Shared-car mobility services: Theoretical challenges and application of novel stated-choice methods
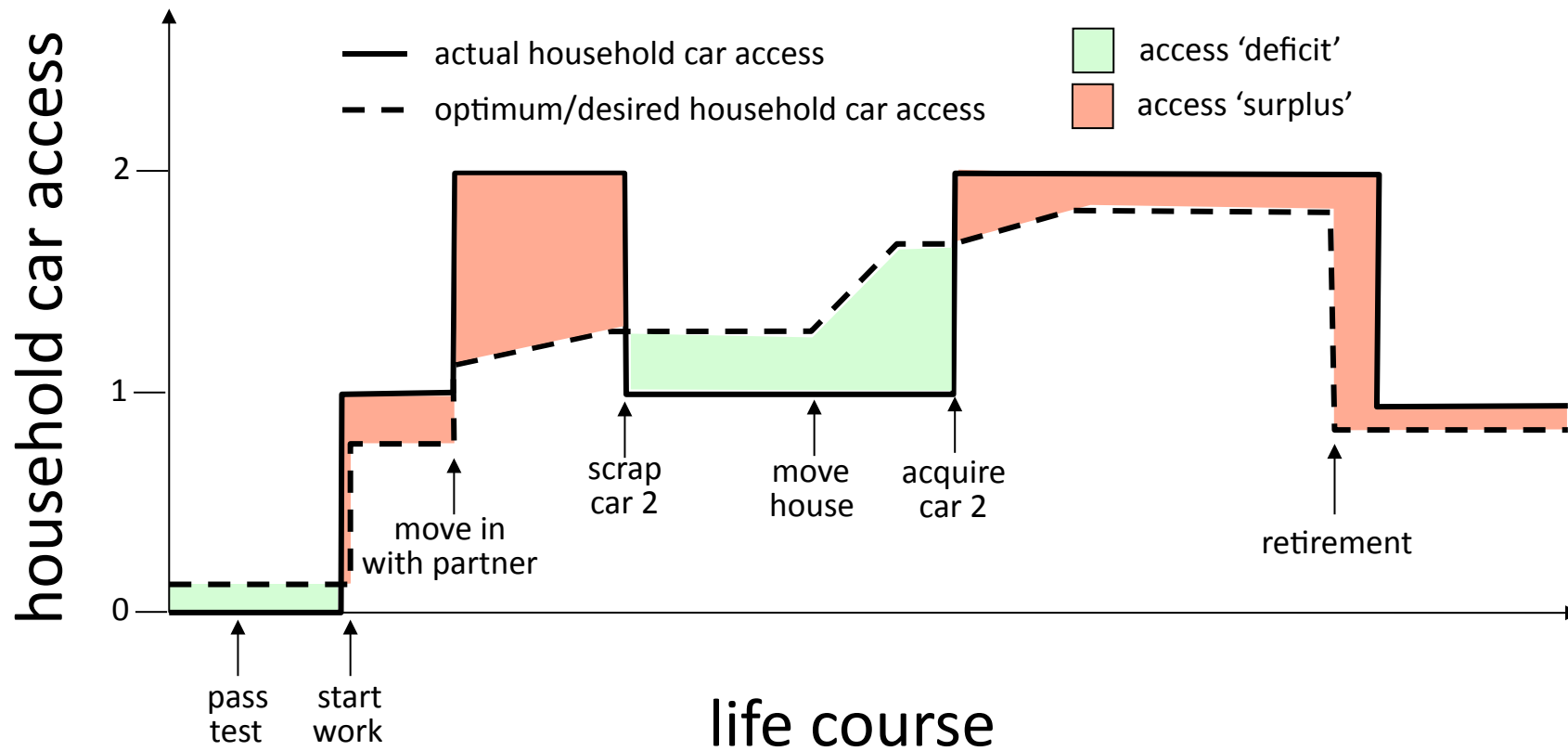
Scott Le Vine
Imperial College

ETH-IVT
Workshop on survey innovation & quality
6 Dec 2012

Cars come in integers...

Increasingly relevant

- Start-ups...

- **Established firms**: Daimler, Enterprise, Ford, GM, Hertz, Honda, Peugeot, VW,...

- Policy interest: Local authorities through to national government

- More diverse, less distinct: Round-trip, one-way, P2P, integrated with wider transport networks.

