# AUTONOMOUS VEHICLES:

# WILLINGNESS TO PAY AND WILLINGNESS TO SHARE


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VENTURER

# VENTURER

- Multi-partner project focussing on Connected and Autonomous Vehicles
- Understand barriers and drivers to widespread CAV adoption
- Vehicle trials and social research

# AUTONOMY ON THE HORIZON: ARE WE PREPARED?

- Large-scale shift from human-driven to computer-controlled vehicles would be a defining global change in both transport networks and societies in the 21st Century
- Wide range of predictions as-to when this might happen:
  - From 65% of the US fleet AVs in 2050 (Litman, 2014)
  - To 90% of all vehicle trips AV by 2030 (Hars, 2014)
- See also: (Rowe, 2015; Bansal and Kockelman, 2017; Alexander and Gartner, 2014)

# AUTONOMY ON THE HORIZON: ARE WE PREPARED?

- Industry and press say it will be much sooner even than the academic literature suggests

*"November or December of this year, we should be able to go from a parking lot in California to a parking lot in New York, no controls touched at any point during the entire journey."*

(Elon Musk, extract from: Greene, 2017)


# AUTONOMY ON THE HORIZON: ARE WE PREPARED?

- Challenge: AV technology is racing ahead – academics, policy makers, transport authorities, and citizens all must simply "keep up"?
- Important that there is a debate about how these new technologies influence our societies
- Potential for big benefits:
  - reduced traffic (congestion and vehicles)
  - fewer accidents
  - meaningful travel-time use
- Potential for significant worsening of current networks:
  - worse traffic/congestion
  - reductions in safety
  - risks to privacy and security
  - worsening inequalities

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See: Greenblatt and Saxena, 2015; Greenblatt and Shaheen, 2015; DfT, 2016; Litman, 2014; Fagnant and Kockelman, 2015; Trommer *et al.*, 2016; Le Vine *et al.*, 2015; Schoettle and Sivak, 2014, 2015; Bansal and Kockelman, 2017; NHTSA 2013; Davidson and Spinoulas, 2016


SHARE YOUR
EDUCATION
$44 per hour to teach French in New York (if you're a native speaker)
on Apprentus, a market for tutors
VIDEO GAMES
$25 for your used copy of Titanfall for Xbox One
on 99Gamers, a marketplace with its own virtual currency
OFFICE
$75 per hour for your boardroom in London's Euston Square
on Zipcube, where people traffic in office space, down to the desk
BOOKS
$0 Try a book on civics, you hypercapitalist monster
on Literatoo, which indexes neighbors' libraries
TIME
on TaskRabbit, an hourly assistant service that pretty much sums up America
$50 per hour to assemble furniture for hapless San Franciscans
COOKIES
on Doughbies, because cookies!!!
$12 for six fresh-from-the-oven treats delivered to your office in San Francisco
NANNY
on NannyShare, which is exactly what it sounds like
Savings of $10 an hour, or whatever you can negotiate with other parents
KITCHEN
on VoulezVous-Diner, which sells home-cooked meals
$23 a plate at your maison in Marseille
BEDROOM
on Airbnb, where, yes, the reviews do matter
$103 per night (if your studio is in central Paris)
SUITCASE
on Backpack, where people sell unused luggage space
$92 to bring an iPhone 6 across national borders, then ship it locally (buyer pays for shipping)
BOAT
$1,359 per day skippering your 40-footer, The Jolly Jellyfish
on Board a Boat, where you can rent your ship and skills
CRAFTS
$95 for your knitted-wool rendition of a dissected rat
on Etsy, which we totally believe you knew about first



**But will we…?**

# ONLINE QUANTITATIVE SURVEY

- Recruitment via local authority citizen panels
- Focus on:
  - Willingness to use 4 AV options for urban journeys
  - Willingness to pay

