins
|Distns. of RPs. Std.Devs or limits of triangular.....						
NsBTT	.00940**	.00368	2.55	.0107	.00218	.01662
TsBDISTC	.00983***	.00356	2.76	.0058	.00285	.01681
NsBCST	.02658***	.00550	4.84	.0000	.01581	.03735



Wave 5 Option 6: Interact Jobs per square km/1000 and Strategic Centres Dummy variables so Strategic centre specific Jobs per square km/1000 and no stand-alone Strategic centres Only Plus have a stand-alone jobs per square km/1000 for only non-strategic Centres

Comment: If you use this, we have a var for jobs per square km/1000 for new strategic centres or any other location.

Mapping equation between the probability of WFH vs commuting and statistical influences. Constrained (0,1) Tobit Model: probability WFH.

Variable	Mean (t-value)
Constant	0.093 (27.65)
Age (years)	-0.002 (46.41)
Cars per adult in household	-0.033 (10.98)
Number of people living in household	-0.002 (4.06)
Occupation manager (1,0)	0.113 (49.72)
Occupation professional (1,0)	0.117 (55.09)
Occupation clerical and administration (1,0)	0.111 (50.34)
Occupation sales (1,0)	0.124 (48.19)
Occupation community and personal services (1,0)	0.119 (43.90)
Occupation labourer (1,0)	0.010 (3.46)
Chose PT for commute (1,0)	0.012 (10.03)
Distance from home to work (kms)	0.001 (19.08)
Located in Newcastle (1,0)	-0.022 (11.39)
Located in Illawarra (1,0)	-0.015 (6.77)
Located in Central Coast (1,0)	-0.028 (14.14)
Monday (1,0)	0.118 (64.85)
Tuesday (1,0)	0.097 (57.67)
Thursday (1,0)	0.063 (42.48)
Friday (1,0)	0.118 (65.08)

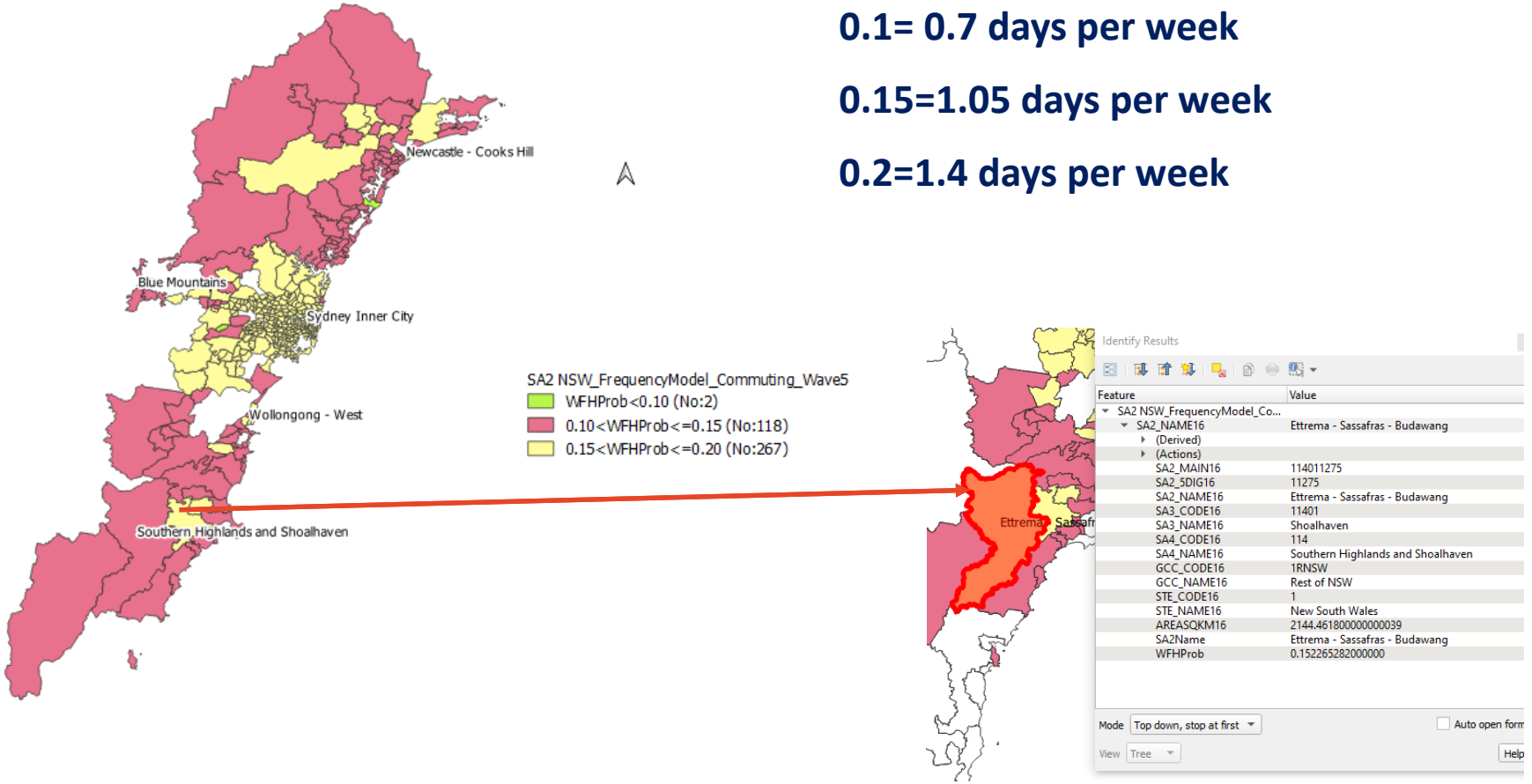
$$R^2_{DECOMPOSITION} = \frac{\frac{1}{n}\sum_{i=1}^{n}\left(\hat{y}_i - \bar{y}\right)^2}{\frac{1}{n}\sum_{i=1}^{n}\left(\hat{y}_i - \bar{y}\right)^2 + \frac{1}{n}\sum_{i=1}^{n}\left(y_i - \hat{y}_i\right)^2}$$

$$= \frac{\text{Variation of predicted mean}}{\text{Variation of predicted mean} + \text{Residual variation}}$$

Veall, M. and Zimmermann, K. (1992) propose a surrogate R-squared for a Tobit model. The measure, referred to as the decomposed R-squared takes the variance of the conditional mean function around the overall mean of the data in the numerator. The denominator contains the sum of the numerator and a residual variance, the true value minus the conditional mean function.