  Hertz: "*aiming to get a significant amount of the [car hire] fleet installed with [car club] technology*"

Public affairs mgr Paula Rivera, quoted in: http://gigaom.com/cleantech/can-hertz-shake-up-car-sharing-2, 22/5/12

3

Shared-assets or accessed-assets?

http://www.whitbread.co.uk/whitbread/media/newspressreleases/individualnewsarticle/
premierinnnewplanningpermissionsrecord.html

http://www.ethiopiahewitt.com/projects/booth/

http://cloudcomputingcompaniesnow.com/

http://www.privategpbrighton.co.uk/taxi.html

Gaming-simulation

Survey instruments:

– Intake forms

– 7-day activity-travel diaries

– Single-sheet diary summaries

– Acetate overlays
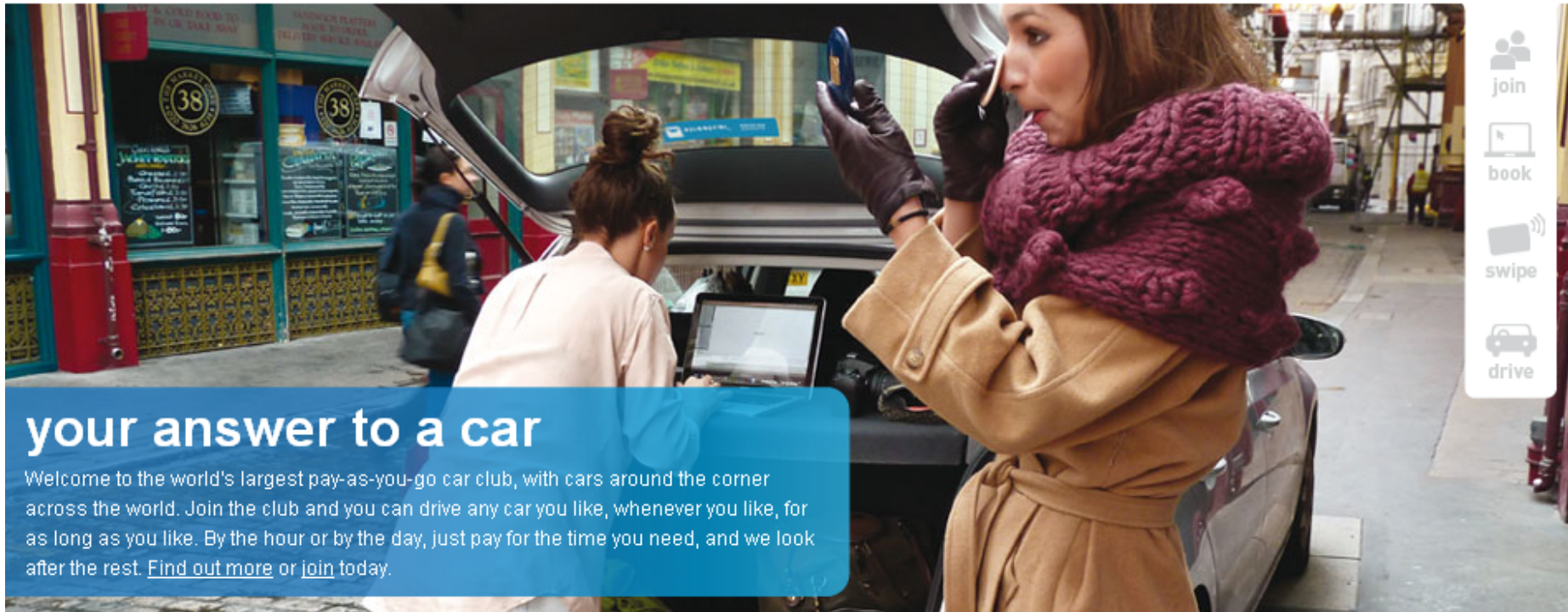

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Car clubs v. 'owned' cars

- Payment structure: upfront v. pay-as-you-go

- Flexibility

- Control

- Parking, inspection, misc. hassles

- Spontaneity

- Dealing with damage

Challenge: mode choice?

	Personal car	**Car club**
Journey time	X mins.	X+k mins.
Journey cost	£Y	£Y+m
Hassle	Low	High
Pre-trip planning	Low	High

Car subscription v. car ownership

your answer to a car

Welcome to the world's largest pay-as-you-go car club, with cars around the corner across the world. Join the club and you can drive any car you like, whenever you like, for as long as you like. By the hour or by the day, just pay for the time you need, and we look after the rest. Find out more or join today.

join

book

swipe

drive

www.streetcar.co.uk

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Car subscription v. car ownership

But why subscribe? (or own a car?)

- Traditional: f(demog., income, residence)

- Emerging: f(", ", ", car-based accessibility to *your* activities)

Car ownership generalised

- Understand and predict which **_mobility resources_** a person owns

- **MR**: any product, service, status, or information that enables or facilitates travel in some way

- Some methods of travel may require one or several

Structure of choice sets

- System of five market-traded, durable, specialised MRs

- Thus 2^5 = 32 portfolios:

    - A, B,...,AB,...,ABCDE, None

- Seven methods of travel

    - Drive car
    - Ride bicycle
    - Take public transport
    - Walk
    - Take taxi

+ Car club & 'one-way' car club

Specification

- For some portfolio *d* of MRs...