## Sample (n = 730)

- 36.6% female
- Age: 52.1% 30-59 / 48.9% 60+
- 12% disabled
- 40% concessionary bus pass
- Main mode: 59% car, 13% bus, 12% cycle, 13% walk, 3% other
- 94% licence-holders
- 10% no motor vehicles in household
- 56% degree / 24% A levels or diploma

# STATED PREFERENCE EXPERIMENTS: FOUR AV SCENARIOS

## DV-Car

- Personally-owned
- Similar to conventional car
- Private use
- Always available
- Pay for costs of vehicle including ownership and upkeep

## DV-Taxi

- Similar to conventional taxi
- Available for private hire
- Exclusive use of vehicle during journey
- Summoned or booked via mobile app
- Pay for journey

## Shared-DV

- Shared-taxi service
- Small vehicle (6-10 seats) – shared with other people
- Public use
- Summoned or booked via mobile app
- Pay for journey

## DV-Bus

- Similar to conventional bus
- Follows set routes, has set stops, and approximate timetable
- Large vehicle shared with other people
- Advanced RTI available
- Pay for journey

| | Car | DV-Car |
|---|---|---|
| |  |  |
| **Ownership and cost** | You own it and pay up-front and on-going costs | |
| **Sharing of vehicle** | You have exclusive use of the vehicle | |
| **Journey Planning** | You work out the route yourself | The car works out the quickest route |
| **Calling/booking** | No need to call or book a vehicle | |
| **Carrying out the journey** | You drive yourself to your destination | The car drives you to your destination |
| **Activity during journey** | Talking to passengers, listening to music/radio, using hands-free | Same as car, plus reading, using phone or laptop, looking out of window, playing games, snoozing |
| **Parking** | You find and pay for parking | The car finds parking and parks itself, but you pay for parking |
| **Journey time** | 12 minutes | |
| **Time taken to access vehicle at the beginning and end of the journey** | 5 minutes | 2 minutes<br>*(this is shorter than for the normal car as you do not have to park)* |
| **Journey cost**<br>*This is based on what the AA says that it costs to run an average car. It includes all costs: ownership, fuel, tax, and parking* | £1.75 | *See question below* |

| | Bus | DV-Car |
|---|---|---|
| |  |  |
| **Ownership and cost** | You pay for the journeys you make using cash, smart cart, or ticketing app | You own it and pay up-front and on-going costs |
| **Sharing of vehicle** | You share with other passengers | You have exclusive use of the vehicle |
| **Journey Planning** | You plan according to the timetable available at bus stops, in printed timetables, and online | The car works out the quickest route |
| **Calling/booking** | No need to call or book a vehicle | |
| **Carrying out the journey** | You go to a nearby bus stop and ride it to a bus stop near your destination | The car drives you to your destination |
| **Activity during journey** | Talking to passengers, listening to music/radio, reading, using phone or laptop, looking out of window, playing games, snoozing | |
| **Parking** | No parking or parking payment required | The car finds parking and parks itself, but you pay for parking |
| **Journey time** | 20 minutes | 12 minutes |
| **Time taken to access vehicle at the beginning and end of the journey** | 10 minutes | 2 minutes |
| **Journey cost**<br>*This is based on the average price of a single bus fare for this journey length in Bristol* | £1.50 | *See question below* |

| | Car | DV-Taxi |
|---|---|---|
| |  |  |
| **Ownership and cost** | You own it and pay up-front and on-going costs | You pay for the journeys you make via the web or a smartcard |
| **Sharing** | You have exclusive use of the vehicle | |
| **Journey Planning** | You work out the route yourself | The car works out the quickest route |
| **Calling/booking** | No need to call or book a vehicle | You order in real time or pre-book using the web on your smartphone or other device |
| **Carrying out the journey** | You drive yourself to your destination | The car picks you up and drives you to your destination |
| **Activity during journey** | Talking to passengers, listening to music/radio, using hands-free | Same as car, plus reading, using phone or laptop, looking out of window, playing games, snoozing |
| **Parking** | You find and pay for parking | No parking or parking payment required |
| **Journey time** | 12 minutes | |
| **Time taken to access vehicle at the beginning and end of the journey** | 5 minutes | |
| **Journey cost** *This is based on what the AA says that it costs to run an average car. It includes all costs: ownership, fuel, tax, and parking* | £1.75 | *See question below* |