Variable	Mean (t-value)
Total jobs per square km/1000 at non-strategic centres (=0 in a strategic centre)	0.0002 (2.04)
Total jobs per square km/1000 in Bondi Junction	-0.001 (1.81)
Total jobs per square km/1000 in Campbelltown-Macarthur Metropolitan Cluster	-0.046 (0.98)
Total jobs per square km/1000 in Chatswood	0.006 (5.20)
Total jobs per square km/1000 in Greater Parramatta Metropolitan Centre	0.003 (8.39)
Total jobs per square km/1000 in Greater Penrith	-0.037 (8.22)
Total jobs per square km/1000 in City	0.0002 (13.18)
Total jobs per square km/1000 in North Sydney	0.0004 (2.41)
Total jobs per square km/1000 in Hornsby	0.003 (0.72)
Total jobs per square km/1000 in Kogarah	0.008 (4.02)
Total jobs per square km/1000 in Liverpool	-0.008 (1.96)
Total jobs per square km/1000 in Macquarie Park	0.001 (1.35)
Total jobs per square km/1000 in Norwest	-0.004 (1.60)
Total jobs per square km/1000 in St Leonards	0.001 (1.02)
Total jobs per square km/1000 in Olympic Park	-0.002 (1.10)
Commuting travel time by car to main office location (mins)	-0.001 (13.34)
Disturbance standard deviation: Sigma	***0.0423 (113)***
Sample size	***6,419***
Number of estimated parameters	***36***
Log-likelihood	***11185.4***
Adjusted R-squared (OLS)	***0.762***
R-squared (decomposition)	***0.438***

GSMA with Strategic Centre Dummy Variables interacted with Jobs per square km (Option 6): Wave 5



0.1= 0.7 days per week

0.15=1.05 days per week

0.2=1.4 days per week

Southern Highlands has a high WFH incidence in Wave 5

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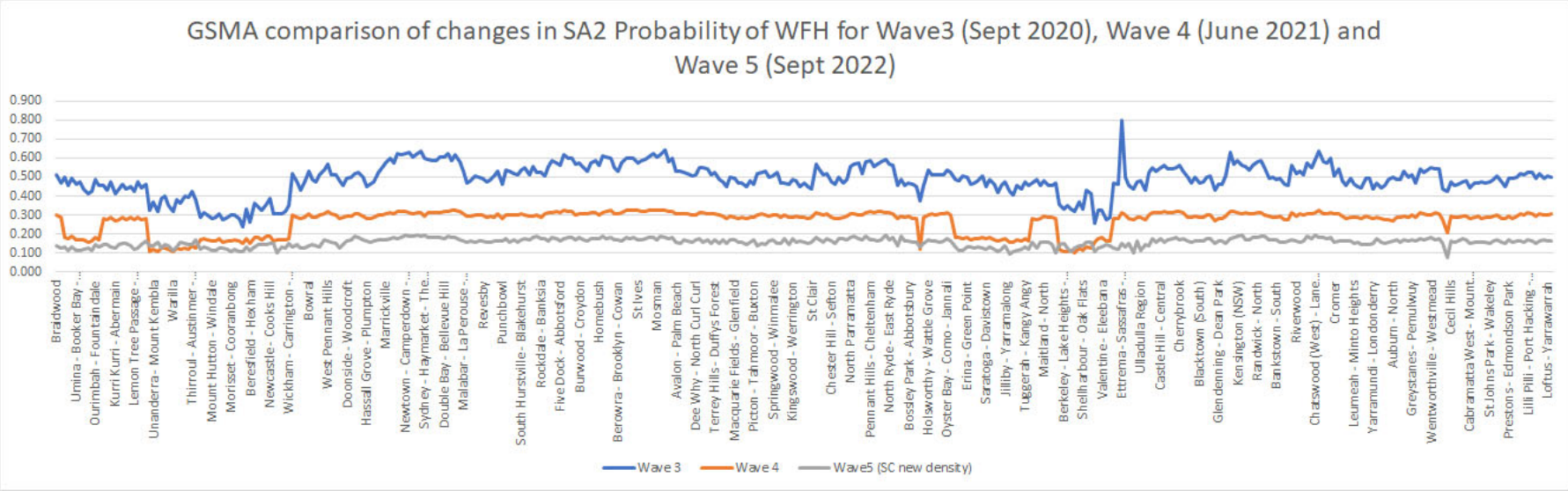
GSMA comparison of changes in SA2 Probability of WFH for Wave3 (Sept 2020), Wave 4 (June 2021) and Wave 5 (Sept 2022)
0.900
0.800
0.700
0.600
0.500
0.400
0.300
0.200
0.100
0.000
Bradwood
Umina - Booker Bay -...
Ourimbah - Fountaindale
Kurri Kurri - Abermain
Lemon Tree Passage -...
Unanderra - Mount Kembla
Warilla
Thirroul - Austinmer -...
Mount Hutton - Windale
Morisset - Cooranbong
Beresfield - Hexham
Newcastle - Cooks Hill
Wickham - Carrington -...
Bowral
West Pennant Hills
Doonside - Woodcroft
Hassall Grove - Plumpton
Marrickville
Newtown - Camperdown -...
Sydney - Haymarket - The...
Double Bay - Bellevue Hill
Malabar - La Perouse -...
Revesby
Punchbowl
South Hurstville - Blakehurst
Rockdale - Banksia
Five Dock - Abbotsford
Burwood - Croydon
Homebush
Berowra - Brooklyn - Cowan
St Ives
Mosman
Avalon - Palm Beach
Dee Why - North Curl Curl
Terrey Hills - Duffys Forest
Macquarie Fields - Glenfield
Picton - Tahmoor - Buxton
Springwood - Winmalee
Kingswood - Werrington
St Clair
Chester Hill - Sefton
North Parramatta
Pennant Hills - Cheltenham
North Ryde - East Ryde
Bossley Park - Abbotsbury
Holsworthy - Wattle Grove
Oyster Bay - Como - Jannali
Erina - Green Point
Saratoga - Davistown
Jilliby - Yarramalong
Tuggerah - Kangy Angy
Maitland - North
Berkeley - Lake Heights -...
Shellharbour - Oak Flats
Valentine - Eleebana
Ettrema - Sassafras -...
Ulladulla Region
Castle Hill - Central
Cherrybrook
Blacktown (South)
Glendenning - Dean Park
Kensington (NSW)
Randwick - North
Bankstown - South
Riverwood
Chatswood (West) - Lane...
Cromer
Leumeah - Minto Heights
Yarramundi - Londonderry
Auburn - North
Greystanes - Pemulwuy
Wentworthville - Westmead
Cecil Hills
Cabramatta West - Mount...
St Johns Park - Wakeley
Prestons - Edmondson Park
Lilli Pilli - Port Hacking -...
Loftus - Yarrawarrah
Wave 3
Wave 4
Wave5 (SC new density)

Relating Non-Commuting Trips to Commuting Trips and WFH by Workers during COVID-19 late 2020 and two periods in 2021, pre- and post-lockdown

Balbontin, C., Hensher, D.A. and Beck, M. J (2022) The influence of working from home on the number of modal commuting and non-commuting trips during 2020 and 2021 pre- and post-lockdown in Australia, paper at *17th International Conference on Competition and Ownership of Land Passenger Transport* (Thredbo 17), Sydney, Australia, September 2022. Paper #24.

Wave A: August-September 2020, when there were relatively minor restrictions in Australia

Wave B: April-May 2021, a period at the start of what would be the longest sustained period of lockdown in NSW (with relative freedoms still existing in QLD throughout the same time period)

Wave C: December 2021, the period at the end of this prolonged lockdown in NSW.

