Are respondents aware of the process strategies used in decision-making? Modelling business location decisions using multiple stated process strategies

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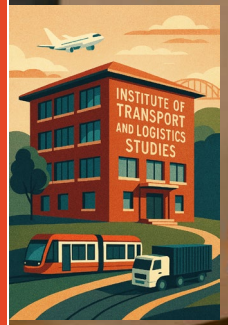
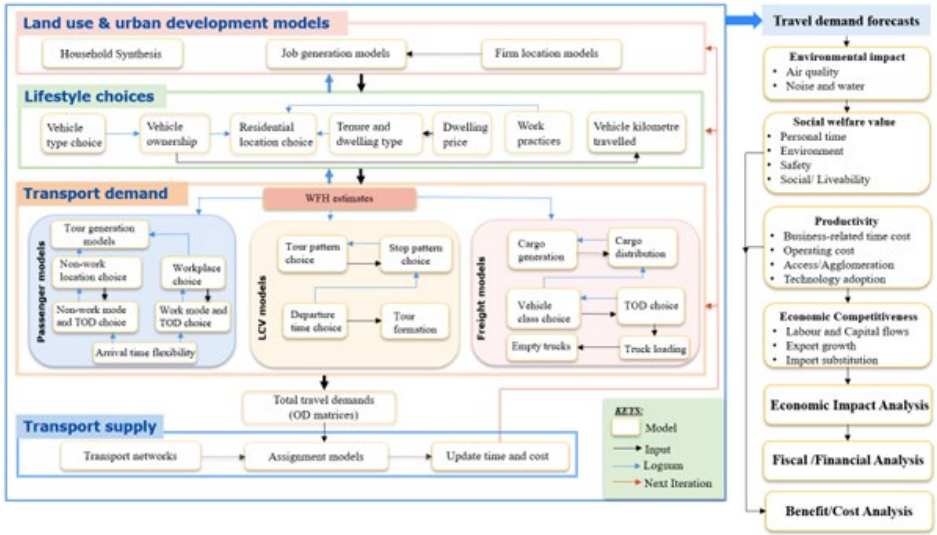
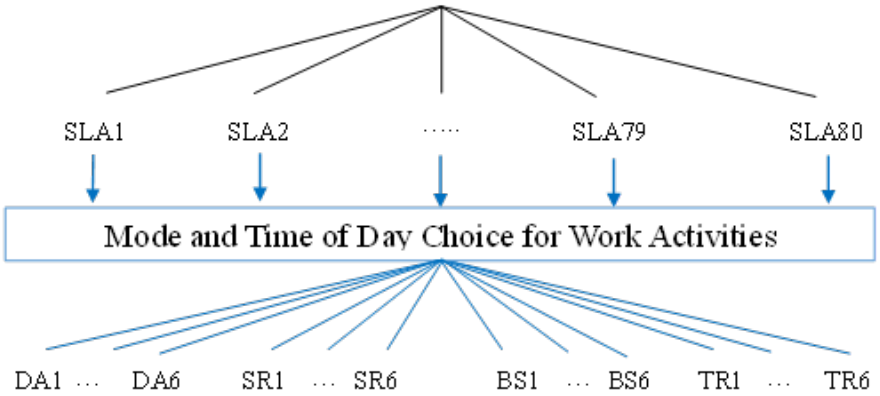


Clarifying Focus

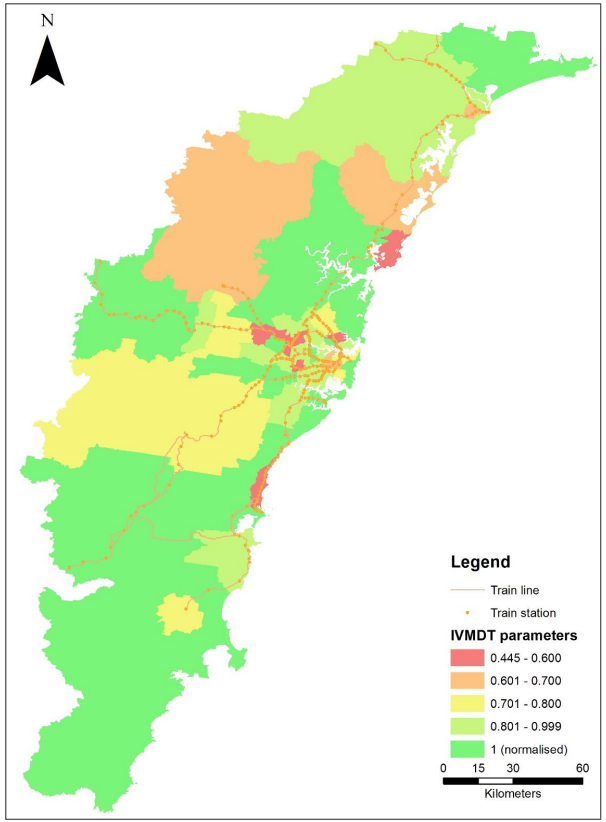
- Workplace location choice (of employees) – Metroscan diagrams
- Business location choice (or organisation) – main focus of talk





Workplace location choice (of employees)

Estimation results of the work location choice model for Sydney GMA



Variable description	Parameter	Sig. level
Accessibility measures		
Accessibility to jobs in different industries	-1.832	***
Accessibility to jobs in the same industry	0.283	***
Log of jobs in industry relevant to worker		
Manufacturing	0.521	***
Health Care and Social Assistance	0.302	**
Electricity, Gas, Water and Waste Services	0.648	***
Education and Training	0.577	***
Financial and Insurance Services	0.641	***
Information Media and Telecommunications	0.501	***
Construction	0.575	***
Transport, Postal and Warehousing	0.867	***
Rental, Hiring and Real Estate Services	0.719	***
Retail Trade	0.349	**
Public Administration and Safety	0.759	***
Professional, Scientific and Technical Services	0.636	***
Wholesale Trade	0.441	***
Arts and Recreation Services	0.749	***
Administrative and Support Services	0.510	***
Other Services	0.713	***
Logsum of mode and time of day choice	0.445 – 1.0	***
Interactions between worker's occupation and statistical region		
Professional (1/0/-1, base = other occupations) × Inner Sydney (1/0)	0.222	**
Clerical worker (1/0/-1, base = other occupations) × Inner Sydney (1/0)	-0.568	***
Manager (1/0/-1, base = other occupations) × Inner Sydney (1/0)	0.390	***
Region-specific constants		
Canterbury-Bankstown (1/0, base = Inner Sydney)	-2.454	***
Central Coast (1/0, base = Inner Sydney)	-2.374	***
Central Northern Sydney (1/0, base = Inner Sydney)	-1.892	***
Central Western Sydney (1/0, base = Inner Sydney)	-0.895	***
Eastern Suburbs (1/0, base = Inner Sydney)	-1.096	***
Fairfield-Liverpool (1/0, base = Inner Sydney)	-2.806	***
Hunter (1/0, base = Inner Sydney)	-3.845	***
Illawarra (1/0, base = Inner Sydney)	-3.094	***
Inner Western Sydney (1/0, base = Inner Sydney)	-1.795	***
Lower Northern Sydney (1/0, base = Inner Sydney)	-0.668	***
North Western Sydney (1/0, base = Inner Sydney)	-1.879	***
Northern Beaches (1/0, base = Inner Sydney)	-2.168	***
Outer South Western Sydney (1/0, base = Inner Sydney)	-2.235	***
St George-Sutherland (1/0, base = Inner Sydney)	-2.392	***

