Transport Knowledge Conference 2016
CUSTOMER FOCUSSED TRANSPORT
Thursday 10 November 2016 | James Cook Hotel Wellington

Using Choice Modelling to Measure Transport User Preferences

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Motivation

- Transport sectors present numerous examples of people choosing just one from a number of competing alternatives – i.e. making “discrete choices”.

- Examples – transport users’:
  - *Route choice* – including roads or zones with prices
  - *Mode choice* – including ride-sharing, or active modes
  - *Vehicle choice* – including EVs, or AVs
  - *Driving choices* – e.g. speed or not, drink-and-drive or toke-and-drive, safely load my truck or overload it, drive excessive hours, etc.

Discrete Choice Demand Analysis

- *Discrete Choice Demand Analysis* (DCDA) allows us to measure transport user preferences, predict user choices, and evaluate users' decision trade-offs:
  - Widely-used and well-understood, in multiple sectors.
- Pioneered by Daniel McFadden in early 1970s, to predict demand for a novel transport mode in San Francisco – Bay Area Rapid Transit (BART):
  - Official forecast was for 15% demand share
  - McFadden predicted 6.3% – actual was 6.2%.
- Developing the approach earned McFadden a Nobel.

Discrete Choice Demand Analysis (cont'd)

BART and Daniel

Outline of the Approach

- The “genius” of DCDA is that it decomposes the things that people might choose into their constituent attributes:

Is this an EV? …

Outline of the Approach (cont'd)

… or is this an EV?

Heaps of torque

An interrupted holiday just waiting to happen

Free parking

A very slow refuel

Something cool and new that my neighbours don't have

Licence to use a bus lane

A statement about how much I care about the planet

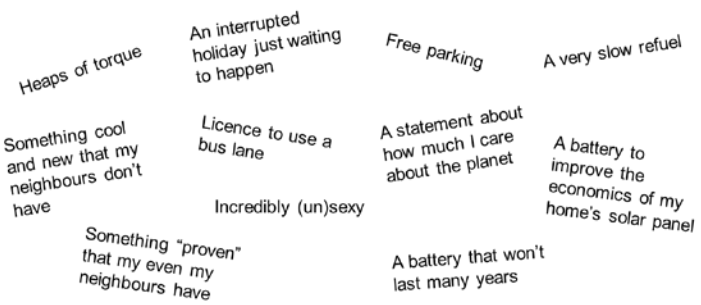
A battery to improve the economics of my home's solar panel

Incredibly (un)sexy

Something "proven" that my even my neighbours have

A battery that won't last many years

Outline of the Approach (cont'd)



Product Attributes

Consumer Characteristics

Data on Consumer Choices and Consumers (Revealed, or Stated)

$$LL_M^E(\beta \mid x, y) = \sum_{n=1}^{N} \sum_{j=1}^{J} y_{nsj} \ln\left[E\left(P_{nj}(x_{nj} \mid \beta_n) \right) \right]$$

Infer preferences from choice data

Data Types – Either or Both of …

- *Revealed preference* (RP) data:
  - Data on actual user choices – ideally, of individuals
  - "Gold standard", but has its own limitations – e.g. incomplete, insufficient variation, statistical issues.

- *Stated preference* (SP) data:
  - Choice data obtained from experimentally-designed surveys – individuals asked to choose from menus
  - "Hypothetical", but handles novel situations, and can get multiple observations plus respondent details.