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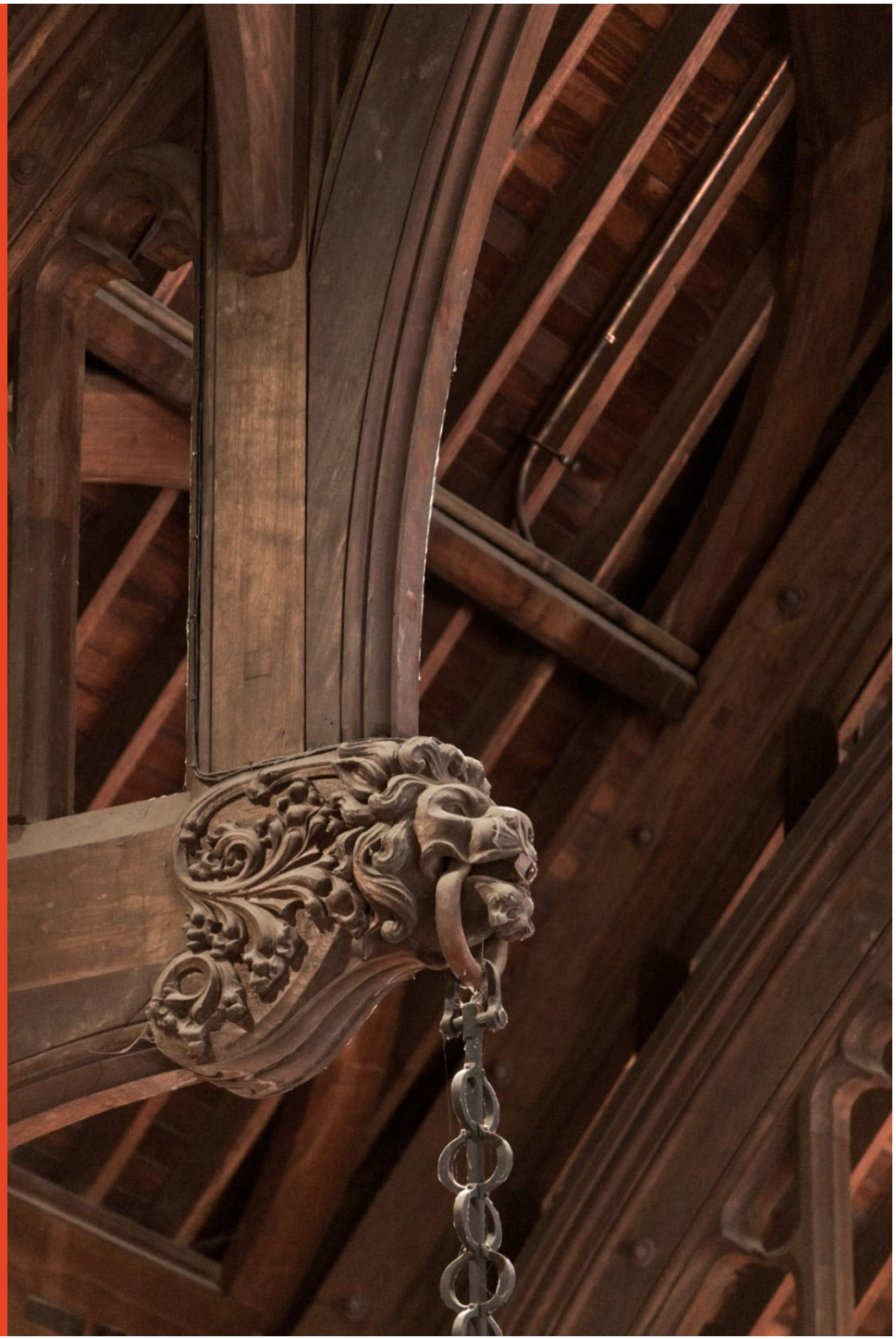
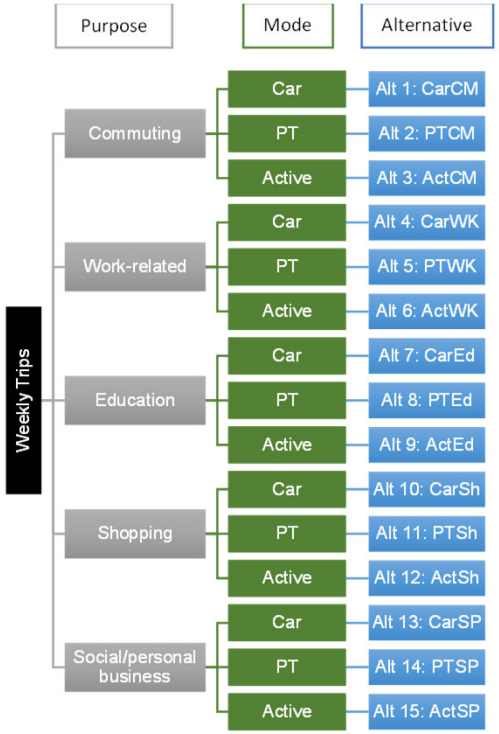
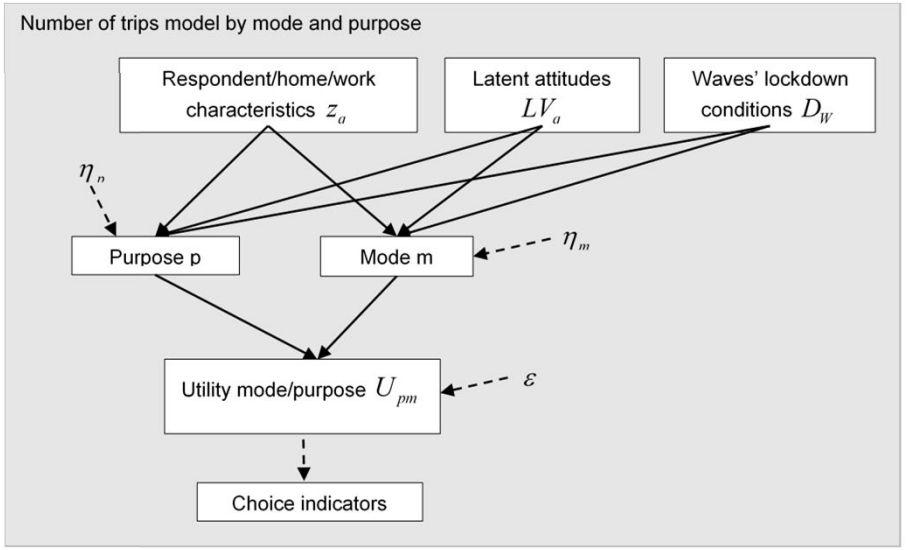