Operation of aggregate joint firm location and job generation model (from organisation perspective)

$$\ln X_{fi} = \alpha + V_f + W_i + Z_{if}$$

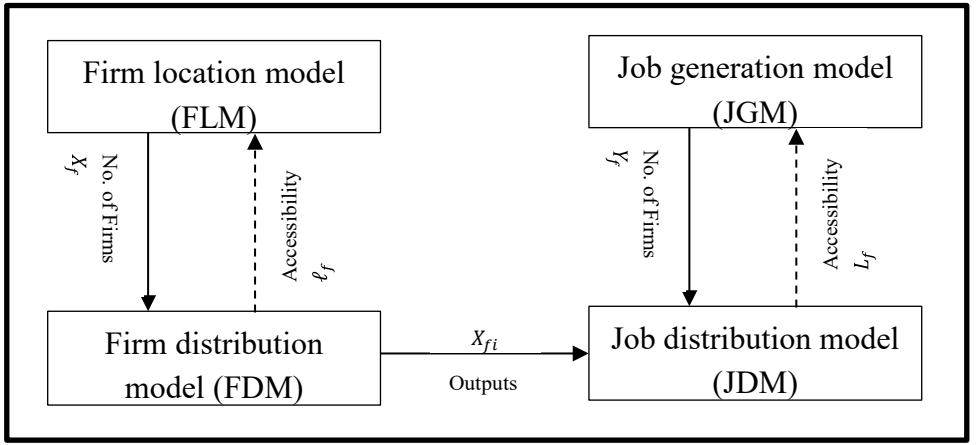
X_{fi} is the number of firms located for industry f in zone i;

V_f is a linear combination of all factors affecting firm location and specific to industry f; W_i is a linear combination of all factors specific to zone i affecting firm location, and Z_{if} is a linear combination of all factors showing the interactions between industry f and location zones i and includes all transport and accessibility variables.

Equations (1) and (2) are gravity-type models, which implies that the use of 3SLS estimator or any least square estimator may lead to the so called 'adding up' problem For example, if x_f is the observed number of firms in industry f, the 3SLS estimator of Equation (1) does not guarantee that $x_f = \sum_i X_{if}$. Similarly, if x_i is the observed number of firms in zone i, the equality relation $x_i = \sum_f X_{if}$ is not guaranteed. The models in Equations (1) and (2) also assume absolute utility (Shepherd 2012), which means that changes in the attributes of one alternative or making that alternative not available will not affect the demand of other alternatives during forecasting and policy testing.

$$\ln Y_{fi} = \gamma + G_f + H_i + E_{fi} + \beta \ln X_{fi}$$

Y_{fi} represents the number of jobs created by industry f in zone i; G_f is a linear combination of all factors specific to industry f affecting job creation; H_i is a linear combination of all factors specific to zone i affecting the creation of jobs in that zone, and E_{if} is a linear combination of all factors showing the interactions between industry and industrial zones and includes all transport and accessibility variables.



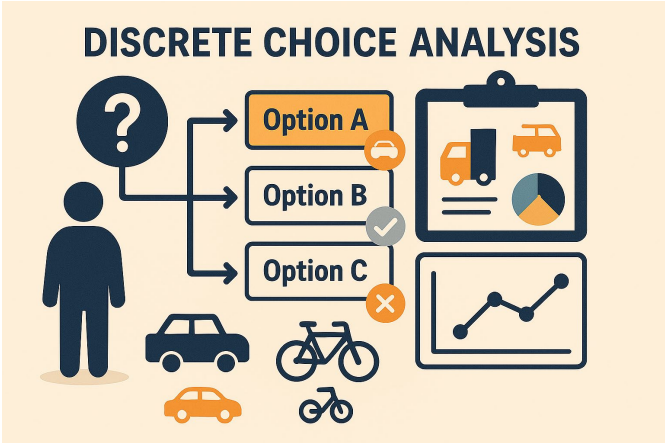
To deal with the above limitations, Equations in (1) and (2) are transformed into nested logit models (Daly and Zachary 1978;, Hensher et al. 2015) before applying them in forecasting and testing of various policy instruments. The nested logit models do not suffer from the adding up problems and are known to be suitable for forecasting and testing of various policies of interest as they based on relative utility (Hensher 2001; Daly and Zachary 1978).

Firm Location Choice Model (Business perspective)

- Discrete choice studies are increasingly used in urban planning to understand preferences and to make informed decisions based on its outcomes

- Traditional discrete choice modelling approaches have evolved in a setting in which some very specific behavioural **assumptions** are made in specifying choice-making

- These assumptions have given rise to the study of alternative process strategies in decision-making



INTRODUCTION

- Process strategies can be either directly asked to respondents (stated) or inferred through the models, although typically this is limited to a very few process rules such as **attribute non-attendance.**
- This research aims to look at **4 behavioural process rules**: **stated value learning** (VL), **majority of confirming dimensions** (MCD) and **attribute non-attendance** (ANA), in addition to the traditional approach which is referred to as linear in the parameters and additive in the attributes (LPAA/RUM)

- Stated ANA has been studied in the literature but, to the best of our knowledge, this was the first study to incorporate stated VL and MCD together with ANA.
  - Hensher, D.A. (2014) Process heuristics in choice analysis: An editorial, Special Issue of *Journal of Choice Modelling* on Processing Heuristics (edited by David A. Hensher), 11, 1-3.
  - Balbontin, C., Hensher, D.A. and Collins, A. (2017) Is there a systematic relationship between random parameters and process heuristics? (Paper presented at *The Fifth International Choice Modelling Conference* 3 – 5 April 2017, Cape Town, South Africa), *Transportation Research Part E*, 19, 106, 160-177.
  - Hensher, D.A. (2019) Context dependent process heuristics and choice analysis: a note on two interacting themes linked to behavioural realism *Transportation Research Part A,* 125, 119-122.

INTRODUCTION

- The interest of this research is in understanding the decisions made by businesses on where to locate or relocate

- This has been typically given less consideration than residential location in integrated transport and land use modelling systems, and usually not considered in cost-benefit analysis

Hensher, D.A., Ho, C., Teye, C., Liu, W. and Wei, E. (2020) Integrating business location choices into transport and land use planning tools, *Journal of Transport Economics and Policy*, 54 (1), April, 121-150.

Balbontin, C. and Hensher, D.A. (2021) *Modelling business location decisions: identifying main drivers and ANA process strategy behaviour*, *Journal of Transport Geography*, 91, 102955.

MAIN DRIVERS

Literature Review

In-depth interviews with key business location decision-makers

Choice experiment design and pilot surveys

MAIN DRIVERS

Category	Attributes
Accessibility	Public transport service frequency in peak to anywhere
	Walking time to the closest rail station
	50% of your clients are accessible within X minutes
	Distance from your current business location
Office Profile	Rental space cost ($ per square metre)
	Amount of office space (square metres)
	Lease commitment (years)
Location Profile	Number of businesses offering the same or similar products and/or services in the local area* "Agglomeration"

*Local area was defined as a catchment area that is 5 kms in radius around your current business location (where you operate).