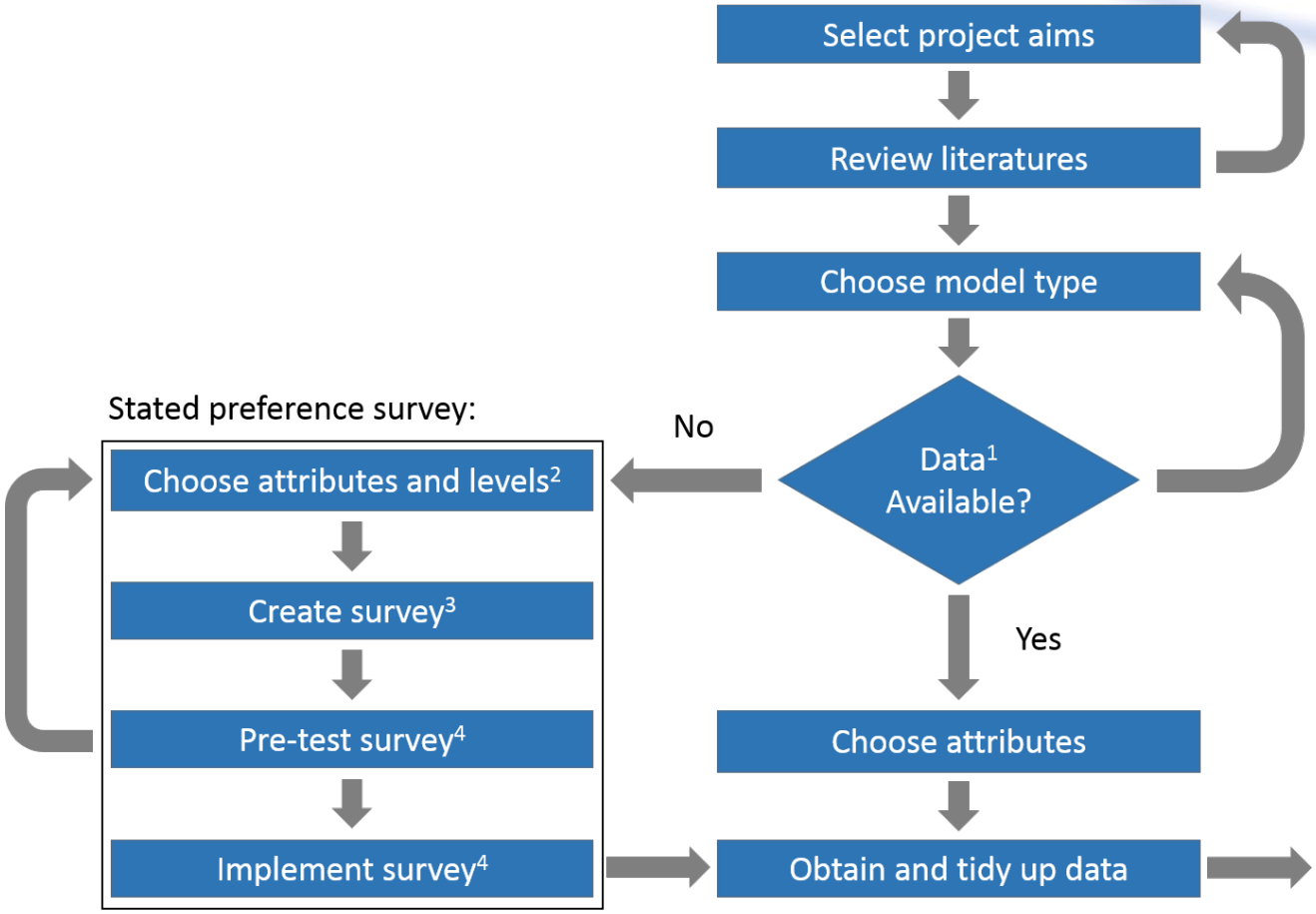
Range of Model Types Includes …

- *Simplest* – "multinomial logit" (MNL):
  - "Data-lite", and implementation easy, but known issues
  - Assumes all users have same preferences.

- *Sophisticated but still easy to implement* – "mixed logit" (ML) with individual-level choice data:
  - Needs more data, but addresses MNL limitations
  - Allows for different users having different preferences.

- *Sophisticated but harder to implement* – ML with aggregated choice data:
  - "Data-lite(ish)", but estimation is trickier.