The multiple discrete-continuous extreme value (MDCEV) Model

Alternatives definition





$$V_{pm} = ASC_{pm} + \sum_j \left(\beta_{mj} z_{qj} + \beta_{pj} z_{qj}\right) + \sum_i \left(\beta_{mi} LV_{qi} + \beta_{pi} LV_{qi}\right) + \beta_{WB} \cdot D_{WB} + \beta_{WA} \cdot D_{WA} + \eta_p + \eta_m$$

$$U(x) = \sum_{p=1}^{P} \sum_{m=1}^{M} \frac{\gamma_{pm}}{\alpha_{pm}} \psi_{pm} \left\{ \left(\frac{x_{pm}}{\gamma_{pm}} + 1 \right)^{\alpha_{pm}} - 1 \right\} \qquad \sum_{p=1}^{P} \sum_{m=1}^{M} x_{pm} p_{pm} = B \qquad \psi_{pm} = \exp(V_{pm} + \varepsilon_{pm})$$

x_{pm} is the number of weekly one-way trips by purpose *p* and mode *m*

The budget B is represented by the total number of one-way trips made by an individual last week

ψ_{pm} = baseline utility parameters or the marginal utility of one unit of consumption of alternative *pm* at the point of zero consumption for that alternative; α_{pm} and γ_{pm} are parameters that show the added benefit to the baseline utility of one additional trip.

The five latent variables extracted are represented as follows:

Authorities and community's response supporters: respondents that believe the authorities and community response towards the pandemic has been appropriate.

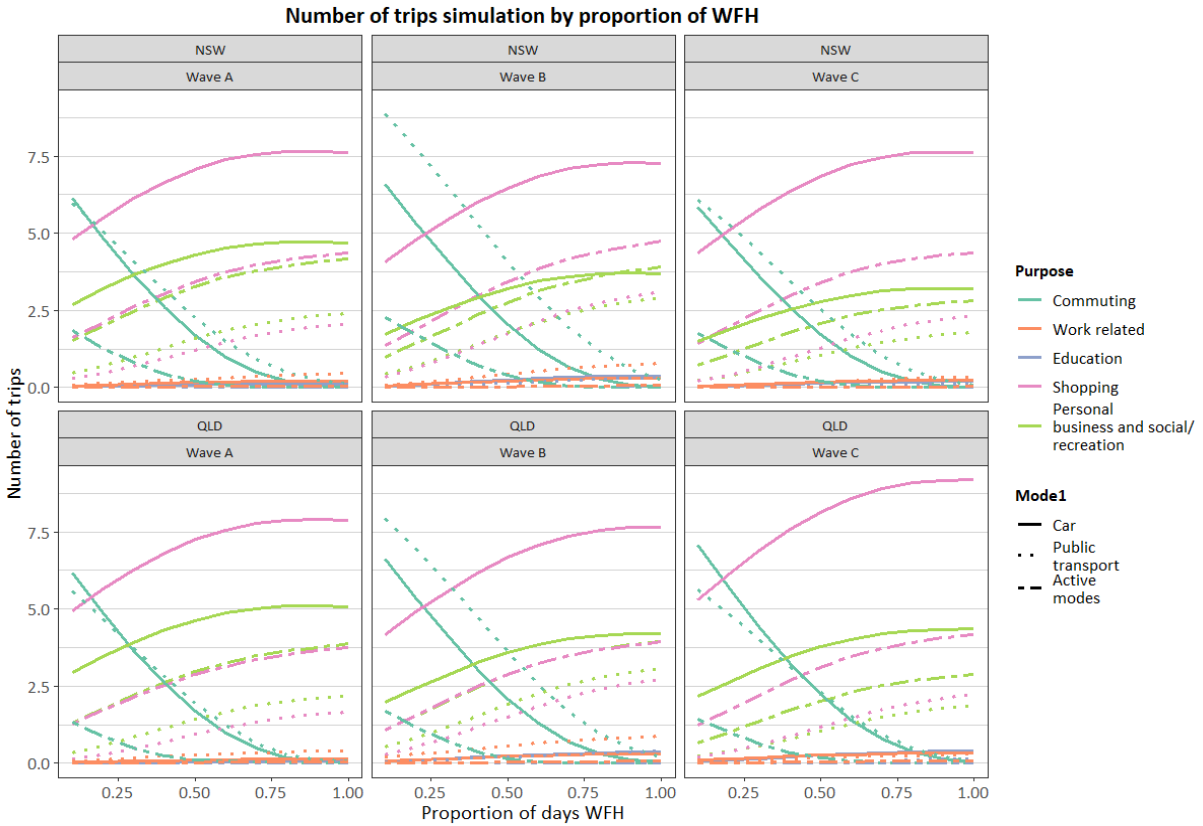
Massive meeting lovers: respondents that feel comfortable having any type of meeting, including music events, watching live entertainment, among others.

Social meeting lovers: respondents that feel comfortable having social meetings with friends, visiting restaurants and pubs, gyms and exercise groups, among others.

High level of life satisfactions: respondents that said to be satisfied and happy with their life.

Concerned about public transport: people that are concerned about hygiene and the number of people in public transport due to COVID-19.

Simulated number of one-way trips by proportion of WFH



Wave A: September-October 2020 when there were relatively minor restrictions

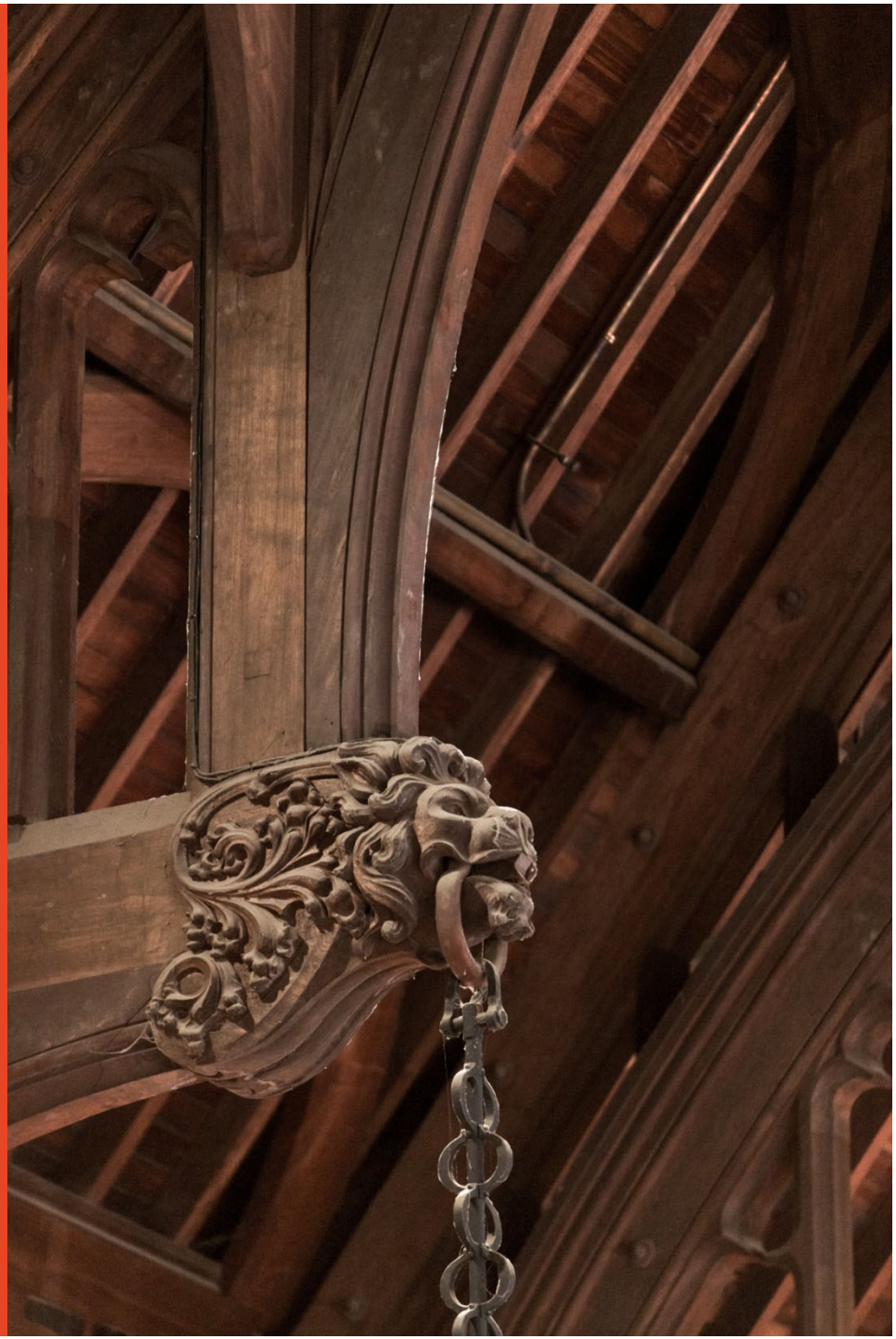
Wave B: March-May 2021, a period at the start of what would be the longest sustained period of lockdown in NSW (with relative freedoms still existing in Queensland throughout the same time period); and

