The Potential Distributional Impacts of Automated Vehicle Technologies

Zan Fairweather and Leslie Martin

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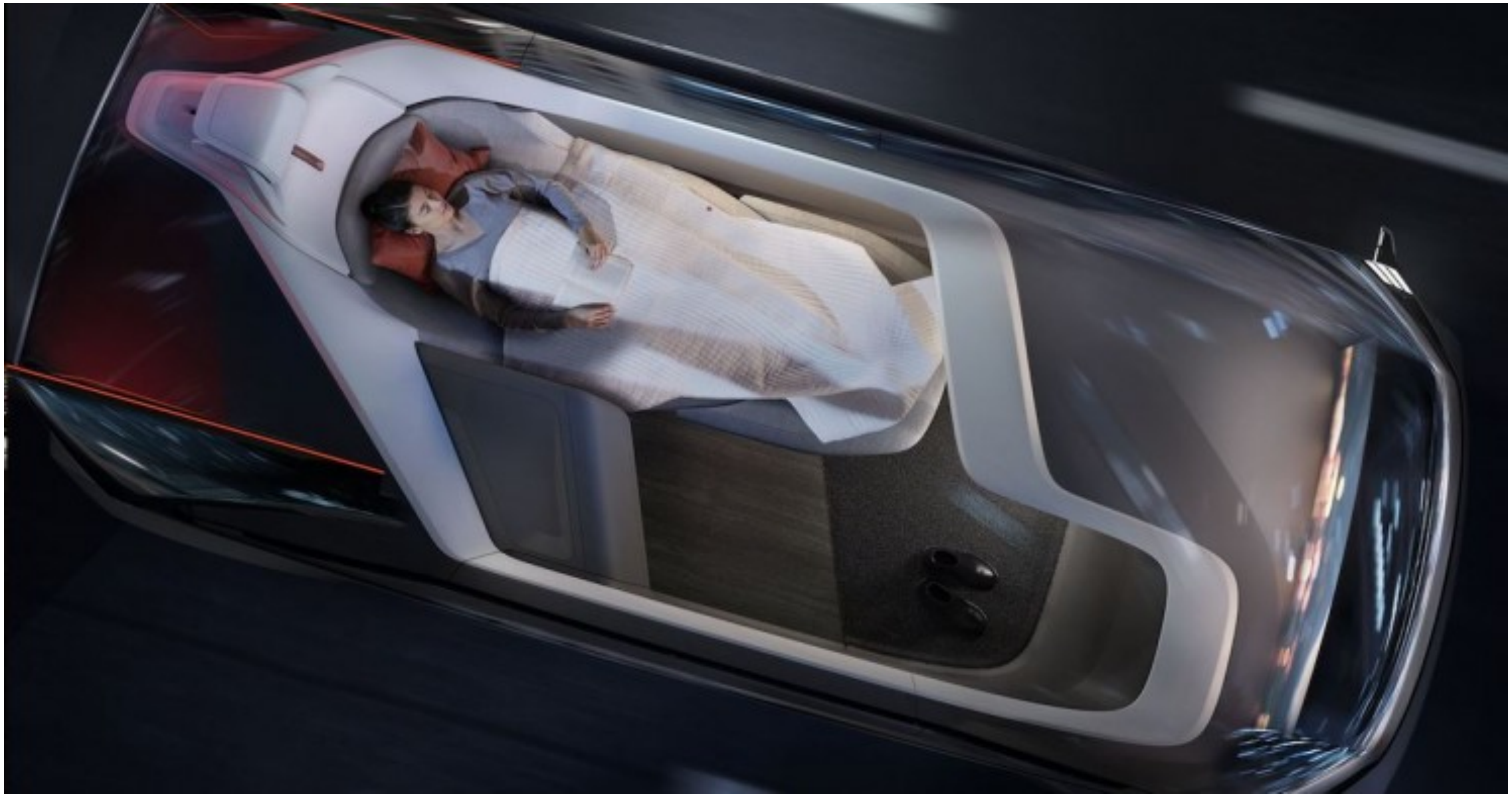
Falling asleep behind the wheel used to be a bad thing