| | Bus | DV-Taxi |
|---|---|---|
| |  |  |
| **Ownership and cost** | You pay for the journeys you make using cash, smart cart, or ticketing app | You pay for the journeys you make via the web or a smartcard |
| **Sharing** | You share with other passengers | You have exclusive use of the vehicle |
| **Journey Planning** | You plan according to the timetable available at bus stops, in printed timetables, and online | The car works out the quickest route |
| **Calling/booking** | No need to call or book a vehicle | You order in real time or pre-book using the web on your smartphone or other device |
| **Carrying out the journey** | You go to a nearby bus stop and ride it to a bus stop near your destination | The car picks you up and drives you to your destination |
| **Activity during journey** | Talking to passengers, listening to music/radio, reading, using phone or laptop, looking out of window, playing games, snoozing | |
| **Parking** | No parking or parking payment required | |
| **Journey time** | 20 minutes | 12 minutes |
| **Time taken to access vehicle at the beginning and end of the journey** | 10 minutes | 5 minutes |
| **Journey cost** *This is based on the average price of a single bus fare for this journey length in Bristol* | £1.50 | *See question below* |

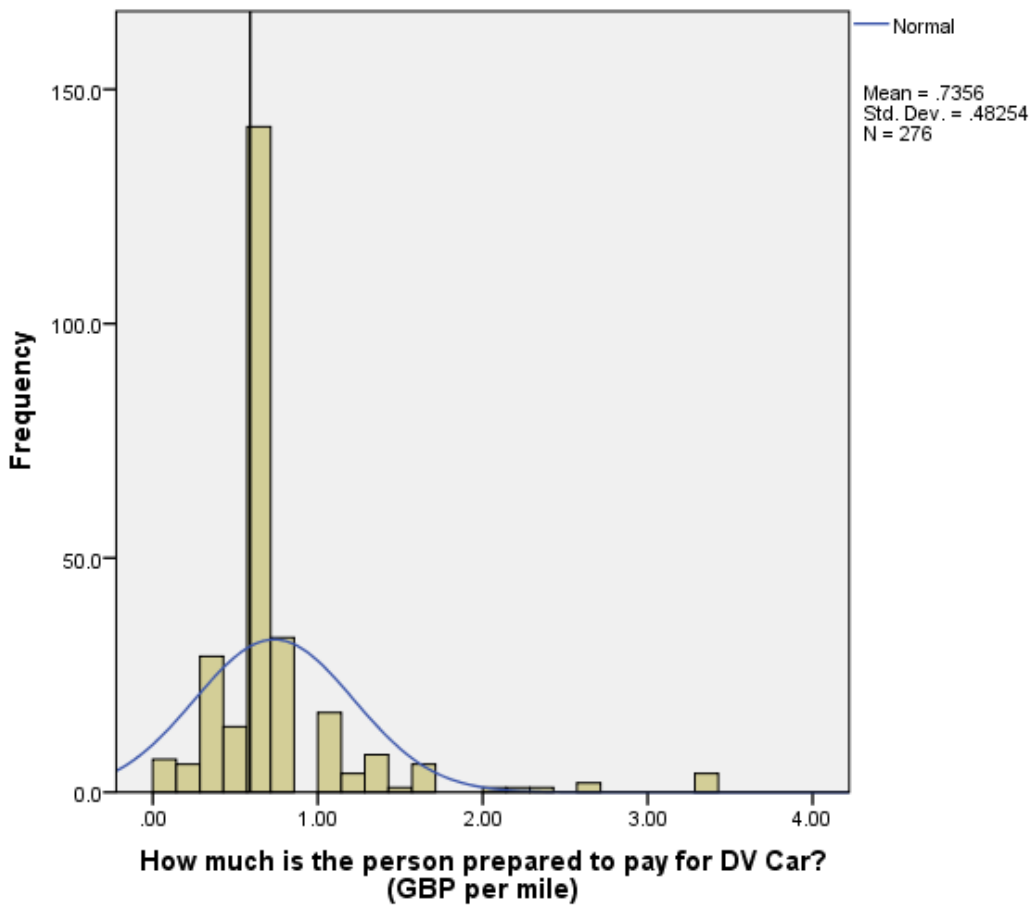
## Willingness to Use AV scenarios

| DV scenario | Would use? | N | % |
|---|---|---|---|
| DV-Car | Yes | 321 | 47.3 |
| | No | 358 | 52.7 |
| DV-Taxi | Yes | 309 | 45.5 |
| | No | 370 | 54.5 |
| Shared-DV | Yes | 250 | 36.8 |
| | No | 429 | 63.2 |
| DV-Bus | Yes | 319 | 47.0 |
| | No | 360 | 53.0 |

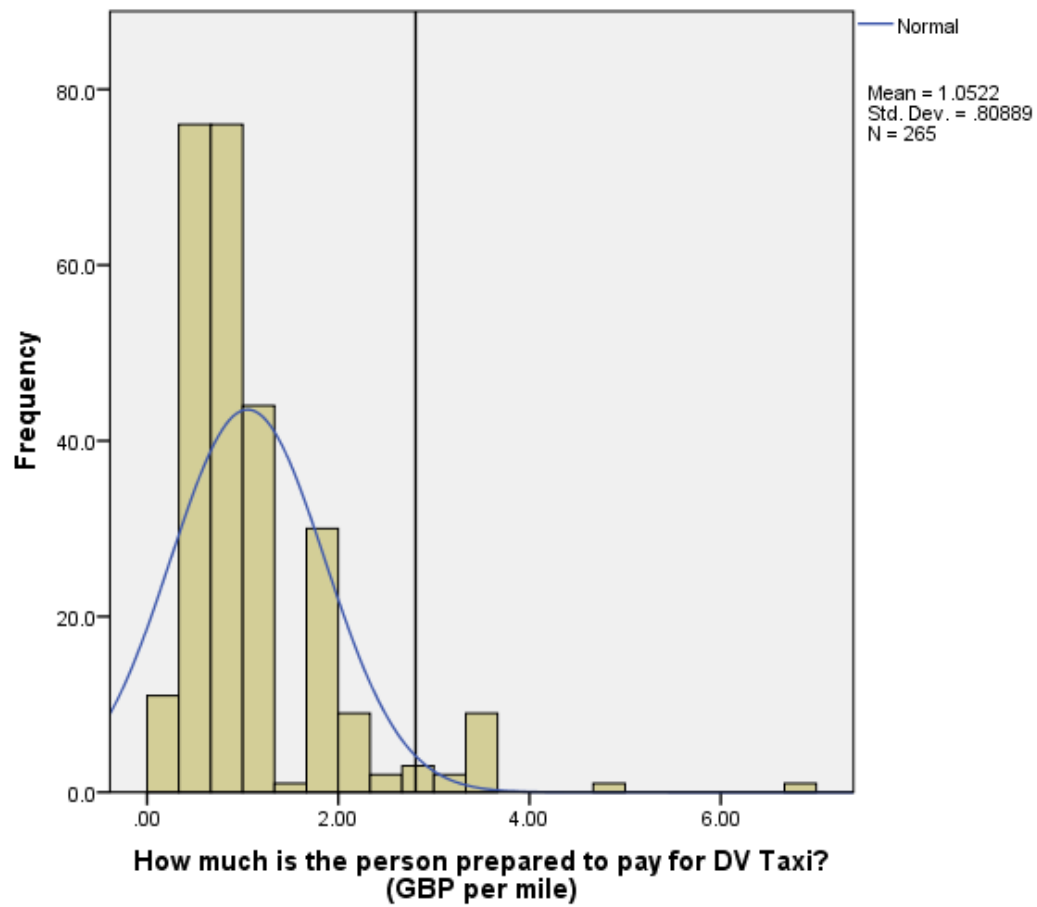
## Reasons for preferring AV or non-AV car