Wave C: November-December 2021, the period at the end of this prolonged lockdown in New South Wales

Inferred Direct Elasticities

Metropolitan workers	Commute	Work-related	Education	Shopping	Personal business	Social/ recreation
Age (years)	-0.350		-0.870		-0.496	
Gender female (0,1)		-0.328	0.275	-0.045		-0.046
Personal income ('000AUD$)	0.052			0.022		0.146
Number of children in household	0.016	-0.162	0.405	0.099		-0.089
At least one child in primary school (0,1)	-0.041	0.182	0.520	-0.060		
Number of cars per adult in household	0.103	0.485	0.382		0.224	0.108
Distance from home to office (kms)	-0.026	0.053	-0.131	-0.067		
Proportion of days WFH	**-0.132**	**-0.231**	**0.204**	**0.039**	**0.039**	**0.053**
Occupation clerical and administration (0,1)	0.042	-0.177				
Used car to go to work last week (0,1)	-0.165	-0.151	-0.166	-0.065	0.158	-0.073
Work located in CBD area (0,1)		0.123	-0.213	0.071		
Central Coast (0,1)					-0.295	
Brisbane (0,1)	-0.063	-0.317			-0.151	-0.148
Located in the state of NSW (0,1)			-0.223			-0.097

Integrated Transport, Land Use and Environmental Model Systems: GSMA MetroScan



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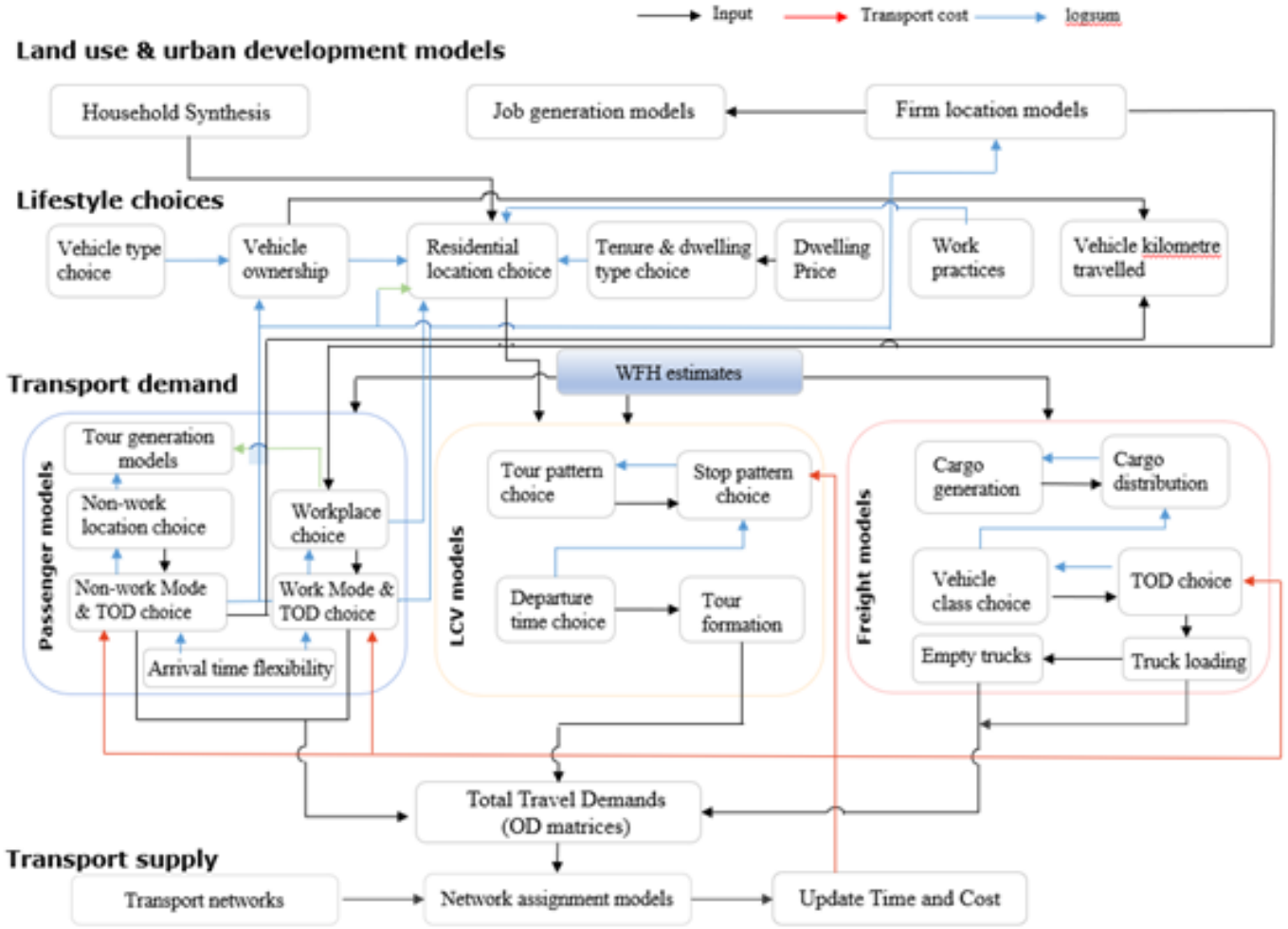
Tracing changes in accessibility on location responses: and where WFH impacts fit in