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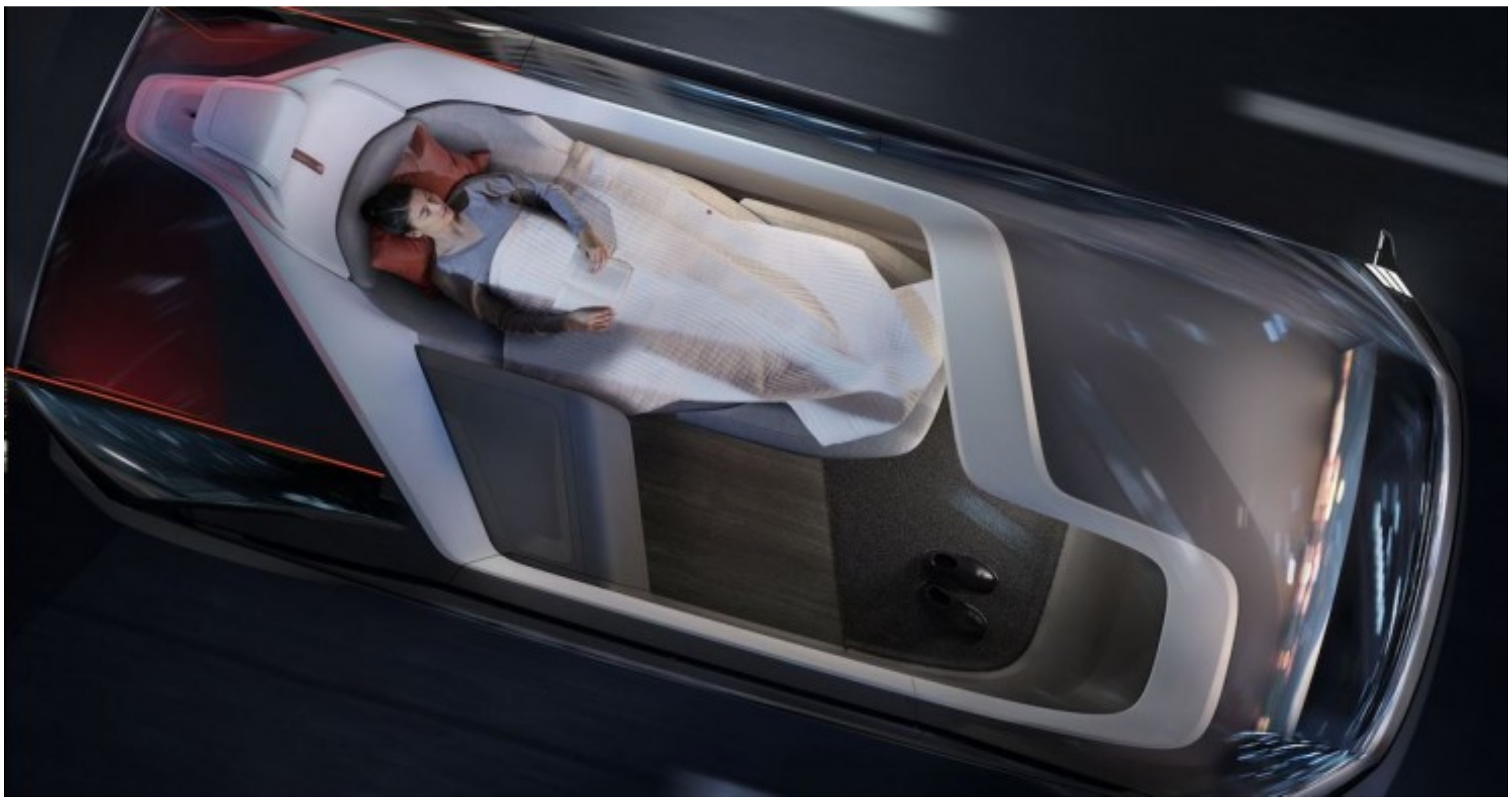

AVs lower private cost of being stuck in traffic

Many potential benefits to AVs

- Improve access ride services for children, elderly, disabled
- Reduce need to park / time spent parking
- Lower private cost of congestion

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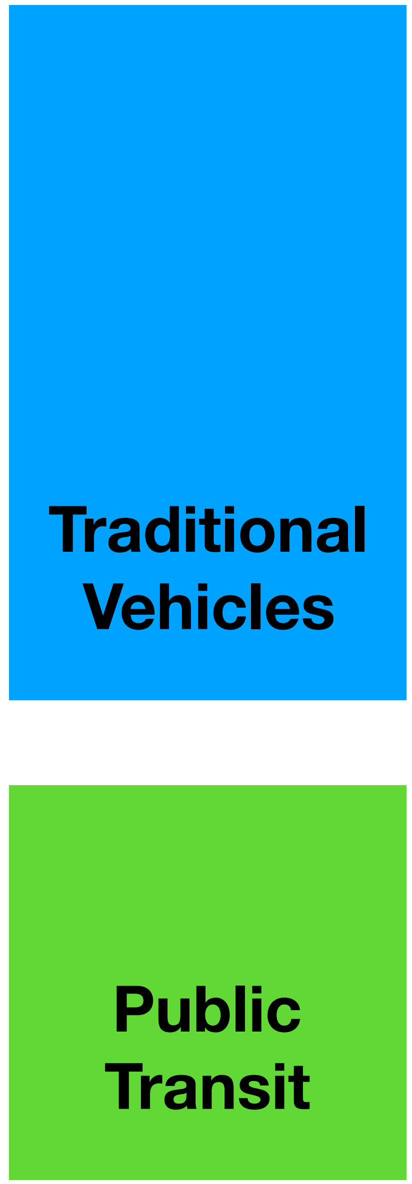
But do not lessen the externality imposed on others at congested times/places