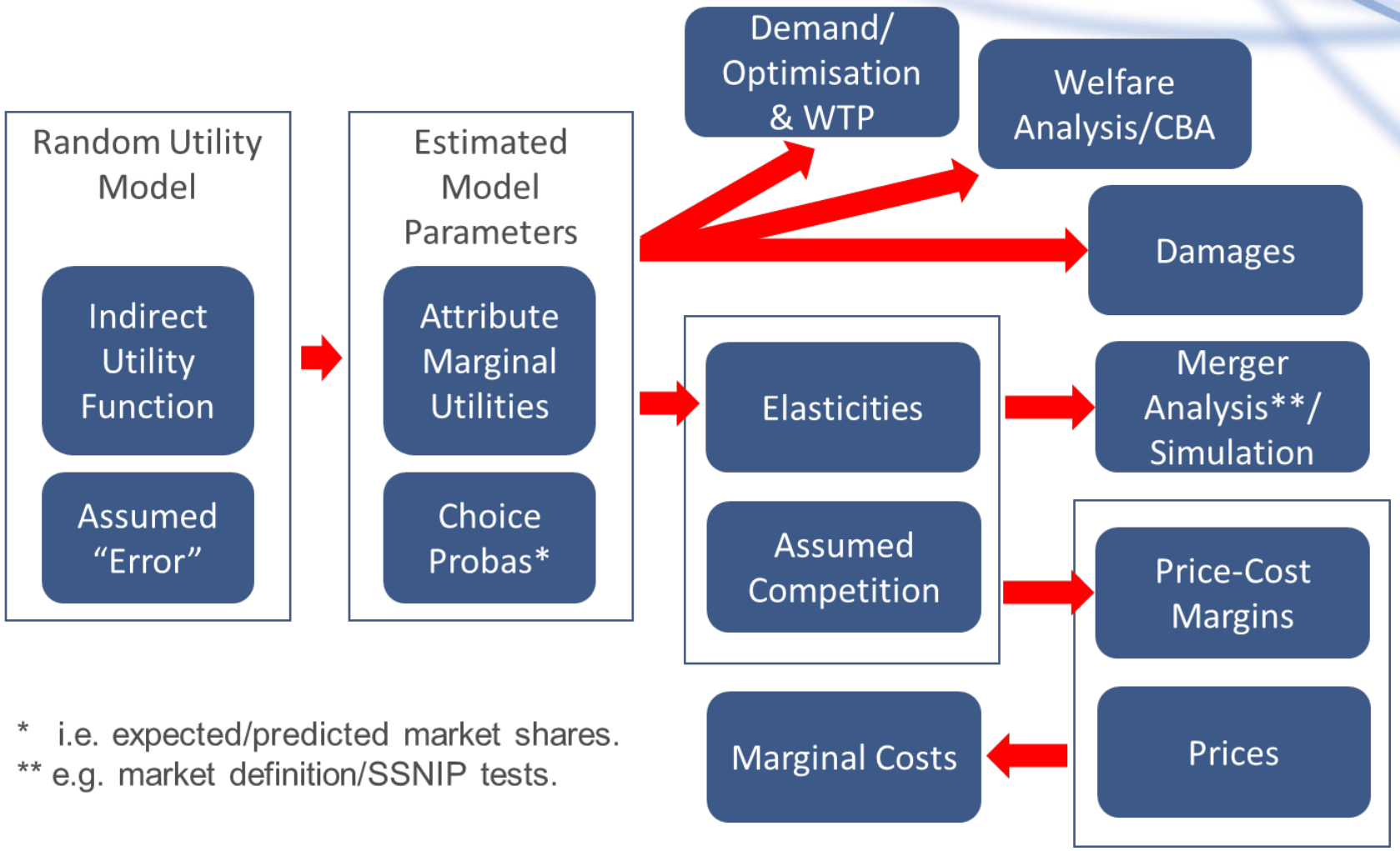
What does DCDA Involve?



Notes:

1. Principally data re choice alternatives, but ideally also re decision makers.
2. Multiple technical and institutional considerations.
3. Using specialised software to produce efficient survey with desirable statistical properties for selected demand model.
4. E.g. consumer panels, personal interviews, etc.
5. Estimate choice probabilities, demand, WTP, elasticities, etc, and simulate scenarios.

What can you do with DCDA?



* i.e. expected/predicted market shares.
** e.g. market definition/SSNIP tests.

Applying DCDA using the HTS?

- June 2016 study for MoT, with Dr Lydia Cheung at AUT.
- HTS has survey data on actual individual transport user choices → RP, but not collected with DCDA in mind.
- Can it be used to estimate transport users' willingness-to-pay (WTP), and hence trade offs, between:
  - Travel time
  - Travel time reliability/variability
  - Safety
  - Ride quality
  - Travel cost?

Applying DCDA using the HTS? (cont'd)

- Could implement a ML mode choice model for urban trips, but HTS needs augmenting using additional data:
  - Gaps re travel cost, ride quality, non-urban trips, …
- Asking a lot of the data to accommodate all of these interrelated transport attributes at once:
  - Studies commonly include *travel cost* and *travel time*
  - Increasingly common to include *travel time reliability*
  - Relatively new to include *safety* – but only accident risk, not personal safety (e.g. PT)
  - Rare to include *ride quality* – hard to measure.

Conclusion

- DCDA commonly used to estimate consumer preferences in a wide range of sectors/situations.
- Pioneered for transport, and very well-established:
  - Including for “newer” issues like EV uptake, toll road demand, etc.
- Unlocks the “black box” of consumer preferences:
  - Key ingredient for any proper economic analysis
  - What can you usefully say without knowing these preferences?