MetroScan (GSMA)- very fast runs <40 mins on HPC

The demand-side behavioural model system for passenger, light commercial, and freight travel activity. **Built in is Freight, WFH, Electric car transition……numerous outputs; agglomeration, social exclusion, well-being…**



MetroScan W/Wo WFH June 2021

Modal Activity per annum (all trip purposes):	Base (before WFH)	Allowing for WFH	Percentage change
Car drive alone	3,063,173,050	2,970,069,248	-3.039
Car with passengers	1,650,606,668	1,669,612,761	1.151
Bus	194,705,461	178,345,562	-8.402
Train	252,787,164	229,722,719	-9.124
Total motorised modes	5,161,272,343	5,047,750,290	-2.199
Modal shares (all trip purposes):			
Car drive alone	59.35%	58.84%	-0.859
Car with passengers	31.98%	33.08%	3.427
Bus	3.78%	3.53%	-6.411
Train	4.90%	4.55%	-7.122
Passenger Vehicles:			
Total daily car kms	252,725,288	225,630,166	-4.848
Total revenue for PT use ($pa)	1,482,019,696	1,352,421,896	-8.745
Total revenue from parking ($pa)	302,715,424	301,733,633	-0.325
Total government revenue for GST	64,381,101,223	61,259,401,088	-4.848
Total revenue from toll roads ($)	867,317,568	849,985,927	-1.998
Total annual auto VKM ($)	9,165,032,041	8,720,639,491	-4.848
Total government revenue from fuel excise ($pa)	3,302,013,595	3,141,906,108	-4.848
Generalised cost per annum for PT ($pa)	9,726,699,697	8,806,113,504	-9.423
Generalised cost per annum for car ($pa)	104,504,496,348	98,546,845,871	-5.53
Generalised cost per person trip for PT ($)	21.726	21.58	-0.672
Generalised cost per person trip for car ($)	22.13	21.24	-4.022
Generalised cost per person trip car & PT ($)	22.095	21.267	-3.745
Freight Vehicles:			
Total government revenue from fuel excise ($pa)	1,162,090,474	1,168,269,296	0.532
Annual Total distance travelled Articulated	3,478,798,038	3,497,879,878	0.549
Annual Total distance travelled Rigid	2,331,654,333	2,343,466,600	0.507
Generalised cost per trip for freight ($)	126,303	123,487	0.532
Emissions and Pollution:			
Total CO_2 for passenger and freight movements	16,746,997,718	16,144,193,943	-3.599
Total CO_2 for passenger movements	12,432,062,391	11,829,258,616	-4.849
Total annual carbon dioxide for trucks	4,314,935,327	4,337,961,459	0.534
Total annual local air pollution costs for trucks	2,674,467,833	2,688,976,524	0.542

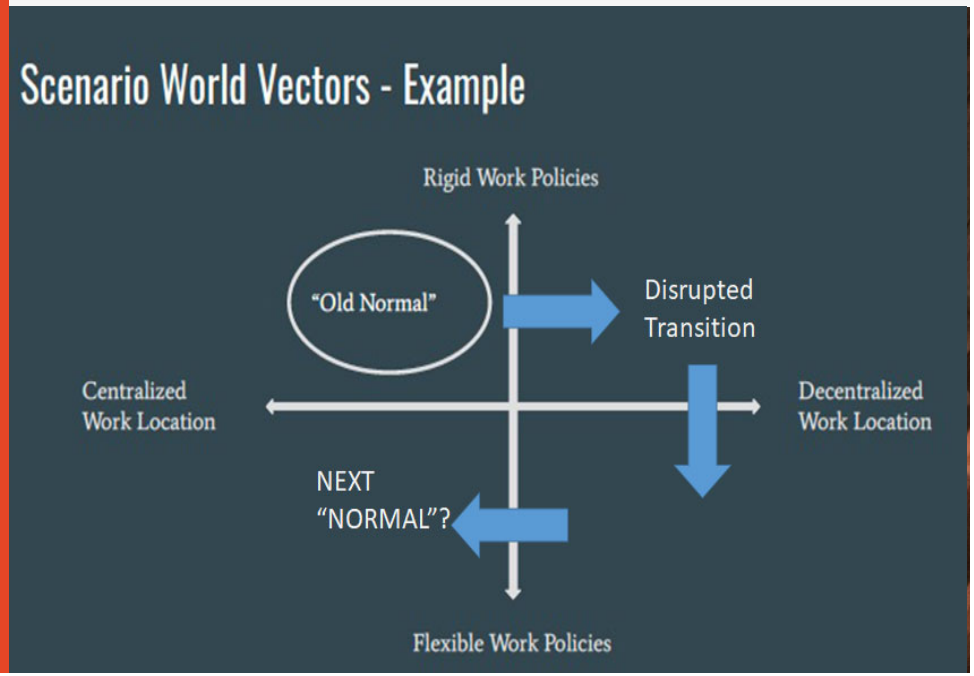
The Big Accumulating Take Away Evidence: Structural Change

Beck, M. J. and Hensher, D.A. (2022) Australia 6 months After COVID-19 Restrictions Part 1: Changes to Travel Activity and Attitude to Measures, Paper #7a. *Transport Policy*, 128, 286-298.

https://doi.org/10.1016/j.tranpol.2021.06.006

Beck, M. J. and Hensher, D.A. (2022) Australia 6 months After COVID-19 Restrictions Part 2: The Impact of Working from Home, Paper #7b. *Transport Policy*, 128, 274-285.

https://doi.org/10.1016/j.tranpol.2021.06.005



The Key Policy Take Away ('Until we come fully out of COVID jail"): Love it or hate it, remote and hybrid/blended work is the future.