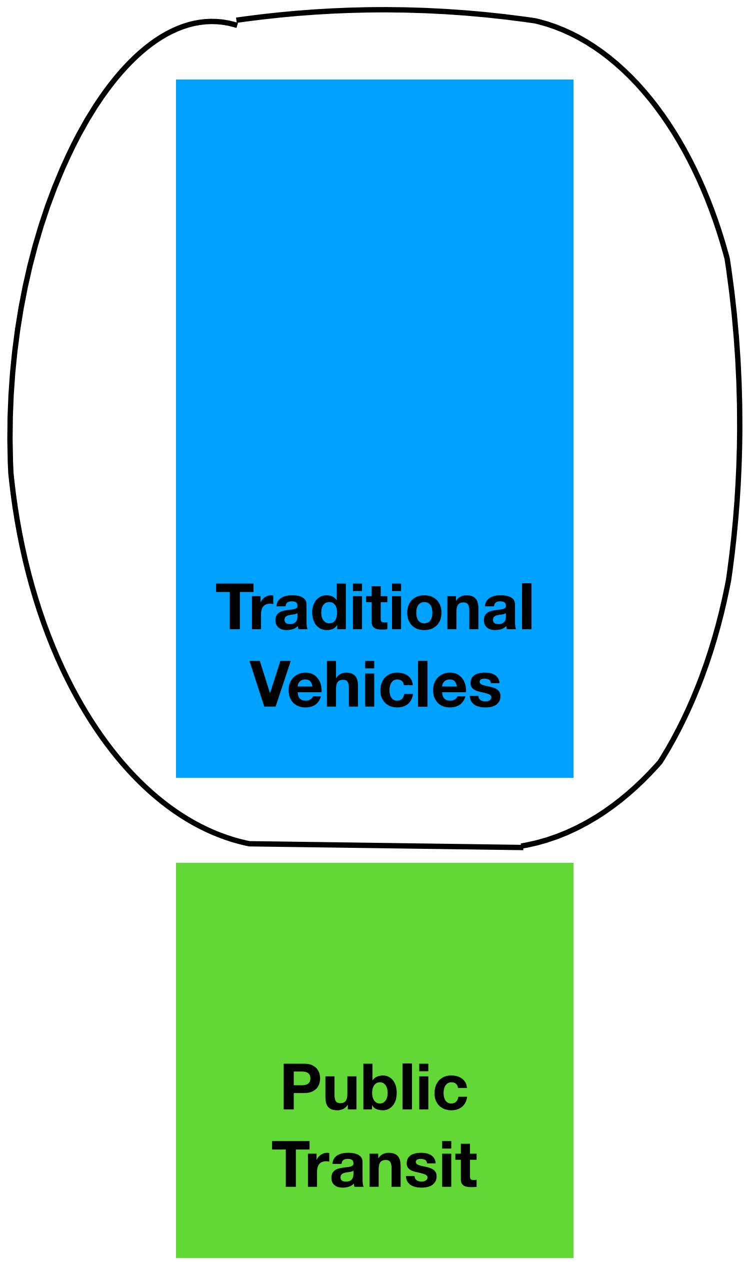
They accentuate wedge between private and social cost

Consider a model of commutes:

Time horizon where locations are fixed

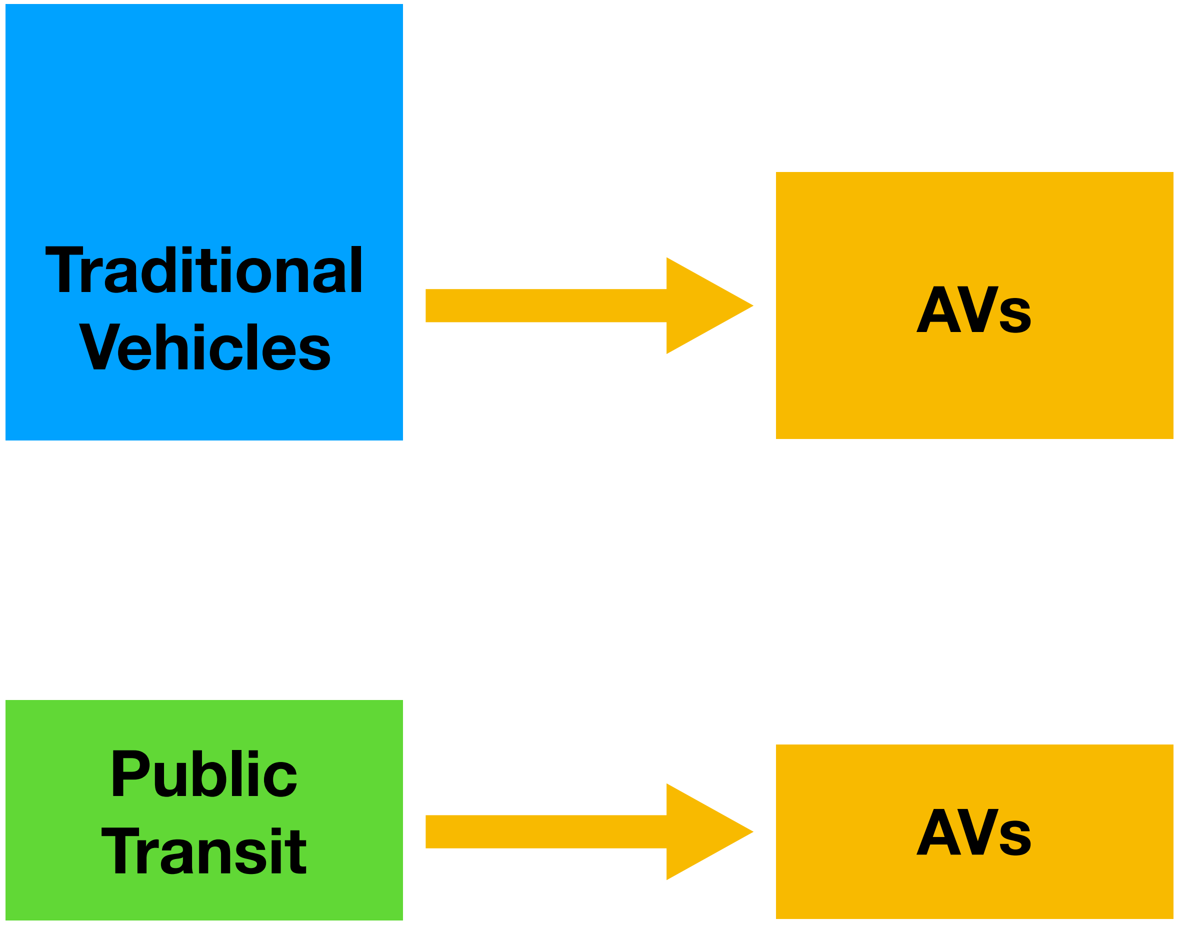
Can pick mode

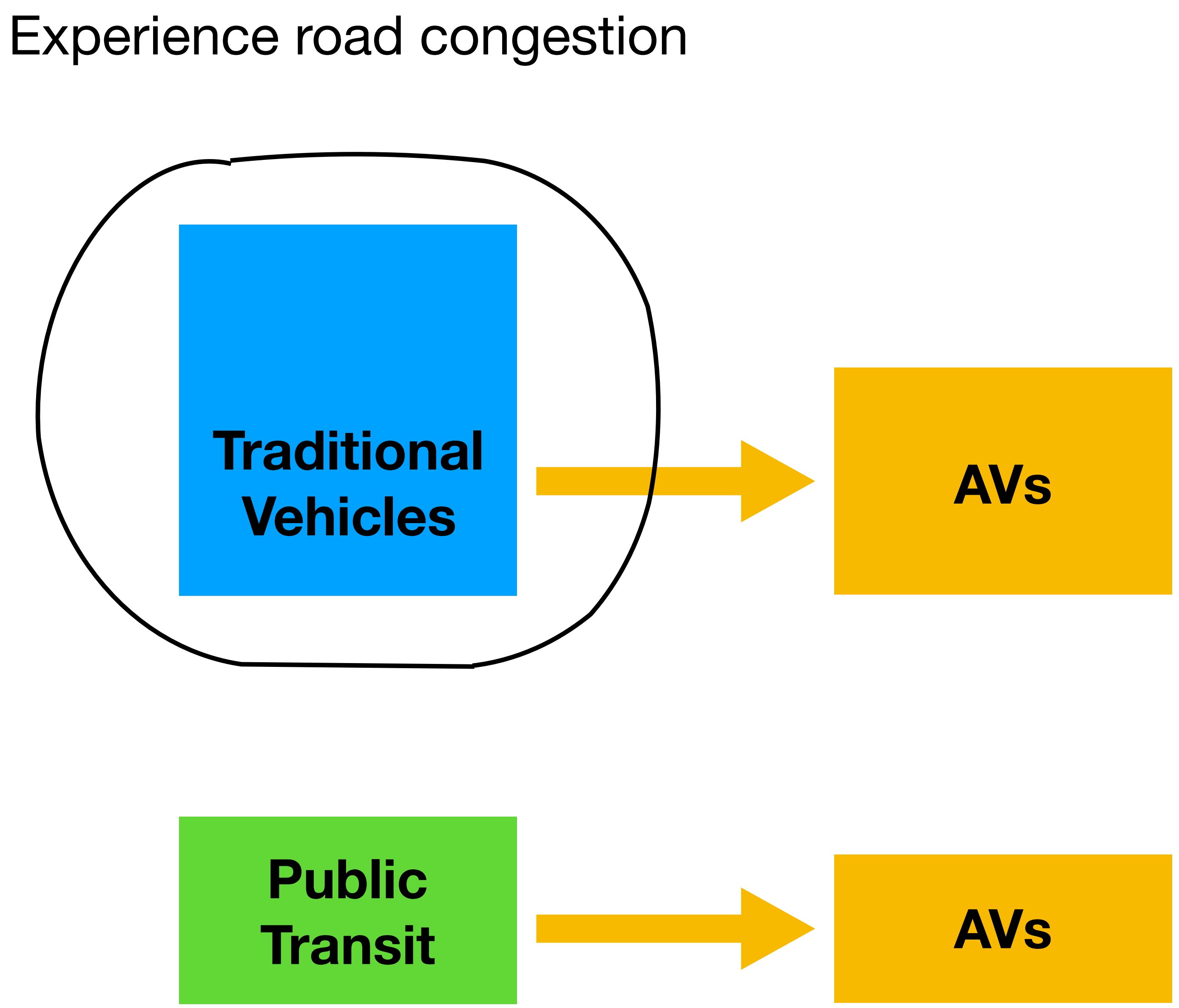




Contribute to road congestion