DISCRETE CHOICE EXPERIMENT

- We designed an online survey
- Respondents were selected who were involved in the business location decisions of an organisation (sometimes as an adviser and not an employee)
- We included questions about the respondent's industry, the role of the respondent, their business' attitudes towards the physical and economic infrastructure, and the choice experiment
- Each respondent was faced with four choice sets
- Data was collected from small, medium and large businesses located within the Greater Sydney Metropolitan Area (GSMA)

Attribute level descriptions in the stated choice experiment

	Attributes	Levels (5)	Pivot/rule	Expected sign
Accessibility	Public transport service headway in peak to anywhere	Every 5, 10, 15, 30, 60 minutes	Not pivoted	-
	Walking time to the closest rail station	5, 10, 15, 25, 45 minutes	Not pivoted	-
	50% of your clients are accessible within	-50%, -25%, 0%, 25%, 50%	Pivoted	-
Office profile	Rental space cost ($ per square metre)	If current < $500: -50%, -25%, 0%, 25%, 50% Otherwise: -50%, -25%, 0%, 12.5%, 25%	Pivoted	-
	Amount of office space (square metres)	-50%, -25%, 0%, 25%, 50%	Pivoted	?
	Lease commitment (years)	3, 5,10,15,20 years	Not pivoted	-
Location profile	Number of businesses offering the same or similar products and/or services in the local area*	-75%, -50%, 0%, 50%, 75%	Pivoted	?
Other	Distance from your current business location	2kms, 7kms, 15kms, 30kms, 50kms	Not pivoted	?

- *Local area is defined as a catchment area that is 5 kms in radius around a current business location (where you operate)

STATED CHOICE EXPERIMENT

Features	Current location	Location 1	Location 2
Public transport service frequency in peak to anywhere	15 mins	15 mins	60 mins
Walking time to the closest rail station	10 mins	45 mins	25 mins
50% of your clients are accessible within	50 mins	38 mins	50 mins
Rental space cost ($ per square metre)	$100	$125	$75
Amount of office space (square metres)	100㎡	125㎡	50㎡
Lease commitment (years)	5	20	20
Number of businesses offering the same or similar products and/or services in the local area	11-20	15	4
Distance from your current business location	-	30 kms	30 kms
Q1. Which alternative would be **most attractive (i.e. preferred)** as a business location?	○	○	○

STATED CHOICE EXPERIMENT

Features	Current location	Location 1	Location 2
Public transport service frequency in peak to anywhere	15 mins	30 mins	15 mins
Walking time to the closest rail station	10 mins	45 mins	25 mins
50% of your clients are accessible within	50 mins	63 mins	50 mins
Rental space cost ($ per square metre)	$100	$50	$150
Amount of office space (square metres)	100㎡	125㎡	50㎡
Lease commitment (years)	5	5	15
Number of businesses offering the same or similar products and/or services in the local area	11-20	8	15
Distance from your current business location	-	15 kms	7 kms
Q1. Which alternative would be **most attractive (i.e. preferred)** as a business location?	◉	○	○
Q2. If your current location was not available anymore, which alternative would you select?		○	○

STATED CHOICE EXPERIMENT - ANA

Please indicate which attribute(s) you ignored when assessing the choice scenarios in previous screens in Choice Task 1.

Please select all that apply.

	Select all you ignored
Accessibility	
Public transport service frequency in peak to anywhere	☐
Walking time to the closest rail station	☐
50% of your clients are accessible within	☐
Office Profile	
Rental space cost ($ per square metre)	☐
Amount of office space (square metres)	☐
Lease commitment (years)	☐
Location Profile	
Number of businesses offering the same or similar products and/or services in the local area	☐
Other	
Distance from your current business location	☐
I did not ignore any features	○

STATED CHOICE EXPERIMENT – VALUE LEARNING (VL)

Q1. Did the characteristics of the alternatives that you saw in the earlier choice tasks influence your decisions in the following ones?

- ❑ Yes
- ❑ No

STATED CHOICE EXPERIMENT – MCD(majority of confirming dimensions) and LPAA

Q2. What made you choose one alternative? (Please select all that apply)

- ❑ I chose the **first** alternative whose characteristics satisfied my requirements (ignoring the remaining alternatives).
- ❑ I eliminated alternatives that failed to meet my requirements, starting with the most important characteristics.
- ❑ I compared the alternatives' characteristics considering that some characteristics are more important to me than others
- ❑ I chose the alternative that has the highest number of best performing characteristics (relative to the other alternatives).
- ❑ Others. Please specify.

STATED CHOICE EXPERIMENT – LPAA

Q2. *What made you choose one alternative? (Please select all that apply)*

- ❑ *I chose the **first** alternative whose characteristics satisfied my requirements (ignoring the remaining alternatives).*
- ❑ *I eliminated alternatives that failed to meet my requirements, starting with the most important characteristics.*
- ❑ *I compared the alternatives' characteristics considering that some characteristics are more important to me than others*
- ❑ *I chose the alternative that has the highest number of best performing characteristics (relative to the other alternatives).*
- ❑ *Others. Please specify.*

STATED CHOICE EXPERIMENT – MCD

Q2. *What made you choose one alternative? (Please select all that apply)*

- ❑ *I chose the **first** alternative whose characteristics satisfied my requirements (ignoring the remaining alternatives).*
- ❑ *I eliminated alternatives that failed to meet my requirements, starting with the most important characteristics.*
- ❑ *I compared the alternatives' characteristics considering that some characteristics are more important to me than others*
- ❑ *I chose the alternative that has the highest number of best performing characteristics (relative to the other alternatives).*
- ❑ *Others. Please specify.*

METHODOLOGY

Models estimated (with and without ANA):

1. **LPAA**, where it is assumed that every individual uses LPAA.
2. **Stated multiple heuristics (StVL-StMCD)**, where it is assumed that individuals use the heuristics that they said ('stated') they used.
3. **Inferred multiple heuristics (InfVL-InfMCD)**, where it is assumed that everyone might use all heuristics regardless of what they said.
4. **Stated VL and Inferred MCD (StVL-InfMCD)**
5. **Inferred VL and Stated MCD (InfVL-StMCD)**

METHODOLOGY

LPAA model

$$U_i^{\text{LPAA}} = \beta_{0,i} + \beta_1 \cdot x_{1,i} + \ldots + \beta_m \cdot x_{m,i} + \ldots + \eta_{iq} + \varepsilon_i$$

$\beta_{0,i}$ is the alternative specific constant of alternative *i*;
β_m is the parameter estimate associated with attribute *m*;
$x_{m,i}$ is the level of attribute m for alternative *i*;
η_{iq} is a component of the error term that varies across individuals but is the same within an individual q;
ε_i is the random error term