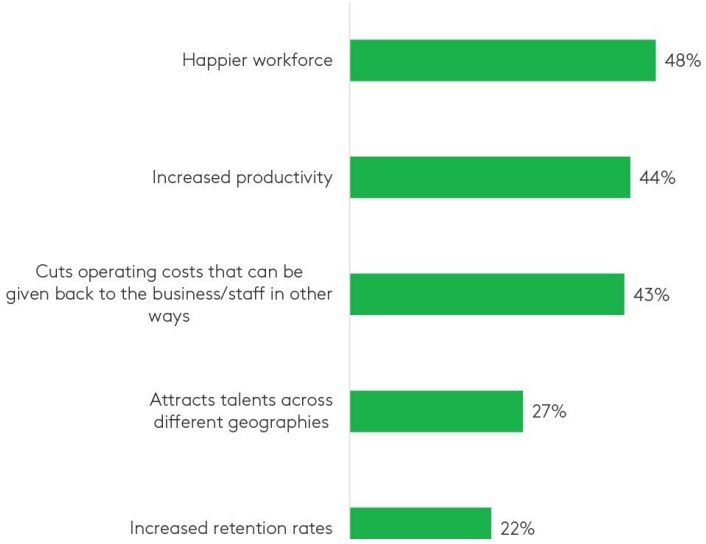
- With WFH being seen as one of, if not the most, impactful transport policy instrument available for many years,
  - **the policy settings that flow from this WFH and WNH 'next normal' are expected to include infrastructure investments that align more with suburban investments to benefit walking and cycling and the broader agenda of the 20 minute city where reduced commuting distances become a greater priority.**
- Importantly the changed profile of commuting may look more like reduced frequency over a week while preserving much of the longer distance commute over fewer days while either avoiding commuting at all on some days or commuting to a close by satellite office.
- **These structural changes are evolving and look like becoming a permanent fixture of the mobility land use scape.**
- Lot of trends in place that are being reinforced.
- Interesting comments re "Return to the Office":
  - Having a window cf. not, increases productivity by 13% (many homes have a window in a study/office)
  - Offices with poor light penetration are a concern with many offices (except if open office design)
    - Meeting rooms may be less windows compared to where people sit most of the time
- Some offices are becoming apartments and retail also becoming multi-use.
- Let's give everybody access – democratise the office place and given them better choices – so it is about giving people better access to choices
- But caution about overestimating the impact of the short turn; but there is no 'normal' – we will not return to the past and why would we want to?.

Countries differ in their norms, but office workers everywhere want the same thing: **flexibility**

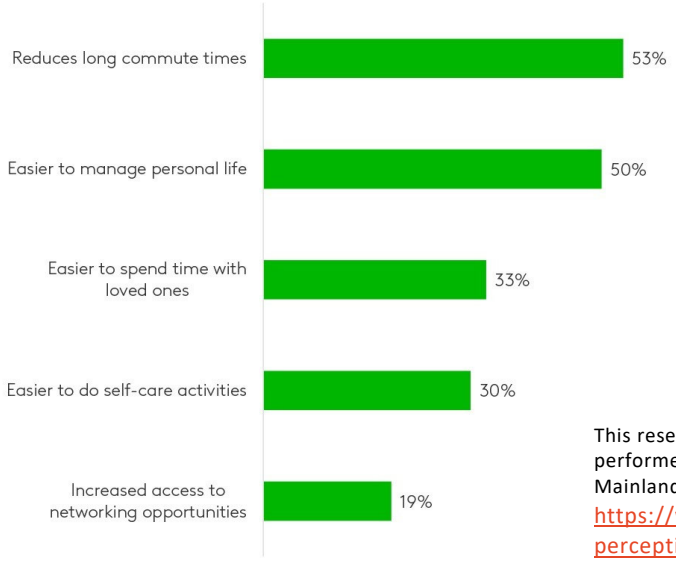
- In the **United States**, about a third of office workers had returned to fully in-person work by the end of the first quarter of this year, according to Future Forum, a research group at Slack that surveyed more than 10,000 knowledge workers across six countries.
- And the rest of the world isn't rushing back to the office either:
  - Only 26 percent in **Britain**, 28 percent in **Australia**, 32 percent in **Germany**, and 35 percent in **France** have done so.
- **Japan** is a bit of an outlier—there, more than half of white-collar workers are back in the building
- but elsewhere, most employees either continued working fully remotely or split their time in a hybrid model; more than three-quarters of those canvassed in a separate, published survey from Future Forum said they liked this flexibility.
- **Britain**, where before the pandemic, workers would on average spend more than an hour commuting each day—time that has since been repurposed for catching up on sleep, doing household chores, or caring for family members and pets.
  - **In London, despite an extensive mass-transit system, nearly three-quarters of workers say they'll never go back to their pre-pandemic ways.**

Aligns well with other surveys: Flexibility is here to stay

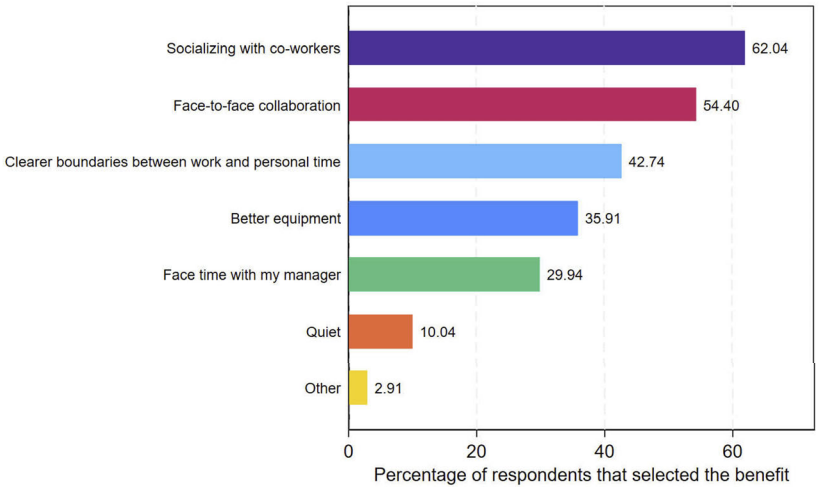
What postitives do you think flexibilty creates for companies?



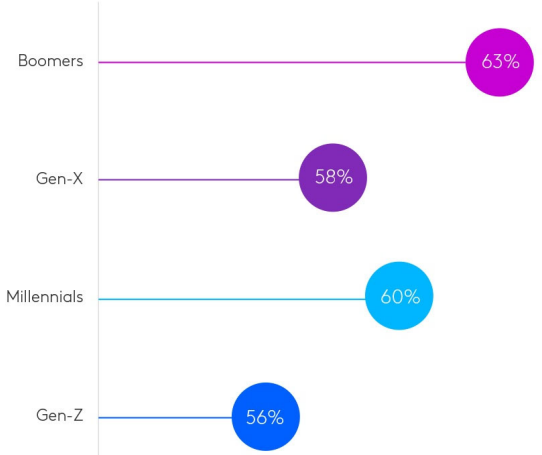
What positives do you think flexible working creates for employees?



Q: "What are the top three benefits of working on your employer's business premises?" N=20,732 workers in 34 countries surveyed in April-May 2023.