- *"Of the various methods of travel it enables, how well does the 'best' one get me to activity j"...*

- Person *i* repeats this *J* times, once for each activity in a set of travel needs

$$V_d^{i,travel} = \left(\sum_{j_i}^{J_i} \gamma_{j_i} * \frac{1}{\lambda^{travel}} \ln \sum_{m \in \mu_d}^{M} e^{\left(V_{mj_i}^{i,travel} * \lambda^{travel} \right)} \right)$$

$$U_d^i = V_d^{i,non-travel} + V_d^{i,travel} + \varepsilon_d^i$$

Should Jane...

		TAKE A TAXI / MINICAB	DRIVE HER OWN CAR	DRIVE A CAR CLUB CAR	WALK	TAKE PUBLIC TRANSPORT	CYCLE
			[if so, she must...]	[if so, she must...]		[if so, decide how to pay]	[if so, she must...]
			BUY A CAR	JOIN A CAR CLUB		SEASON TICKET	BUY A BICYCLE
			cancel	cancel		PAYG	cancel
Some things Jane will do in a typical week...	(working at desk)	65 min each way £40 in total	60 min each way £25 in total	65 min each way £70 in total	120 min each way	60 min each way £10 in total	90 min each way
	(family/dinner)	20 min each way + £15	15 min each way + £3	20 min each way + £17	60 min each way	45 min each way + £5	30 min each way
	(shopping)	20 min each way + £15	15 min each way + £6	20 min each way + £15	60 min each way	30 min each way + £5	30 min each way
	(groceries)	15 min each way + £10	10 min each way + £1	15 min each way + £10	60 min each way	45 min each way + £5	20 min each way
	(child football)	20 min each way + £15	15 min each way + £2	20 min each way + £6	45 min each way	30 min each way + £2	15 min each way

Jane

What it means...

She will:

Buy a car   £4000/year

Her weekly travel & spending:

Petrol/parking costs: £137

Time driving: 11h 50m

I would do this
if I were Jane

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Should Jane...	TAKE A TAXI / MINICAB	DRIVE HER OWN CAR [if so, she must...]	DRIVE A CAR CLUB CAR [if so, she must...]	WALK	TAKE PUBLIC TRANSPORT [if so, decide how to pay]	CYCLE [if so, she must...]
		ⓘ BUY A CAR / cancel	ⓘ JOIN A CAR CLUB / cancel		ⓘ SEASON TICKET / PAYG	ⓘ BUY A BICYCLE / cancel
Some things Jane will do in a typical week... (work)	65 min each way £40 in total	60 min each way £25 in total	65 min each way £70 in total	120 min each way	60 min each way	90 min each way
(family meal)	20 min each way + £15	15 min each way + £3	20 min each way + £17	60 min each way	45 min each way	30 min each way
(shopping)	20 min each way + £15	15 min each way + £6	20 min each way + £15	60 min each way	30 min each way	30 min each way
(groceries)	15 min each way + £10	10 min each way + £1	15 min each way + £10	60 min each way	45 min each way	20 min each way
(child's football)	20 min each way + £15	15 min each way + £2	20 min each way + £6	45 min each way	30 min each way	15 min each way

Jane

What it means...

She will:

Buy a public transport season ticket   £150/month

Join a car club   £50/year

Her weekly travel & spending:

Petrol/parking costs: £2

Car club use fees: £15

Taxi fares: £10

Time driving: 30 mins

Time on public transport: 10h 50m

Time walking: 1h 20m

Time as taxi passenger: 20 mins

I would do this if I were Jane

OK, before we begin let me introduce you to Jane

Jane lives with her partner and son (age 7). They are moving to London soon, to a place in Outer London

She is in her 30s, and works in an office

Next

Her flat search has narrowed to four neighbourhoods in Outer London

She has asked for your advice:

She wants to know how you would get around from each place that she is considering

Next

Choice-making by proxy

- Complex, highly-personal choice task

- Seek a high degree of plausibility

- Seek to avoid a high-burden stage to pivot off the respondent's existing behavior & life constraints

- Small multi-disciplinary body of literature

- Choice task: "*What would **YOU** do?*", but in context of giving advice

Choice-making by proxy (2)

Minimizing self-other discrepancies...

- Target "other" ideally as **vivid** as possible

    "   "   "   **concrete**   "

    "   "   "   **known to the choice-maker**

Imagine you are giving advice to your best friend...

v.

...to someone somewhere in the United States...

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Choice-making by proxy (3)

- Avatar introduced with a handshake

- Similar profile as respondent (age, gender, employment, place, family structure)

- Avatar requests advice

- Demographics determine activities

- De-brief questions on self-other mental overlap

BBQ at her sister's place (once)

Take son to football practice (once)

Should Jane...