METHODOLOGY

Stated multiple heuristics model (StVL-StMCD)

$$U_i^{\text{StVL-StMCD}} = \beta_{0,i} + f(\cdot)_{\text{LPAA},i} + d_{\text{VL}}\delta_{\text{VL}} f(\cdot)_{\text{VL},i} + d_{\text{MCD}}\delta_{\text{MCD}} f(\cdot)_{\text{MCD},i} + \eta_{i,q} + \varepsilon_i$$

d represents a dummy variable which is equal to 1 if the individual said they used VL/MCD, and 0 otherwise
δ represents a weight for each heuristic

$$f(\cdot)_{\text{LPAA},i} = \beta_1 \cdot x_{1,i} + \ldots + \beta_m \cdot x_{m,i}$$

$$f(\cdot)_{\text{VL},i} = -\left\{\ln\left(1+\exp\left(\beta_1 \cdot x_{1,i} - \beta_1 \cdot x_{1,\text{REF}}\right)\right) + .. + \ln\left(1+\exp\left(\beta_m \cdot x_{m,i} - \beta_m \cdot x_{m,\text{REF}}\right)\right)\right\}$$

$$f(\cdot)_{\text{MCD},i} = \beta_{MCD} \cdot x_{\text{MCDscore},i}$$

represents the number of best performing attributes of alternative *i* (relative to the other alternatives)

represents the 'best' level of attribute *m* the individual has seen throughout the experiment in their chosen alternatives

Inferred multiple heuristics (InfVL-InfMCD)

- **Probabilistically estimated** from the observed choices by embedding multiple decision rules inside a **single utility function,** with **weights** for each heuristic **estimated via a logit-type model**
  - Because we do not know which heuristic they *actually* use on each choice task, each heuristic is assigned a **probability weight,** inferred from the data.
  - For an alternative j: $U_j = \sum_{h=1}^{H} \; w_h \, U_{jh}$
    - U_{jh} = utility of alternative j **under heuristic** h
    - w_h = **estimated probability weight** of heuristic h, where $\sum_h w_h = 1, w_h > 0$
- These **weights are *inferred*** using maximum likelihood estimation.
- This likelihood treats each heuristic as contributing to utility with a probability weight:
  - If w_h is high ⟶ heuristic strongly influences choices.
  - If w_h is low ⟶ heuristic contributes little.

- This approach is described in:
  - **Leong & Hensher (2012/2013)** on embedding multiple heuristics and logit-type weighting
  - **Hensher (2019) keynote on multiple-heuristic choice processes,** discussing probability weighting of heuristics

METHODOLOGY

Inferred multiple heuristics (InfVL-InfMCD)

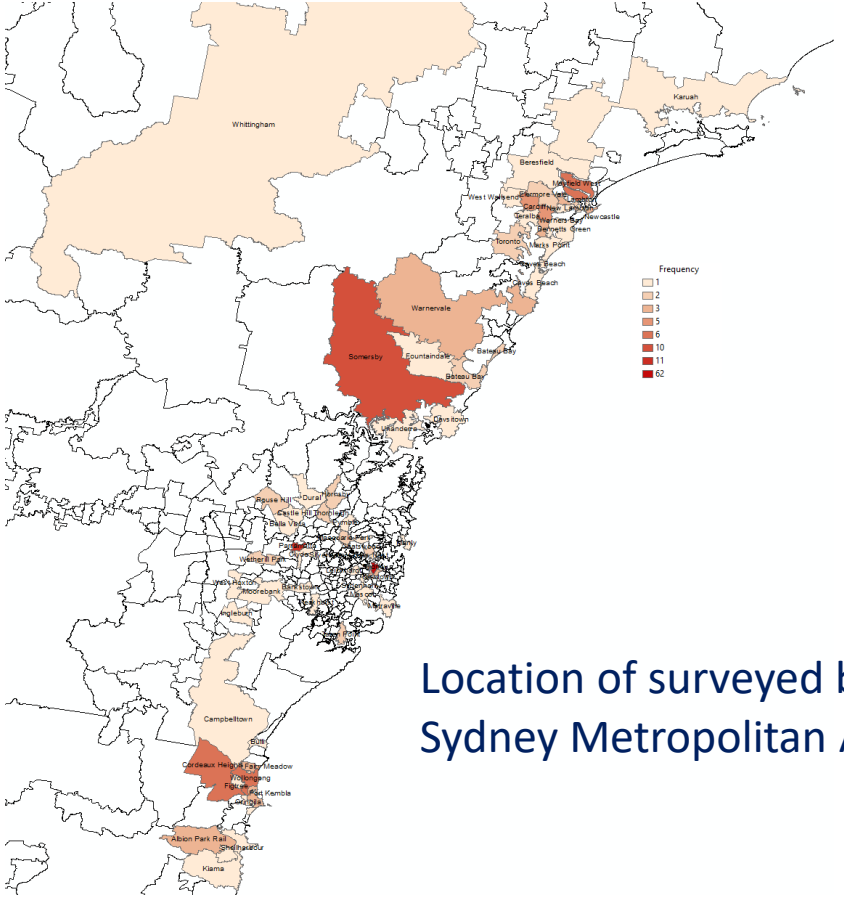
$$U_i^{\text{InfVL-InfMCD}} = \beta_{0,i} + f(\cdot)_{\text{LPAA},i} + \delta_{\text{VL}} f(\cdot)_{\text{VL},i} + \delta_{\text{MCD}} f(\cdot)_{\text{MCD},i} + \eta_{i,q} + \varepsilon_i$$

Inferred VL and stated MCD (InfVL-StMCD)

$$U_i^{\text{InfVL-StMCD}} = \beta_{0,i} + f(\cdot)_{\text{LPAA},i} + \delta_{\text{VL}} f(\cdot)_{\text{VL},i} + d_{\text{MCD}} \delta_{\text{MCD}} f(\cdot)_{\text{MCD},i} + \eta_{i,q} + \varepsilon_i$$

Stated VL and inferred MCD (StVL-InfMCD)

$$U_i^{\text{StVL-InfMCD}} = \beta_{0,i} + f(\cdot)_{\text{LPAA},i} + d_{\text{VL}} \delta_{\text{VL}} f(\cdot)_{\text{VL},i} + \delta_{\text{MCD}} f(\cdot)_{\text{MCD},i} + \eta_{i,q} + \varepsilon_i$$



Location of surveyed businesses in the Greater Sydney Metropolitan Area

Profile of businesses

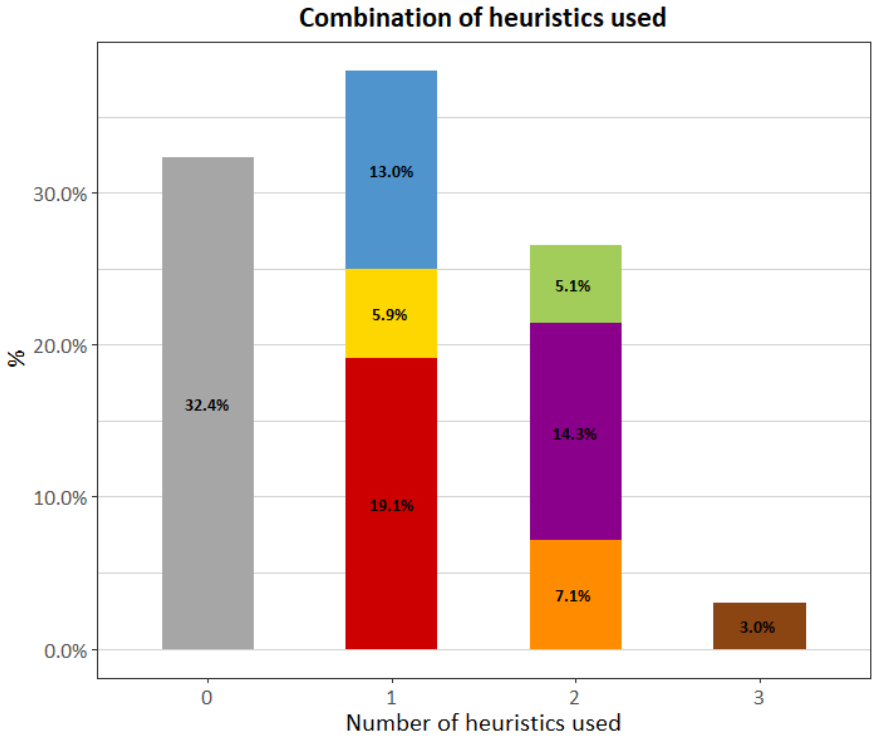
(N = number of respondents)