| Reason(s) | Preference | | | |
|---|---|---|---|---|
| | Driving myself in a car (58%) | | Being driven (42%) | |
| | N | % | N | % |
| Safety | 217 | 50 | 129 | 41 |
| Control | 292 | 67 | 22 | 7 |
| Convenience | 224 | 51 | 188 | 60 |
| Driving experience | 137 | 31 | 58 | 19 |
| Activities during journey | 26 | 6 | 166 | 53 |
| Other | 30 | 7 | 37 | 12 |

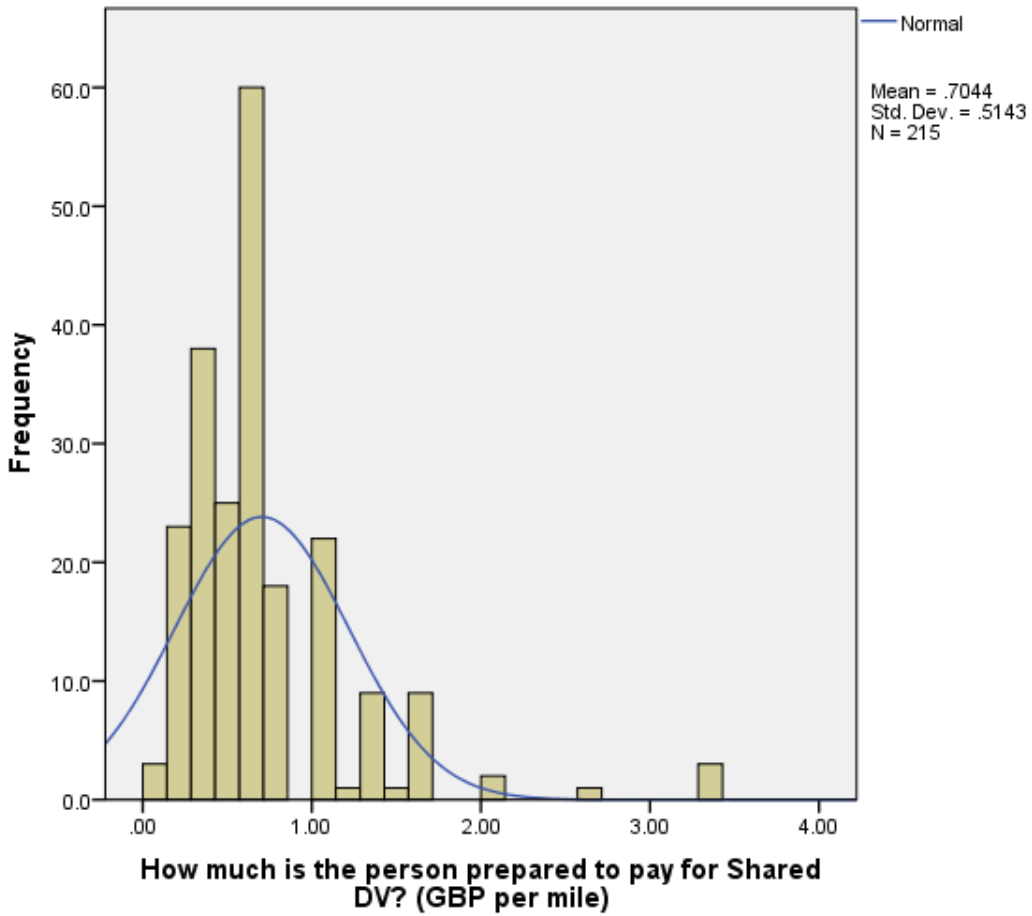
## WTP for DV-Car



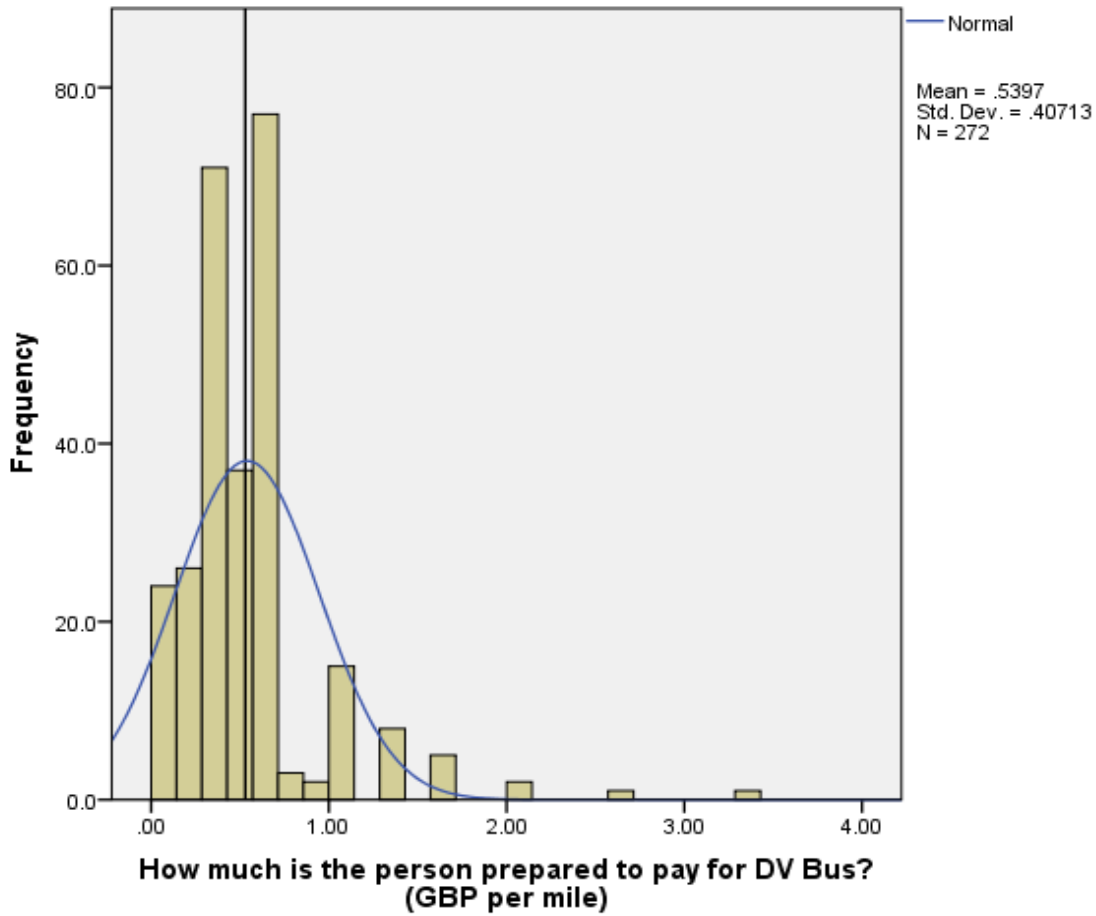

## WTP for DV-Taxi



## WTP for Shared-DV




## WTP for DV-Bus



## WTP comparison with reference to costs per-mile for non-AV equivalents

| Willingness to pay for an AV scenario | | | | |
|---|---|---|---|---|
| | **DV Car (£/mile)** | **DV Taxi (£/mile)** | **Shared DV (£/mile)** | **DV Bus (£/mile)** |
| **Mean** | 0.75 | 1.08 | 0.73 | 0.55 |
| **Median** | 0.67 | 0.83 | 0.58 | 0.50 |
| **Mode** | 0.67 | 0.67 | 0.67 | 0.67 |
| **Minimum** | 0.00 | 0.00 | 0.00 | 0.00 |
| **Maximum** | 3.33 | 6.67 | 5.33 | 3.33 |
| **Std. Deviation** | 0.53 | 0.83 | 0.62 | 0.43 |
| **SP experiment values for non-DV modes** | | | | |
| | **Non-DV Car** | **Non-DV Taxi** | **Shared vehicle** | **Non-DV Bus** |
| **Value given for non-AV equivalent [£/mile]** | **0.59** | **2.81** | ***N/A*[1]** | **0.53** |