		TAKE A TAXI / MINICAB	DRIVE HER OWN CAR	DRIVE A CAR CLUB CAR	WALK	TAKE PUBLIC TRANSPORT	CYCLE
			[if so, she must...]	[if so, she must...]		[if so, decide how to pay]	[if so, she must...]
			ⓘ BUY A CAR — cancel	ⓘ JOIN A CAR CLUB — cancel		ⓘ SEASON TICKET — PAYG	ⓘ BUY A BICYCLE — cancel
		65 min each way £40 in total	60 min each way £25 in total	65 min each way £70 in total	120 min each way	60 min each way £10 in total	90 min each way
		20 min each way + £15	15 min each way + £3	20 min each way + £17	60 min each way	45 min each way + £5	30 min each way
		20 min each way + £15	15 min each way + £6	20 min each way + £15	60 min each way	30 min each way + £5	30 min each way
		15 min each way + £10	10 min each way + £1	15 min each way + £10	60 min each way	45 min each way + £5	20 min each way
		20 min each way + £15	15 min each way + £2	20 min each way + £6	45 min each way	30 min each way + £2	15 min each way

Some things Jane will do in a typical week...

ⓘ **Jane**

What it means...

She will:

Buy a car   £4000/year

Her weekly travel & spending:

Petrol/parking costs: £137

Time driving: 11h 50m

I would do this if I were Jane

Empirically-constrained efficient design

- (Specification) + (priors) + (SC design)
  = AVC matrix

- SC needed to identify subset of parameters, RP provides others

	A1	A2	A3	B1	B2	B3	B4
A1	26.86	22.11	-1.25	-3.53	-13.79	-4.35	-3.50
A2	22.11	23.37	-1.57	-3.35	-10.68	-7.73	-4.17
A3	-1.25	-1.57	0.27	0.28	0.80	0.67	0.86
B1	-3.53	-3.35	0.28	0.56	1.86	0.90	0.99
B2	-13.79	-10.68	0.80	1.86	11.66	3.50	4.94
B3	-4.35	-7.73	0.67	0.90	3.50	6.46	3.06
B4	-3.50	-4.17	0.86	0.99	4.94	3.06	7.20

Empirically-constrained efficiency (2)

A	
5	**2**
2	10

B	
8	**2**
2	9

- D-efficient: Design 'A' more efficient than 'B'

- S-efficient: No – select Design 'B'

- S metric seeks designs with balanced t-stats across parameters

- Journey itineraries from GB National Travel Survey as source of 'constraint' on sampling space

Commuting, Inner London

Duration of car driving itinerary (minutes)

Duration of public transport itinerary (minutes)