Is the business…	**N**	**%**
A listed company	20	13%
A company that is not listed	91	57%
A partnership	12	8%
A family owned business	25	16%
A start-up	0	0%
Foreign owned (in part of full)	21	13%
Domestically owned (in part or full)	23	14%
Other	10	6%
How would you describe your sector?[3]		
Manufacturing	19	12%
Health Care and Social Assistance	12	8%
Education and Training	14	9%
Financial and Insurance Services	25	16%
Information, Media and Telecommunications	17	11%
Construction	17	11%
Retail Trade	13	8%
Professional, Scientific and Technical Services	15	9%
Wholesale Trade	16	10%
Who owns the building?		
Our business	45	28%
Institutional owner	33	21%
Private landlord	81	51%
Business Size		
Small (less than 20 employees)	70	44%
Medium (between 20-50 employees)	85	53%
Large (more than 50 employees)	4	3%
Process strategies		
VL: Did the characteristics of the alternatives provided in the earlier choice tasks influence your decisions in the subsequent choice tasks? Yes	71	45%
What made you choose one alternative?		
I chose the first alternative whose characteristics satisfied my requirements (ignoring the remaining alternatives).	50	31%
I eliminated alternatives that failed to meet my requirements, starting with the most important characteristics.	55	35%
LPAA: I compared the alternatives' characteristics considering that some characteristics are more important to me than others	55	35%
MCD: I chose the alternative that has the highest number of best performing characteristics (relative to the other alternatives).	35	22%
Others. Please specify.	4	3%

DESCRIPTIVE PROFILE OF RESPONDENTS

Our final sample size has 159 businesses, with a total of 1,051 observations for choice modelling

Did respondents say they used more than one process strategy at the same time?



Stated value learning (VL), **majority of confirming dimensions** (MCD) and **attribute non-attendance** (ANA), in addition to the traditional approach which is referred to as linear in the parameters additive in the attributes (LPAA)

Combination of heuristics

- 0 - None
- 1 - LPAA only
- 1 - MCD only
- 1 - VL only
- 2 - MCD and LPAA
- 2 - VL and LPAA
- 2 - VL and MCD
- 3 - VL, MCD and LPAA

Models' parameter estimates (t-values in parenthesis)

			M1: LPAA without ANA	M2: LPAA with ANA	M3: StVL-StMCD without ANA	M4: StVL-StMCD with ANA	M5: InfVL-InfMCD without ANA	M6: InfVL-InfMCD with ANA	M7: InfVL-StMCD with ANA	M8: StVL-InfMCD with ANA
			M1	M2	M3	M4	M5	M6	M7	M8
LPAA			Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
VL			No	No	Stated	Stated	Inferred	Inferred	Stated	Stated
MCD			No	No	Stated	Stated	Inferred	Inferred	Inferred	Inferred
ANA			No	Yes	No	Yes	No	Yes	Yes	Yes
Parameters	Acronym	Alternatives								
ASC alternative locations	ASC_ALT	Alternative locations	-	-	-	-	-	-	-	-
ASC current location	ASC_CURR	Current location	1.250 (4.05)	1.200 (4.07)	1.010 (3.21)	0.972 (3.19)	0.745 (2.44)	0.684 (2.34)	0.635 (1.98)	1.000 (3.47)
Public transport headway	FREQ	All	-0.946 (4.43)	-1.720 (6.27)	-0.932 (4.06)	-1.740 (6.05)	-0.592 (2.05)	-1.280 (4.08)	-1.890 (6.27)	-1.160 (3.92)
Walking time to closest rail station	WLKTR	Alternative locations	-0.906 (3.68)	-1.200 (3.98)	-0.871 (3.17)	-1.180 (3.55)	-0.047 (0.12)	-0.166 (0.39)	-1.250 (3.43)	-0.220 (0.60)
Client accessibility	ACCESS	All	-	-	-	-	-	-	-	-
Rental space cost	RENT	All	-0.041 (0.80)	-0.130 (2.30)	-0.030 (0.56)	-0.128 (2.13)	0.067 (1.01)	-0.008 (0.12)	-0.136 (1.90)	-0.016 (0.27)
Amount of office space - mean	SPACE	All	0.084 (2.82)	0.083 (2.83)	0.089 (3.12)	0.092 (3.01)	0.047 (2.14)	0.042 (1.82)	0.100 (2.62)	0.041 (1.83)
- std dev			0.066 (2.30)	0.068 (2.33)	0.061 (2.28)	0.072 (2.40)	0.041 (1.83)	0.049 (1.92)	0.080 (2.00)	0.044 (1.82)
Lease commitment	LEASE	All	-0.220 (2.16)	-0.313 (2.75)	-0.211 (1.95)	-0.291 (2.39)	0.010 (0.07)	-0.057 (0.39)	-0.343 (2.53)	-0.027 (0.20)
Agglomeration - mean	AGGLOM	All	-0.309 (3.81)	-0.447 (3.63)	-0.308 (3.67)	-0.417 (3.35)	-0.228 (2.62)	-0.301 (2.29)	-0.455 (3.31)	-0.268 (2.22)
- std dev			0.314 (2.48)	0.624 (2.85)	0.305 (2.25)	0.590 (2.53)	0.265 (1.67)	0.593 (2.38)	0.615 (2.38)	0.556 (2.33)
Distance to current location	DIST	Alternative locations	-0.024 (6.17)	-0.030 (6.76)	-0.026 (6.42)	-0.032 (6.92)	-0.024 (5.30)	-0.029 (5.99)	-0.034 (7.13)	-0.026 (5.75)
VL heuristic weight - mean	VL	All	-	-	-2.120 (2.88)	-2.220 (2.50)	-1.950 (2.00)	-2.220 (2.14)	-1.740 (2.12)	-2.700 (2.15)
- std dev			-	-	2.120 (2.88)	2.220 (2.50)	1.950 (2.00)	2.220 (2.14)	1.740 (2.12)	2.700 (2.15)
MCD heuristic weight	MCD	All	-	-	0.166 (2.20)	0.184 (2.08)	0.264 (5.91)	0.321 (6.37)	0.188 (2.15)	0.314 (6.07)
Error Components - std dev	EC_ALT	Alternative locations	2.780 (7.80)	2.740 (7.76)	2.820 (7.82)	2.810 (7.68)	2.530 (7.42)	2.500 (7.37)	2.650 (7.44)	2.650 (7.75)
Error Components - std dev	EC_CURR	Current location	-	-	-	-	-	-	-	-
Number of Parameters Estimated			11.00	11.00	13.00	13.00	13.00	13.00	13.00	13.00
Log Likelihood at convergence			-705.23	-685.39	-702.76	-684.12	-684.89	-666.10	-684.38	-667.63
Log likelihood at zero			-986.37	-986.37	-986.37	-986.37	-986.37	-986.37	-986.37	-986.37
AIC/n			0.151	0.147	0.151	0.147	0.147	0.143	0.147	0.144
Number of observations			1,051							

RESULTS: WITH OR WITHOUT ANA?