Experience road congestion


Traditional Vehicles
AVs
Public Transit
AVs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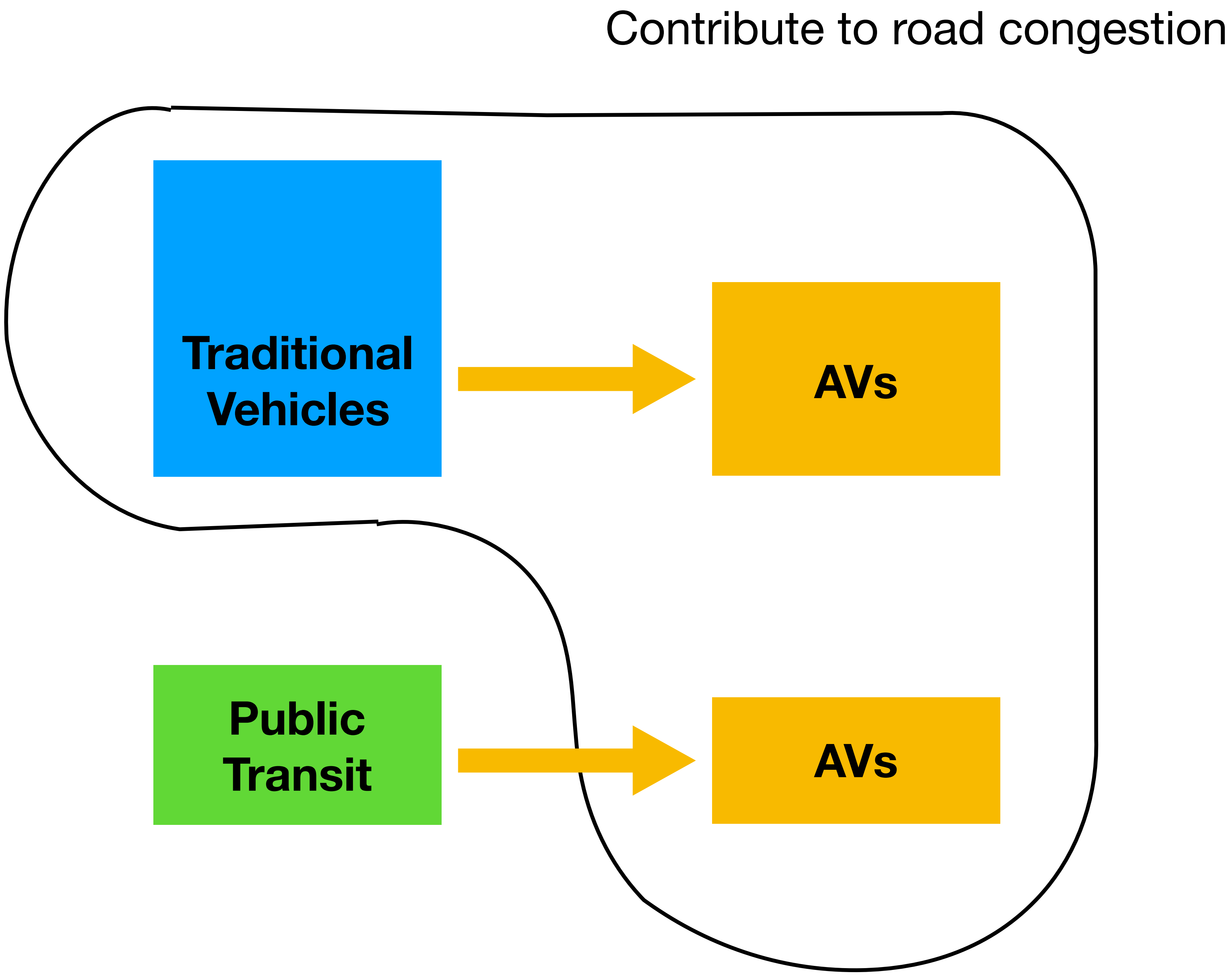