Percent of distribution

15
10
5
0

23

Commuting, <u>Outer</u> London

25
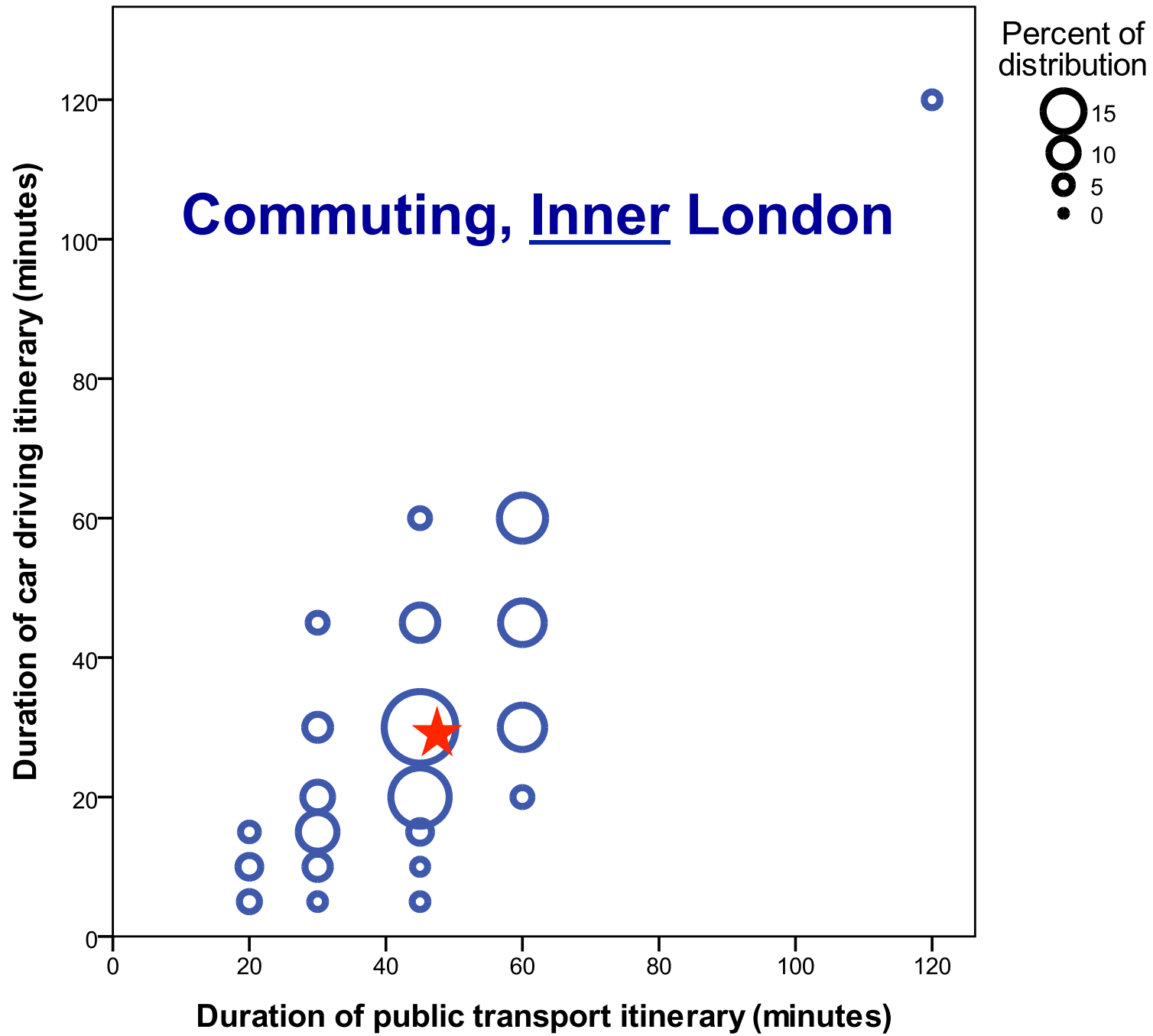