	M1: LPAA without ANA	M2: LPAA with ANA	M3: StVL-StMCD without ANA	M4: StVL-StMCD with ANA
Log-likelihood	-705.23	-685.39	-702.76	-684.12
AIC/n	0.151	0.147	0.151	0.147
Parameters' significance level	Rent is not significant	All attributes are significant	Rent is not significant	All attributes are significant

- Adding ANA improved the model in terms of goodness to fit and also in terms of parameter significance level, as we expect rent to be important for at least some of the respondents.

It was expected, *a priori*, that rent is an important location decision attribute, although it is reasonable that some businesses did not attend to that attribute because, for example, they own the building in which they operate and would plan to do the same if they moved location (although deemed rent as a tax deduction clearly applies).

Therefore, the results presented show the importance of including stated ANA, with all subsequent allowing for ANA.

RESULTS: STATED OR INFERRED MULTIPLE HEURISTICS?

	M4: StVL-StMCD with ANA	M6: InfVL-InfMCD with ANA	M7: InfVL-StMCD with ANA	M8: StVL-InfMCD with ANA
Log-likelihood	-684.12	-666.10	-684.38	-667.63
AIC/n	0.147	0.143	0.147	0.144
Parameters' significance level	All attributes are significant	Time to train station, rent and lease is not significant	All attributes are significant	Time to train station, rent and lease is not significant

- This finding suggests that when inferring VL and MCD (particularly MCD), there is a statistically significant effect on the parameter estimates and the significance level of otherwise important attributes.

WILLINGNESS TO PAY ESTIMATES

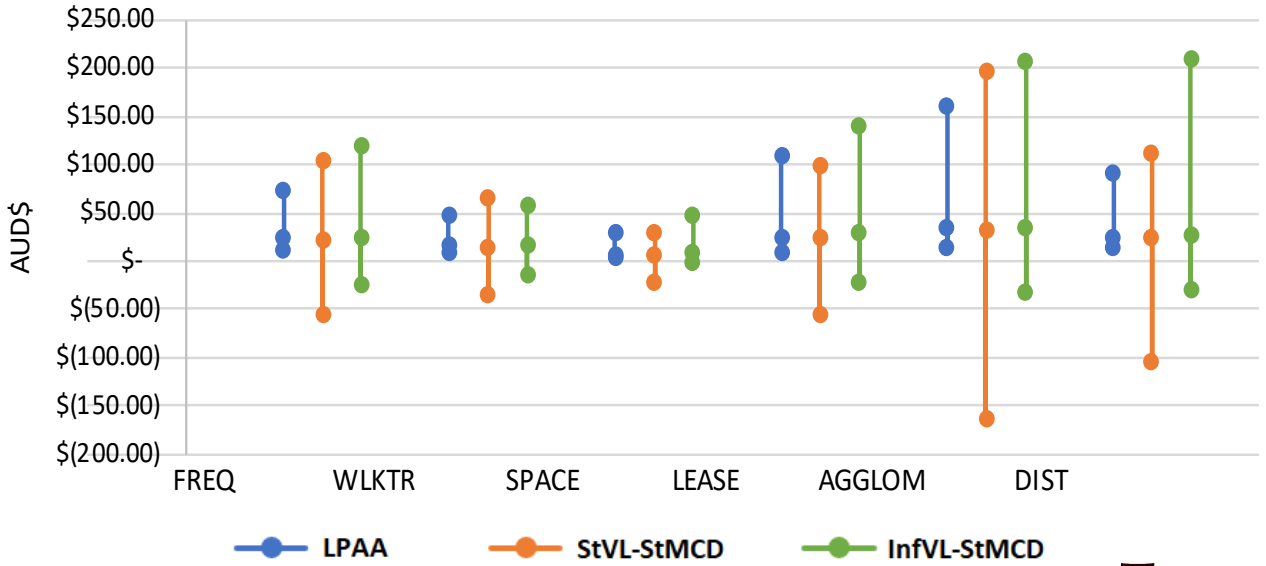
Median willingness to pay estimates (AUD$)

How much a respondent in willing to pay (AUD$) relative to rental price per square metre for	LPAA with ANA	StVL-StMCD with ANA	InfVL-StMCD with ANA
A decrease in public transport headway by 1 minute	$22.06	$21.57	$22.80
A decrease in walking time to the closest rail station by 1 minute	$15.34	$13.94	$14.42
An increase in the amount of office space by 10 square metres	$6.35	$6.22	$6.84
A decrease in the lease commitment by 1 year	$24.02	$23.72	$26.94
A decrease in agglomeration by 1 business around their local area	$34.33	$30.10	$32.29
A decrease in the distance to a current location by 1 kms	$22.83	$24.14	$26.02

In terms of the accessibility variables, the results show that a sampled business would be willing, at the median level, to pay an additional annual rental price per square metre varying between $21.57 and $22.80 to improve the public transport headway by 1 minute; and between $13.94 and $15.34 to decrease the walking time to the closest rail station by 1 minute.

WILLINGNESS TO PAY ESTIMATES

Median willingness to pay estimates (AUD$) with confidence intervals



Although there are no statistically significant differences between the two models, when considering the confidence levels, the median WTPs are different enough to have a significant influence if they are used when assessing a new public transport project.

CONCLUSION

- This research investigates the behavioural and welfare implications of incorporating multiple process strategies in choice models through the inclusion of additional information provided by respondents on how they processed the choice tasks shown to them in the stated choice experiment

- The results showed that ANA was statistically significant when eliciting preferences, suggesting that individuals are aware of the attributes they are ignoring

CONCLUSION

- The results show an improvement in the parameters' significance level when considering individuals use the heuristics that they said they had used (stated multiple heuristics) instead of inferring them (inferred multiple heuristics)

- When comparing the results of using stated or inferred ANA, the model results were similar. This is an interesting result which shows that assuming everyone might use MCD significantly biases the results, but assuming everyone might use VL (despite their responses) does not have such a strong influence on the model results

- The three preferred models in terms of goodness of fit and parameter significance levels were the LPAA, StVL-StMCD, and InfVL-StMCD.