Ideal % of Workweek Spent Remote



This research was conducted online among 7,985 full or part-time workers (whose job function could be performed remotely at least part-time) across eight global markets: US, UK, France, Germany, India, Singapore, Mainland China and Brazil between 14-15 January 2022

https://www.kantar.com/inspiration/research-services/future-of-work-employee-perception-on-flexibility-pf

https://imoveaustralia.com/project/project-outcomes/covid-and-working-from-home-how-has-it-impacted-transport/

https://imoveaustralia.com/wp-content/uploads/2023/02/Working-from-Home-and-implications-for-revision-of-Metropolitan-Strategic-Transport-Models.pdf

https://www.seriouslysocialpodcast.org.au/e/how-avoiding-the-commute-is-making-us-happier

Working from Home Final Report

Working from Home (WFH) and Implications for Revision of Metropolitan Strategic Transport Models

iMOVE Projects 1-031 and 1-034 (2020-2022)

'Flexibility is here to stay' and 'employers who offer a balance of WFH and in office will attract more high-quality employees'

The Future of Office Space Summit, 17 February 2021

iMOVE Australia Limited ("Company")

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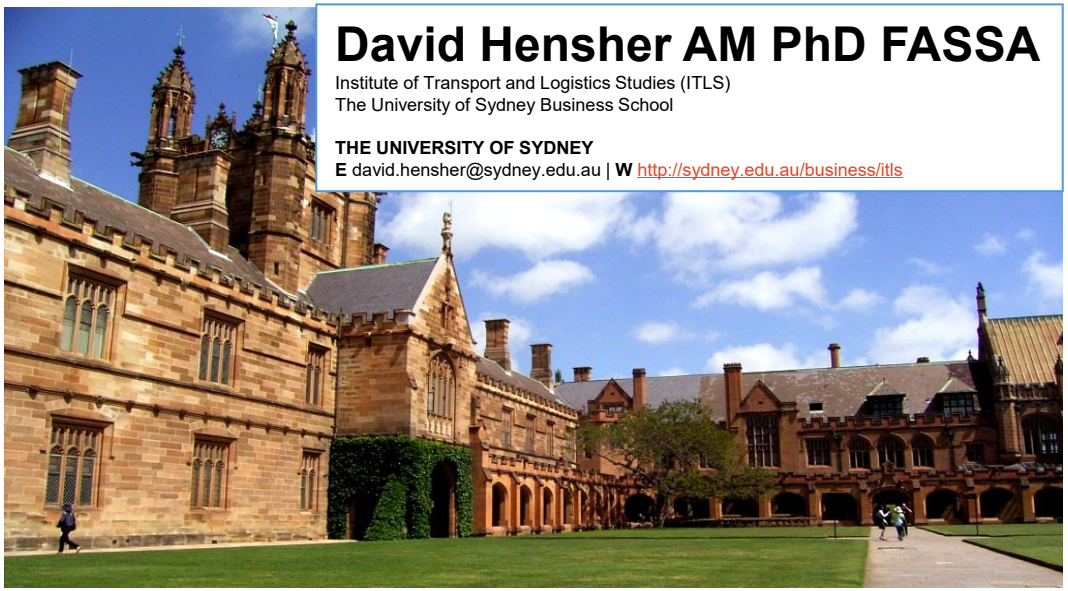

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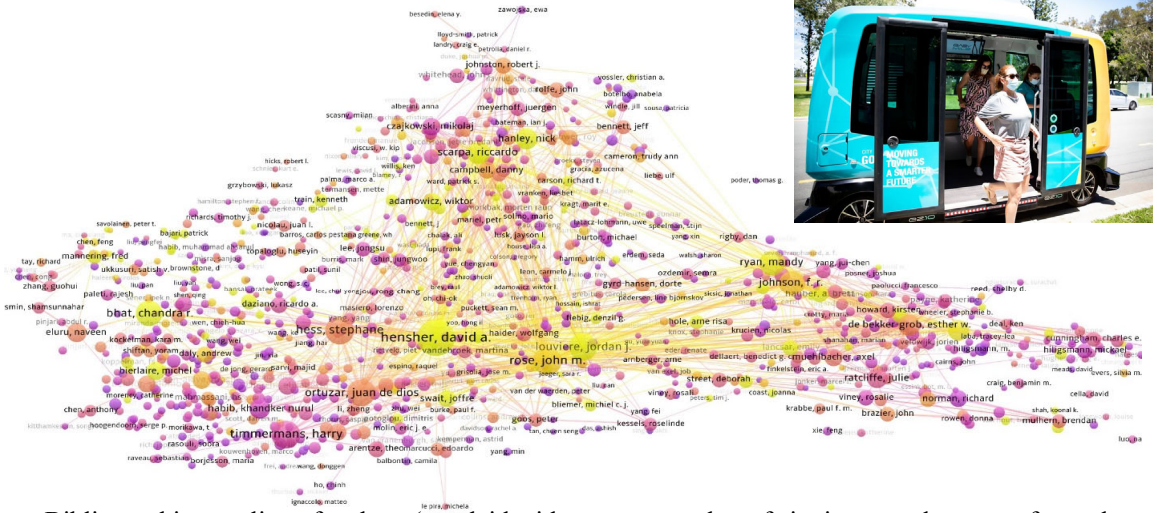

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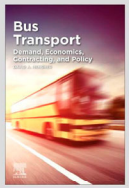

Bus Transport

Demand, Economics, Contracting, and Policy

David A. Hensher, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia

ISBN: 978-0-12-820132-9
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The latest public transportation insights on contracting, performance, image, crowding, and Mobility as a Service

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DESCRIPTION

Bus Transport: Demand, Economics, Contracting, and Policy examines in one source the most critical and current research themes of public transport regulators, planners, operators, researchers, and educators. It highlights the wider economic impacts of public transport and compares energy usage across all public transport modes. The book examines the evolving debate on Mobility as a Service (MaaS) and includes discussion of such themes as; public image issues, performance measurement and monitoring, contract procurement and design models, travel choice and demand, and global public transport reform. The book reflects the leading perspectives on the preservation and health of the bus sector, intending to move public transport reform forward.

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Understanding Mobility as a Service (MaaS)

Past, Present and Future

David A. Hensher, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia; Corinne Mulley, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia; John D. Nelson, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia; Chinh Ho, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia; Göran Smith, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia and Chalmers University, Sweden; and Yale Wong, Institute of Transport and Logistics Studies, The University of Sydney Business School, Australia

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Examines all facets of MaaS, assessing its role in the evolution of today's and tomorrow's transport systems

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- Includes case studies to show how MaaS is delivered around the world
- Covers foundational aspects of MaaS, clarifying what it is for those new to the concept
- Offers an in-depth analysis on a wide range of MaaS topics including governance, contracts, consumer and supplier preferences, links to societal objectives, the role of trials, assessments, and more

DESCRIPTION

The widespread adoption of smartphones, ridesharing and carsharing have disrupted the transport sector. In cities around the world, new mobility services are both welcomed and challenged by regulators and incumbent operators. Mobility as a Service (MaaS), an ecosystem designed to deliver collaborative and connected mobility services in a society increasingly embracing a sharing culture, is at the center of this disruption.

Understanding Mobility as a Service (MaaS): Past, Present and Future examines such topics as:

- How likely MaaS will be implemented in one digital platform app
- Whether MaaS will look the same in all countries
- The role multi-modal contract brokers play
- Mobility regulations and pricing models
- MaaS trials, their impacts and consequences

Written by the leading thinkers in the field for researchers, practitioners, and policy makers, *Understanding Mobility as a Service (MaaS): Past, Present and Future* serves as a single source on all the current and evolving developments, debates, and challenges.

The authors dedicate this book as a contribution to the Volvo Research and Educational Foundations (VREF) Bus Rapid Transit (BRT+) Centre of Excellence (http://www.brt.cl/) and the iMOVE Cooperative Research Centre (CRC) (https://imoveaustralia.com/).

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