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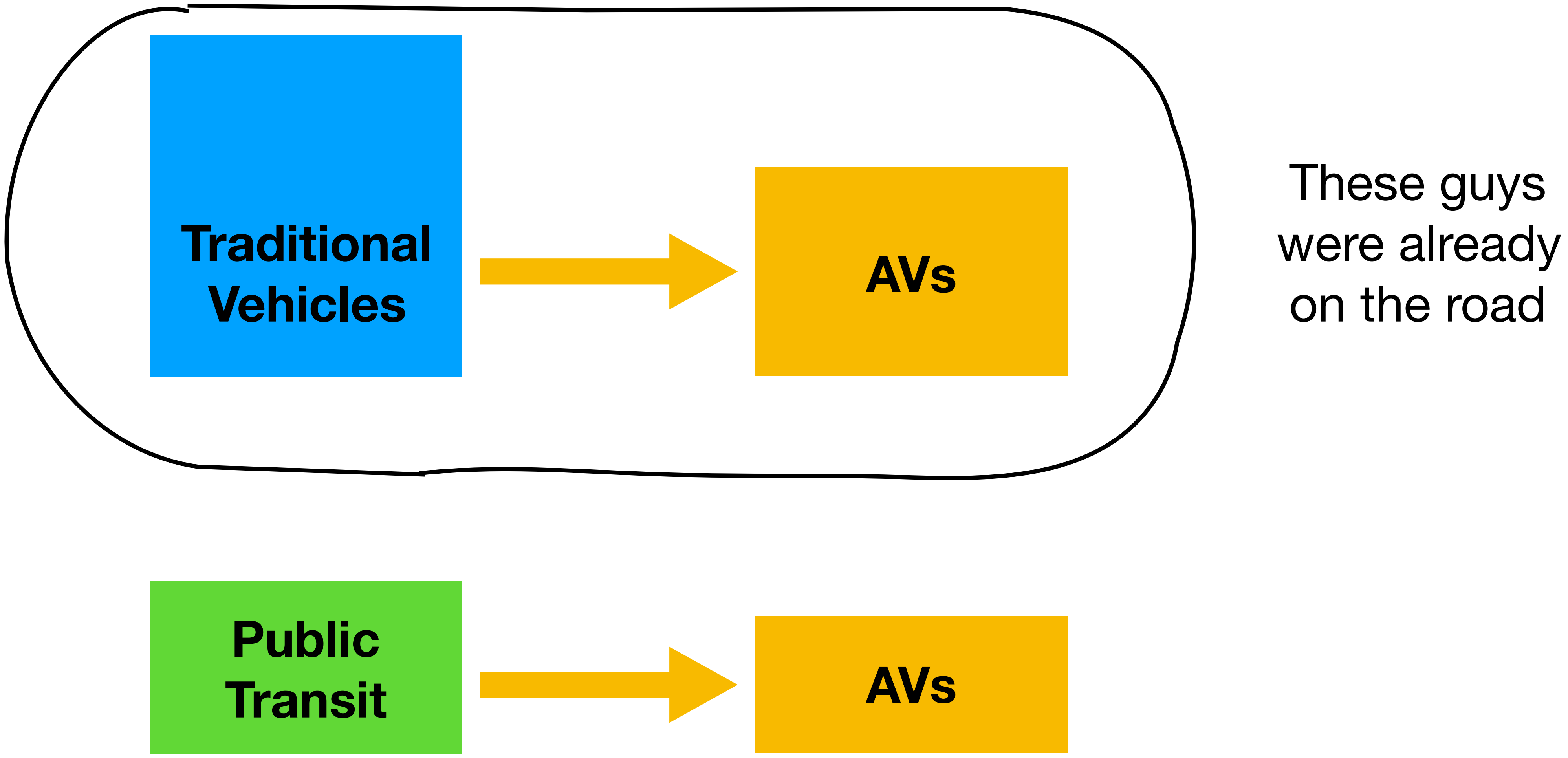
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