CONCLUSION

- The WTP estimates derived from the LPAA model were statistically equivalent to the ones derived from the stated multiple heuristics model

- However, the median WTP for all the attributes was slightly lower in the multiple heuristics models and the confidence intervals were higher than in the LPAA model

- This suggests that even though there are no statistically significant differences between the two models, there are certain patterns that reveal an important influence associated with including stated alternative process strategies

CONCLUSION

- This research presents interesting findings that suggest that asking respondents for additional information on the process strategies used and including these responses in the models, provides a way of building our understanding of decision-making in the context of business location decisions

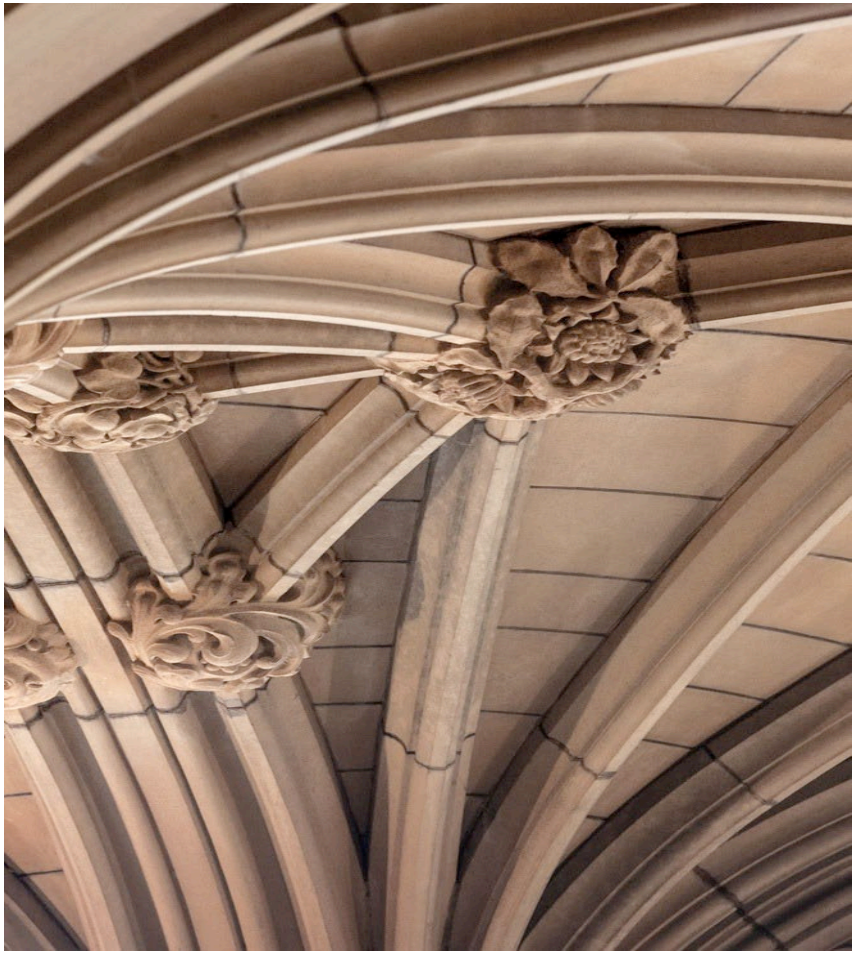
- The results provide new insights that can be used in cost-benefit analyses when assessing transport projects, which traditionally do not consider business location impacts

Non-Linear Random Parameter Models and Multiple (Process) Heuristics Models

Reference Source:
Hensher, D.A., Rose, J.M., and Greene, W.H. (2015) Applied Choice Analysis, Second edition, Cambridge University Press, Cambridge

See especially Chs 20 and 21

These models require high quality data with appropriate variance



THE UNIVERSITY OF SYDNEY

Experience as a conditioning effect on choice

- When we allow for this form of heteroscedasticity, the standard logit model takes the form shown below where V_{qj} is linear-in-parameters.

$$\Pr_{jq} = \frac{\exp\left[\mu\left(E_{qj}\,|\,\gamma\right)\cdot\left(ASC_j + \sum_k \beta_{k\,qj}\cdot x_{k\,qj}\right)\right]}{\sum_{j'=1}^{J}\exp\left[\mu\left(E_{qj'}\,|\,\gamma\right)\cdot\left(ASC_{j'} + \sum_k \beta_{k\,qj'}\cdot x_{k\,qj'}\right)\right]}$$

This model is non-linear-in-parameters since the parameter associated with the experience effect (γ_j) interacts with the parameters β associated with attributes X_{qj}.

$$\mu(E_{qi}) = \ln\left(1+\exp\left(\gamma_q \cdot DummyExp_{qi} + \gamma\cdot Z_q\right)\right)$$

$DummyExp_{q,i}$=a dummy variable that equals to 1 if mode i has been experienced by individual q, and 0 otherwise; z_q represents any statistically significant socioeconomic characteristics

Hensher, D.A., Balbontin, C., Greene, W. G., and Swait, J. (2021) Experience as a conditioning effect on choice – does it matter whether it is exogenous or endogenous?, (presented at the *Sixth International Choice Modelling Conference* in Kobe, Japan, August 2019), *Transportation,* 48, 2825-2855. https://doi-org.ezproxy2.library.usyd.edu.au/10.1007/s11116-020-10149-1

Dan McFadden's Support for the Focus on Process

– Dan McFadden (2001) amongst others, raised the necessity of including information, experience and decision processes in the traditionally used random utility maximization (RUM) framework:

"*What lies ahead? I believe that the basic RUM theory of decision-making, with a much larger role for experience and information in the formation of perceptions and expression of preferences, and allowance for the use of rules as agents for preferences, can describe most economic choice behavior in markets, surveys, and the laboratory. If so, then this framework can continue for the foreseeable future to form a basis for microeconometric analysis of consumer behavior and the consequences of economic policy.*"

McFadden, D., 2001. Economic Choices. **Am. Econ. Assoc**. 91, 351–378 (Nobel Prize talk).

Process Heuristics Need More Attention

- Attribute processing has come of age, and we see many studies using process heuristics such as attribute non attendance (ANA), relative advantage maximisation (RAM), extremeness aversion (EA), regret (RR), value learning (VL) and other process heuristics.

Despite this…..

- Hensher (2014) "…the great majority of choice modelling research has taken, as a maintained assumption, the behavioural position that individuals [*act as if they*] are fully compensatory in the way that they assess and trade-off attributes in choice making and that in circumstances where the analyst imposes a set of attributes to evaluate, as is common in stated choice experiments [also RP studies], it is commonly assumed that all attributes are **relevant** in choice making….."

→Also commonly assumed L(linear) P(parameters) A(additive)A(attributes) specification (but sometimes with interactions)

Hensher, D.A. (2014) Process heuristics in choice analysis: An editorial, Special Issue of ***Journal of Choice Modelling*** *on Processing Heuristics* (edited by David A. Hensher), 11, 1-3.

Hensher, D.A. (2006) How do Respondents Process Stated Choice Experiments? – Attribute consideration under varying information load, ***Journal of Applied Econometrics***, 21 (6), 861-878.

Are respondents aware of the process strategies used in decision-making? Modelling business location decisions using multiple stated process strategies

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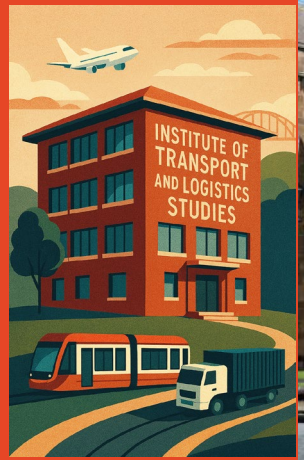


We acknowledge ARC-DP grant (2017-19) DP170100420 and the research program of the Volvo Research and Education Foundation Bus Rapid Transit Centre of Excellence

Covid-19 Impact

- 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.