*[1]Due to the lack of an existing real world shared vehicle system in the study area, it was felt that participants would not have experience of such a system, and so this was not an option provided to people as a non-DV mode for comparison, and so no value for trips by this mode was calculated.*

# WILLINGNESS TO PAY TO USE AVS

| Mode | AV Car | AV Taxi | AV Bus | Shared AV |
|---|---|---|---|---|
| Human-driven actual cost per passenger mile | £0.59 | £2.81 | £0.53 | - |
| Mean W2P per mile | £0.75 | £1.08 | £0.55 | £0.73 |
| Operating cost without driver cost (assumed 50%) | - | £1.40 | £0.26 | ? |
| Net W2P | Will pay >25% premium | WTP much less for AV than costs | 53% producer surplus! | W2P close to AV car W2P |
| Implications for business model | Willing to pay technology premium. Owner-driver AVs financially viable. | Luxury mode but fares much closer to willingness to pay for 'general travel'. | Low cost mode more profitable: compete on price or increase frequency? | Is a high-tech shared taxi service for approx. £0.70 per mile possible? |

## WTP for AV/non-AV with social disposition

| | *Statement: "I don't mind interacting with people I don't know"* | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Strongly agree/ agree** | | **Neither agree nor disagree** | | **Disagree/ strongly disagree** | | |
| | **N** | **%** | **N** | **%** | **N** | **%** | **Sig.** |
| **Would pay more £/mile for AV car than non-AV car** | 86 | 67.7 | 62 | 54.4 | 32 | 44.4 | 0.00 |
| **Would pay more £/mile for AV taxi than non-AV taxi** | 9 | 6.6 | 7 | 6.9 | 2 | 2.9 | *0.49* |
| **Would pay more £/mile for AV bus than non-AV bus** | 65 | 43.0 | 42 | 42.4 | 24 | 35.8 | *0.56* |

## WTU Shared-DV with social disposition

| | *Statement: "I don't mind interacting with people I don't know"* | | | | | |
|---|---|---|---|---|---|---|
| | **Strongly agree/ agree** | | **Neither agree nor disagree** | | **Disagree/ strongly disagree** | |
| | **N** | **%** | **N** | **%** | **N** | **%** |
| **Would not use Shared-DV** | 185 | 59.5 | 123 | 59.7 | 121 | 74.7 |
| **Would use Shared-DV** | 126 | 40.5 | 83 | 40.3 | 41 | 25.3 |
| **Total** | 311 | 100.0 | 206 | 100.0 | 162 | 100.0 |

# CONCLUSIONS (1)

## Willingness to use AVs

- Under 50% of people in all contexts were willing to use AVs over their current option
- Smallest proportion was for shared AV option (36.8%)

## Willingness to pay for AVs

- People will pay a >25% premium for and AV car over the cost of a conventional car
- AV taxis will have to be priced much more closely to other modes for them to be competitive
- AV bus might create over 50% surplus for the operators! ➡ Improved services or bottom line?
- People will pay a similar amount for shared AV as AV car, so potential to encourage modal shift?