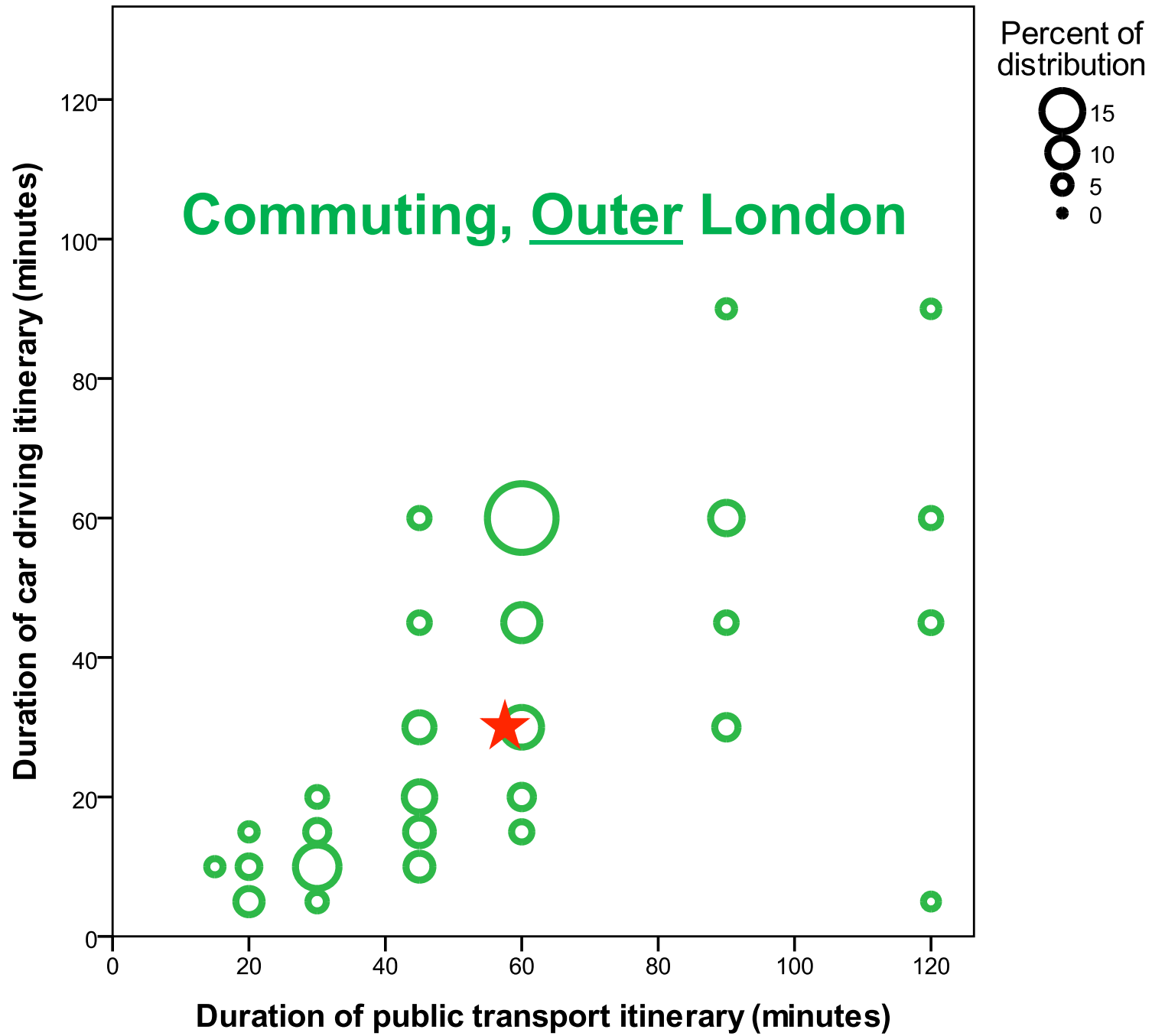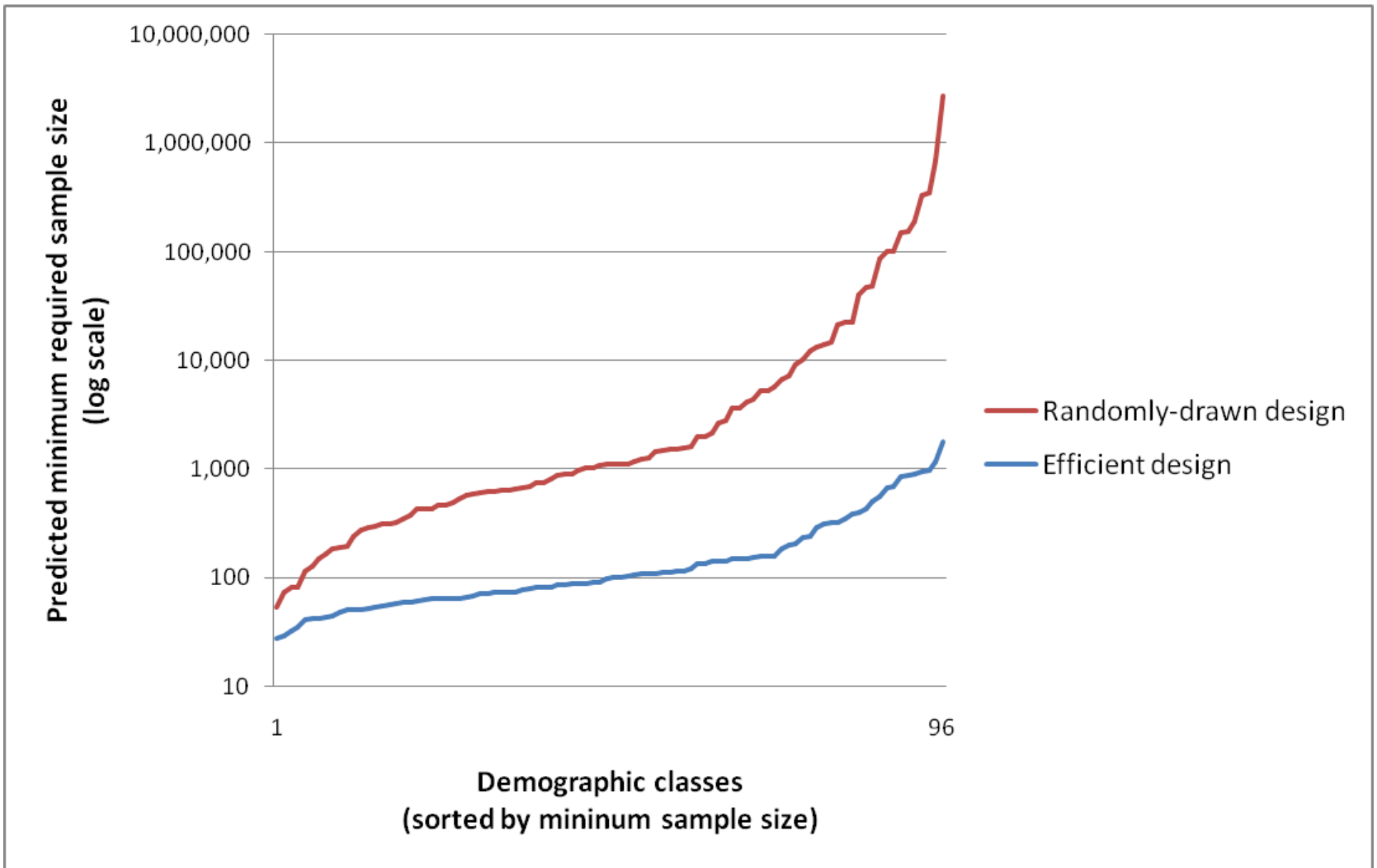
Observed correlations (NTS)