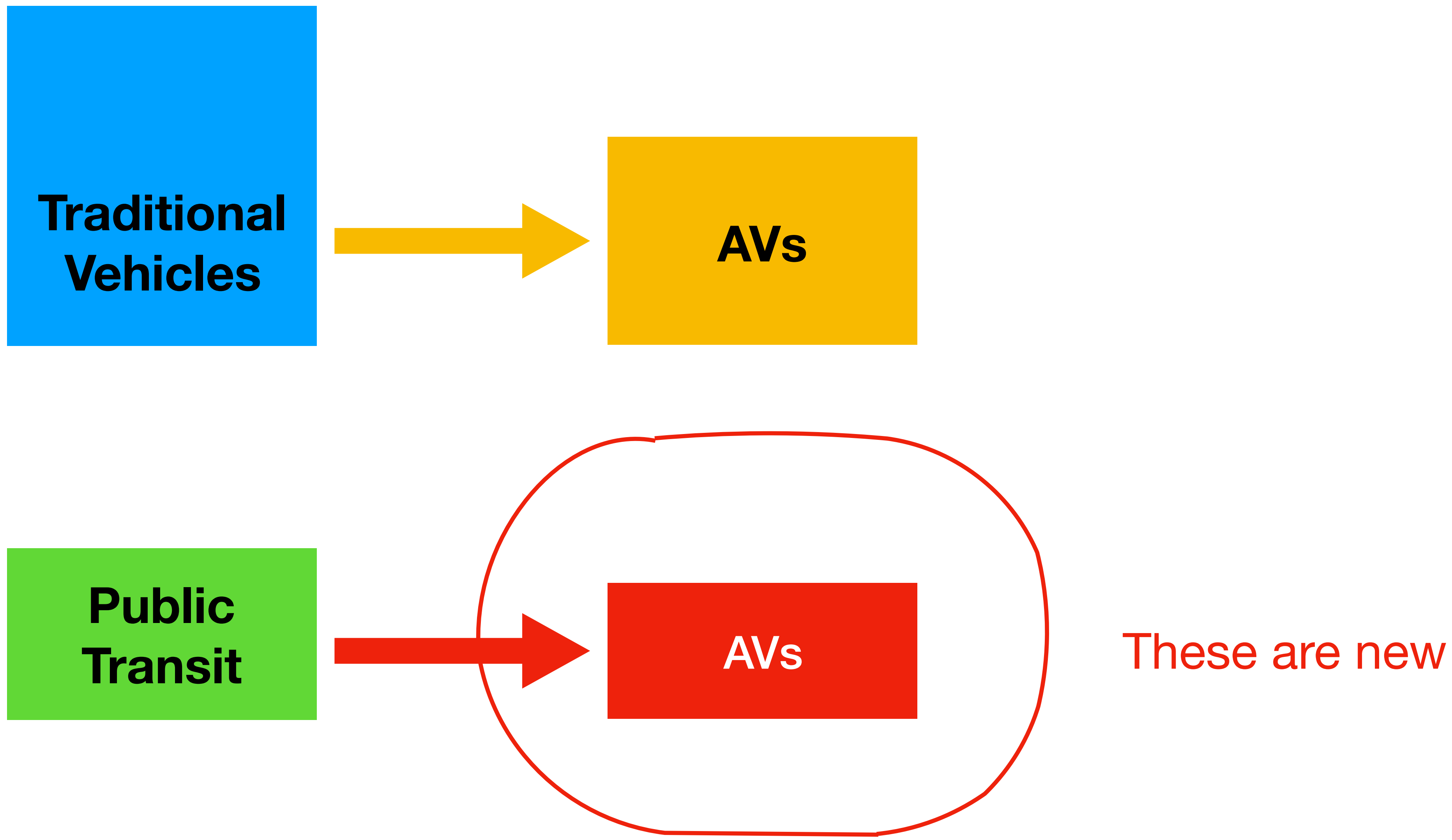
These guys were already on the road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These are new