# CONCLUSIONS (2)

Willingness to share AVs

- Evident challenge in convincing people to share
- Shared AV option is least popular of all four future scenarios by considerable margin
- Two private modes had higher per-mile WTP than shared modes
  - But shared AV similar WTP to private car, so opportunities here?
- In an AV future, price will be crucial. Shared modes will need to offer substantial cost-saving to offset the "privacy premium" that people are willing to pay
- Initial indication of psychosocial element of AV use in different contexts
  - People with more "open" social disposition significantly more likely to want to use a shared AV or pay for AV in general

# THANK YOU!

# Any questions?

# REFERENCES (1)


- Alexander, D., Gartner, J., 2014. Self-driving Vehicles, Advanced Driver Assistance Systems, and Autonomous Driving Features: Global Market Analysis and Forecasts. Available from: https://www.navigantresearch.com/research/autonomous-vehicles. Navigant Consulting, Inc.
- Bansal, P. and Kockelman, K.M., 2017. Forecasting Americans' long-term adoption of connected and autonomous vehicle technologies. *Transportation Research Part A: Policy and Practice*, *95*, pp.49-63.


- Bansal, P. and Kockelman, K.M., 2017. Forecasting Americans' long-term adoption of connected and autonomous vehicle technologies. *Transportation Research Part A: Policy and Practice*, *95*, pp.49-63.


- Davidson, P. and Spinoulas, A., 2016. Driving alone versus riding together-How shared autonomous vehicles can change the way we drive. *Road & Transport Research: A Journal of Australian and New Zealand Research and Practice*, *25*(3), p.51.
- Department for Transport (DfT), 2016. Research on the Impacts of Connected and Autonomous Vehicles (CAVs) on Traffic Flow. Summary Report. Atkins. May 2016.
- Fagnant, D.J. and Kockelman, K., 2015. Preparing a nation for autonomous vehicles: opportunities, barriers and policy recommendations. *Transportation Research Part A: Policy and Practice*, *77*, pp.167-181.
- Greenblatt, J.B. and Saxena, S., 2015. Autonomous taxis could greatly reduce greenhouse-gas emissions of US light-duty vehicles. Nature Climate Change, 5(9), pp.860-863.
- Greenblatt, J.B. and Shaheen, S., 2015. Automated vehicles, on-demand mobility, and environmental impacts. Current sustainable/renewable energy reports, 2(3), pp.74-81.

# REFERENCES (2)


- Greene, B., 2017. *What will the future look like? Elon Musk speaks at TED2017.* [Online Video]. 28 April 2017. Available from: https://blog.ted.com/what-will-the-future-look-like-elon-musk-speaks-at-ted2017/..
- Hars, A., 2014. Autonomous Vehicle Roadmap: 2015–2030. Driverless Future website. Available from: http://www.driverless-future.com/?p=678.
- Le Vine, S., Zolfaghari, A. and Polak, J., 2015. Autonomous cars: The tension between occupant experience and intersection capacity. Transportation Research Part C: Emerging Technologies, 52, pp.1-14.Litman, T., 2014. Autonomous vehicle implementation predictions. Victoria Transport Policy Institute, 28.
- Litman, T., 2014. Autonomous vehicle implementation predictions. *Victoria Transport Policy Institute*, 28.
- NHTSA (2013), Preliminary Statement of Policy Concerning Automated Vehicles, National Highway Traffic Safety Administration (www.nhtsa.gov).
- Rowe, R. 2015. Self-driving cars, timeline. Online. Available at: https://www.topspeed.com/cars/car-news/self-driving-cars-timeline-ar169802.html.
- Schoettle, B. and Sivak, M. (2014) A survey of public opinion about autonomous and self-driving vehicles in the US, the UK and Australia. Michigan: University of Michigan.
- Schoettle, B. and Sivak, M. (2015), Should We Require Licensing Tests And Graduated Licensing For Self-Driving Vehicles?, Report UMTRI-2015-33, Transportation Research Institute, University of Michigan (www.umich.edu/~umtriswt).
- Trommer, S., Kolarova, V., Fraedrich, E., Kröger, L., Kickhöfer, B., Kuhnimhof, T., Lenz, B. and Phleps, P., 2016. Autonomous Driving-The Impact of Vehicle Automation on Mobility Behaviour. Online. [Available from] https://www.ifmo.de/files/publications_content/2016/ifmo_2016_Autonomous_Driving_2035_en.pdf