	Car ownership	# Car driving journeys	Public transport season ticket ownership	# Public transport journeys	Bicycle ownership	# Cycling journeys	# Walk journeys	# Taxi-minicab journeys	# Car passenger journeys
Car ownership		.71	-.09	-.18	.07	.03	-.10	-.04	-.22
# Car driving journeys			-.17	-.27	.07	-.02	-.10	-.05	-.15
Public transport season ticket ownership				.49	-.15	-.07	-.11	-.07	-.19
# Public transport journeys					-.06	-.04	-.13	.03	-.19
Bicycle ownership						.20	.04	-.02	.06
# Cycling journeys							.04	-.03	-.06
# Walk journeys								.03	.01
# Taxi-minicab journeys									-.01
# Car passenger journeys									

- Strongest is between car ownership & driving

- Weak between bicycle ownership & use

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Observed correlatons (SC survey)

	# Car purchases	# Car driving journeys	# Public transport season tickets	# Public transport journeys	# Bicycle purchases	# Cycling journeys	# Car club subscriptions	# Car club journeys	# 'One-way car club' subscriptions	# 'One-way car club' journeys	# Walk journeys	# Taxi-minicab journeys
# Car purchases		.91	-.07	-.31	-.17	-.30	-.09	-.10	-.07	-.20	-.08	-.19
# Car driving journeys			-.12	-.37	-.18	-.34	-.10	-.10	-.03	-.17	-.06	-.23
# Public transport season tickets				.55	-.35	-.34	.09	.13	-.14	-.08	-.12	.21
# Public transport journeys					-.39	-.41	.06	.04	-.18	-.12	-.01	-.01
# Bicycle purchases						.81	-.10	-.14	.01	.00	-.37	-.26
# Cycling journeys							-.08	-.11	-.14	-.12	-.36	-.25
# Car club subscriptions								.87	-.09	-.08	.04	.02
# Car club journeys									-.10	-.09	.05	.06
# 'One-way car club' subscriptions										.82	-.11	-.08
# 'One-way car club' journeys											-.21	-.05
# Walk journeys												.04
# Taxi-minicab journeys												

- Stronger, more-structured patterns (too much strategic-tactical?)

- PT correlates weakly with car club, weakly negatively with one-way car club

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Choice context

- De-brief question:

    "How similar or different was this game to how you think about getting around?"

- 1= 'very different'; 7='very similar'

	r^2 =0.30	
Female	-0.7	p=0.12
Living with partner	1.2	0.01
Children	-0.7	0.08

Engagement with 'avatar'

- De-brief question:

  "You just gave some advice to Jane/Joe. As you thought through Jane's/Joe's choices, how close was your thinking to how you make choices for yourself?"

- 1= 'very different'; 7='very similar'

	$r^2 = 0.34$	
Female	-1.0	p=0.04
Living with partner	-0.9	0.07
Employed	1.1	0.05
Income level	0.6	0.06

Cycling?

- 27% of 'mode choices'

- 'Construal-level' theory on psychological distance:

    -- 'High-level' v. 'low-level' construal

    -- Generalised, abstract context v. concrete & detailed

    -- Manifested in preference structure?

Cycling? (2)

- High v. Low-level construals of cycling attributes

High-level	Low-level
Low cost	Bike storage
Fast (in London)	Changing / showering
'Green'	Bad weather

- Corr(Cycling, stated psych. dist. to Avatar) = 0.28

More 'Avatar' effects

	LL = -692	LL = -670
	Base model	With Avatar 'effects'
Monthly holding costs (£)	-0.0036	-0.029
Prox. to Avatar	--	-- (Not sig.)
Per-journey costs (£)	-0.064	-1.02
Prox. to Avatar	--	**0.14**
Per-journey travel time (minutes)	-0.012	-0.033
Prox. to Avatar	--	**0.0037**

Lessons learned

- ECE tractable; viable alternative to using ad-hoc rules

- 'Avatar-generated' results prima facie plausible, but...