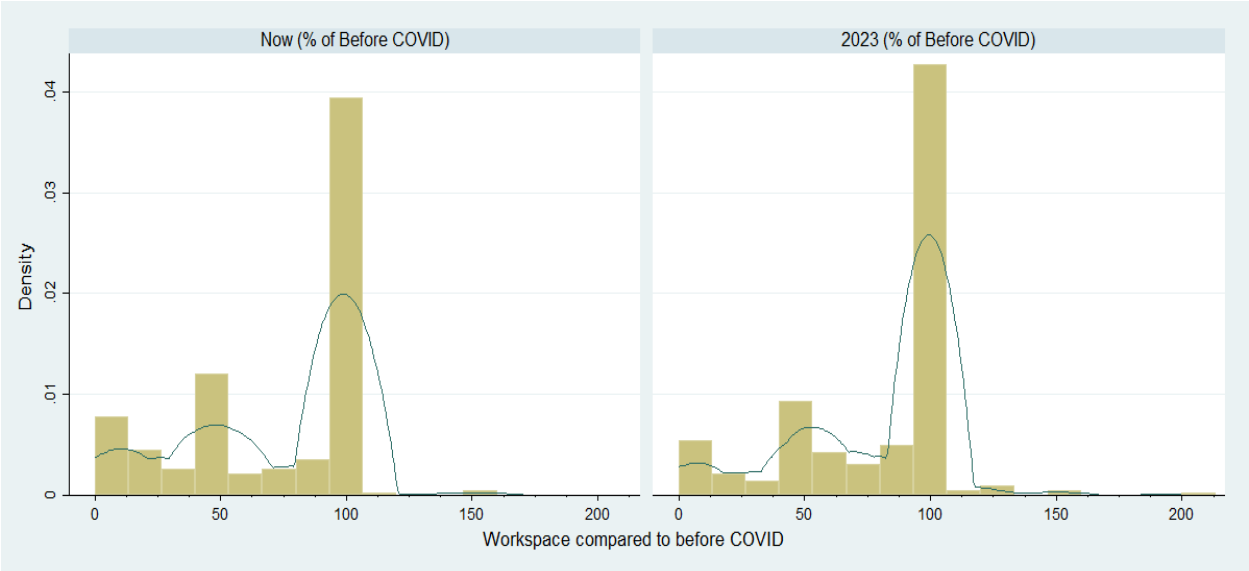
Some Key Descriptive Statistics: 459 organisations in GSMA

Before COVID	Mean	STD	Median	Min	Max
Number of working days	4.4	1.3	5	0	7
WFH Proportion	**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	**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	**72**	36	100	0	150
Commuting time in minute	31	23	30	0	150
In 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
Commuting time in minute	31	23	30	0	150

Do you think more employees will start working at satellite offices (in space which is shared with others or rented for your organisation only) instead of the main office they went to before COVID?
If yes, then ask: What percent of employees will start working at satellite offices?

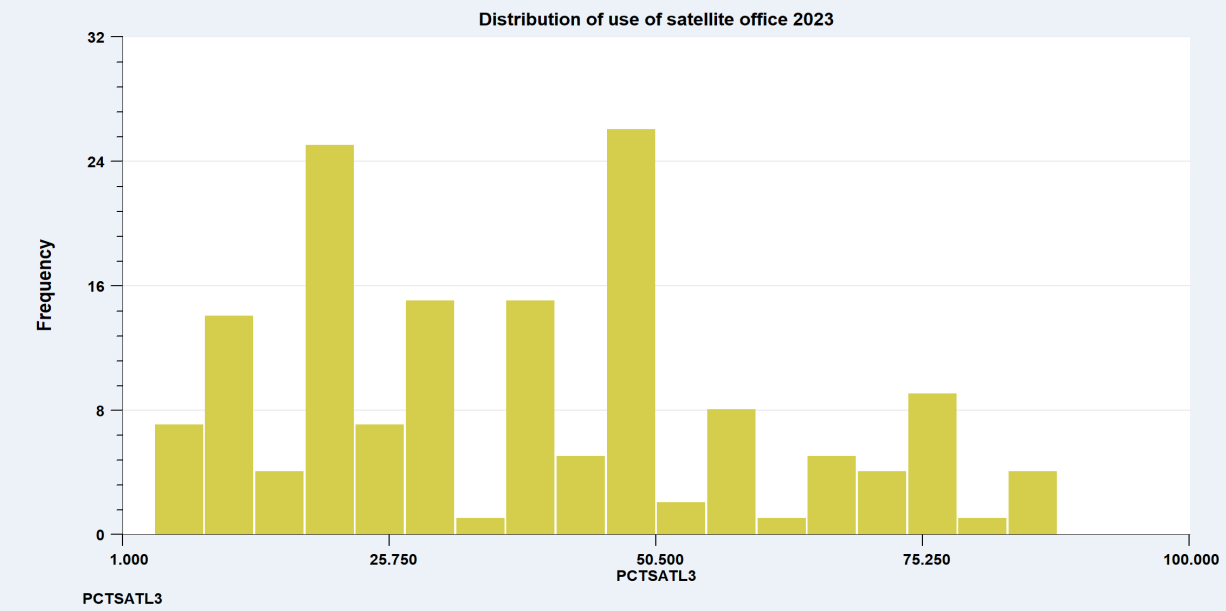
	Mean	STD	Median	Min	Max
% employees in office at one time	57.6	32.5	50	0	100
% employees in satellite office	41.0	24.9	40	1	100

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



Satellite Office Impact: GSMA

There will be, on average, 41% staff in future working in satellite office, but this should be re-weighted by 34.72% who said will have satellite offices.
So for all businesses, the average percent should be **14.34%** after weighting.



Evidence from the Modelling Activity: workspace random effects regression model for GSMA

- Our survey suggests that the total drop in office workspace or office vacancies is close to an average of 28% in April 2022, and expected to be 21% in 2023,
  - showing some recovery of space being leased or owned, and the full recovery to the pre-COVID-19 office occupancy level most likely taking much longer,
  - and hence the decrease due to WFH is only one reason for the reduction of office capacity, representing 25% of the reason in 2023.

- At the same time, in 2023 it is anticipated that some amount of work will occur at a satellite location (14.34%) which we suggest is relatively closer to an employee's home than the Pre-COVID-19 office location.

- The mean elasticity estimate of 0.0198 indicates that, *ceteris paribus*,
  - a 10% increase in the employees using a satellite office results in a 0.198% reduction in the percentage change in the expected amount of workspace at the main office location in April 2022.

METHODOLOGY

Inferred multiple heuristics (InfVL-InfMCD)

$$U_i^{\text{InfVL-InfMCD}} = \beta_{0,i} + f(\cdot)_{\text{LPAA},i} + \delta_{\text{VL}} f(\cdot)_{\text{VL},i} + \delta_{\text{MCD}} f(\cdot)_{\text{MCD},i} + \eta_{i,q} + \varepsilon_i$$

Inferred VL and stated MCD (InfVL-StMCD)

$$U_i^{\text{InfVL-StMCD}} = \beta_{0,i} + f(\cdot)_{\text{LPAA},i} + \delta_{\text{VL}} f(\cdot)_{\text{VL},i} + d_{\text{MCD}} \delta_{\text{MCD}} f(\cdot)_{\text{MCD},i} + \eta_{i,q} + \varepsilon_i$$

Stated VL and inferred MCD (StVL-InfMCD)

$$U_i^{\text{StVL-InfMCD}} = \beta_{0,i} + f(\cdot)_{\text{LPAA},i} + d_{\text{VL}} \delta_{\text{VL}} f(\cdot)_{\text{VL},i} + \delta_{\text{MCD}} f(\cdot)_{\text{MCD},i} + \eta_{i,q} + \varepsilon_i$$