- Exaggerated 'Strategic-tactical' nature

- Systematic heterogeneity in engagement with SC context and 'Avatar' construct
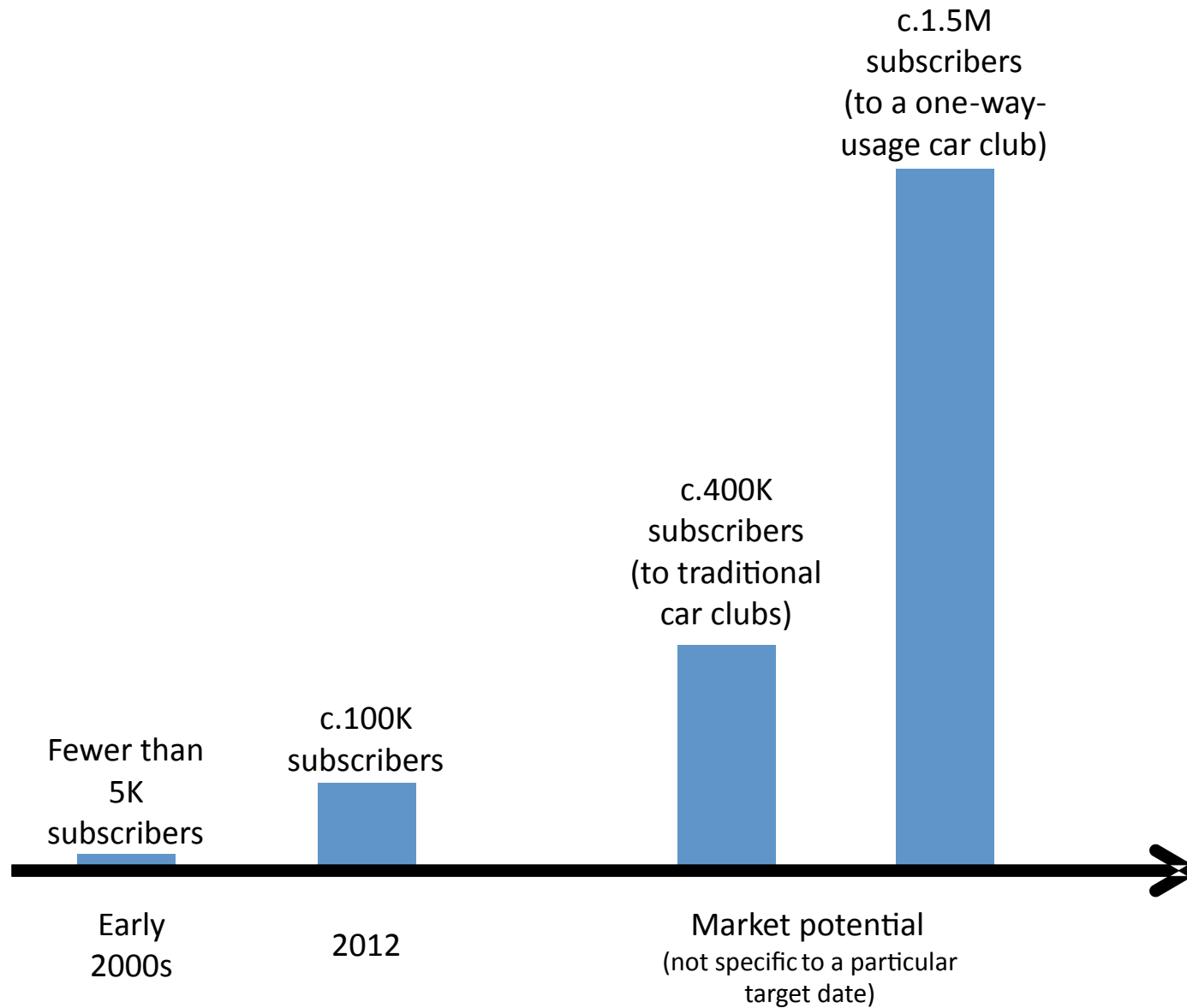
Limitations

- 'Avatar' technique – whose preferences are we getting?

- Basic specification: Focused on developmental issues, omitted empirically-important variables

- Might reasonably expect correlated errors across bundles: AB-ABC? A-B?

- Within-household interactions neglected: person-level analysis

Limitations

- Personal interviews: £70/interview

- 'Car', 'Bicycle', etc. Each treated as a homogenous product

- Attribute levels: 'Resource' costs not varied; thus limited info. to estimate parameter

- Did not address issues of service dependability in depth

Implied market potential: Greater London

c.1.5M
subscribers
(to a one-way-
usage car club)

c.400K
subscribers
(to traditional
car clubs)

c.100K
subscribers

Fewer than
5K
subscribers

Early
2000s

2012

Market potential
(not specific to a particular
target date)

Research needs

- Standardise, simplify methods for wider application

- Incorporate within vertically-integrated travel/ activity models

- 'Fluidity' in activity-travel patterns – i.e. 'induced / suppressed car-accessed activities'

- Establish & quantify biases associated with 'avatar' method

- Can 'avatar' method lower costs of hard-to-reach groups?

Research methods

Asking members of the public about car club participation presents challenges…

- Hypothetical

- Unfamiliar

- Interdependent with other aspects of one's activity-travel pattern

- Interdependent between different people

- Considered across different timescales

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Many open questions

- Further evolution of services and policies?

- Scalability?

- Service robustness?

- Induced travel? Expectations / norms for future car use?

- Life-cycle assessment of environmental impacts?

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