Who will be the winners and losers as this new technology becomes cheaper?

Cashiers,
fast food workers,
house cleaners,
janitors,
child care workers,
school teachers…?

This short paper: back of the envelope calculations of impact of AVs on time behind the wheel, by income group

1. Model adoption as function of income

cost of AVs drops $\rightarrow$ who adopts

adoption by income

Wealthier adopt more earlier:

- More likely to buy new
- NHTS vehicles with semi-autonomous features

2. How many adopters were previously on public transit?

cost of AVs drops → who adopts → how many more cars on road

adoption by income

mode use by income

- NHTS
- ACS

3. How do additional vehicles translate to travel delays?

cost of AVs drops → who adopts → how many more cars on road → how much longer commutes

adoption by income

mode use by income

vehicle carrying capacity

- TomTom historical data on congestion delays
- ACS historical data on commuter flows

4. Who will face longer commutes?

cost of AVs drops → who adopts → how many more cars on road → how much longer commutes → who faces longer commutes

adoption by income

mode use by income

vehicle carrying capacity

time commuting by income and mode

- NHTS
- ACS

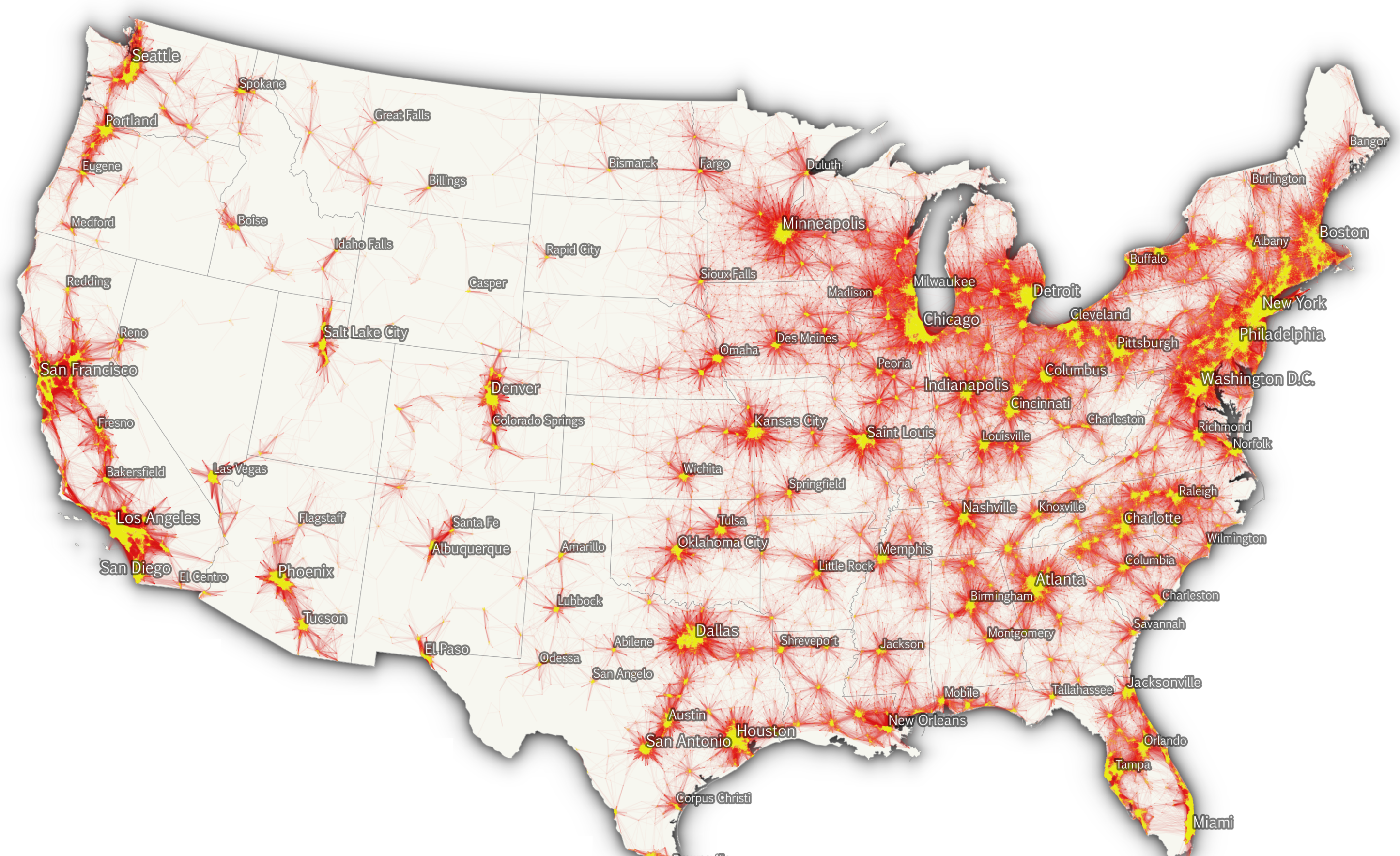
Datasets

2017 National Household Transportation Survey (NHTS):

- 264,000 drivers; 128,000 commuters
- Commute mode, distance, time (average and absent congestion)
- Vehicle make/model/year
- Household-level income (1 of 10 categories)

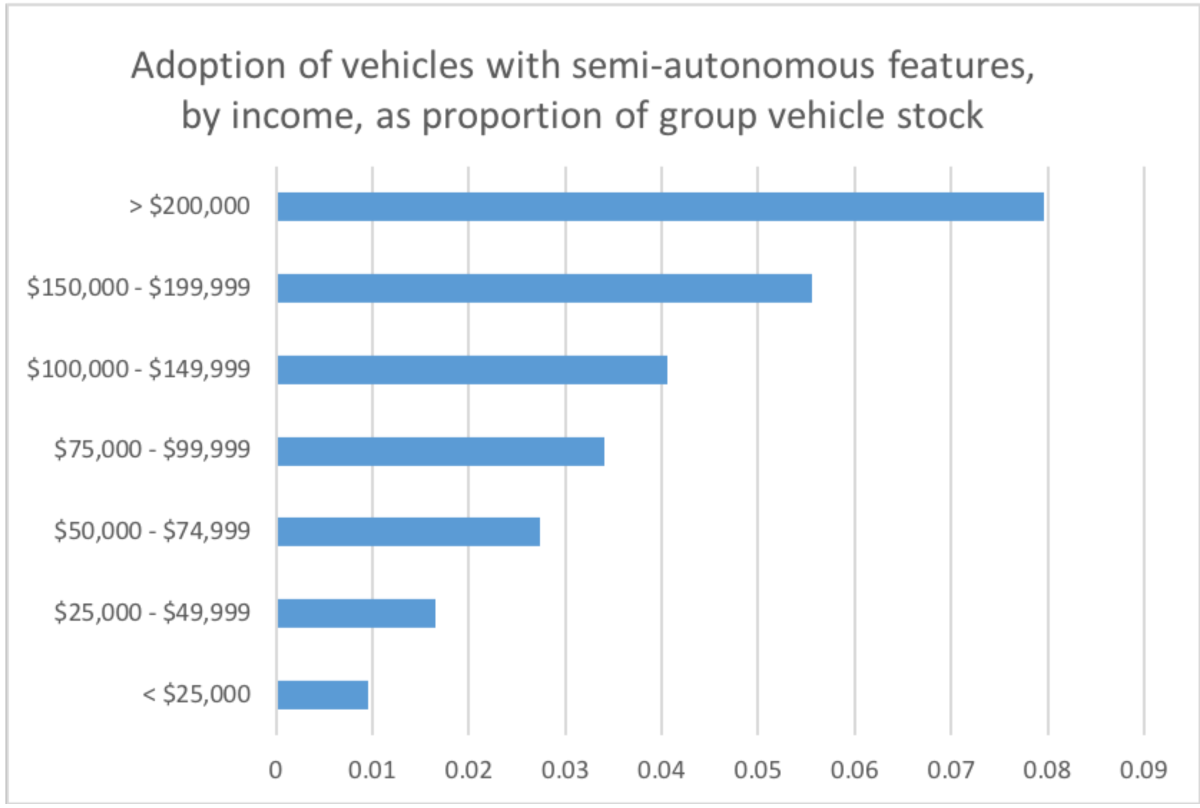
2016 American Community Survey (ACS)

- All census tract-level commute flows by mode
- Census-tract median/mean household income
- Open Street maps to identify road network distances and times absent congestion



Source: Alasdair Rae ACS

Who adopts?



Source: NHTS 2017 vehicle survey

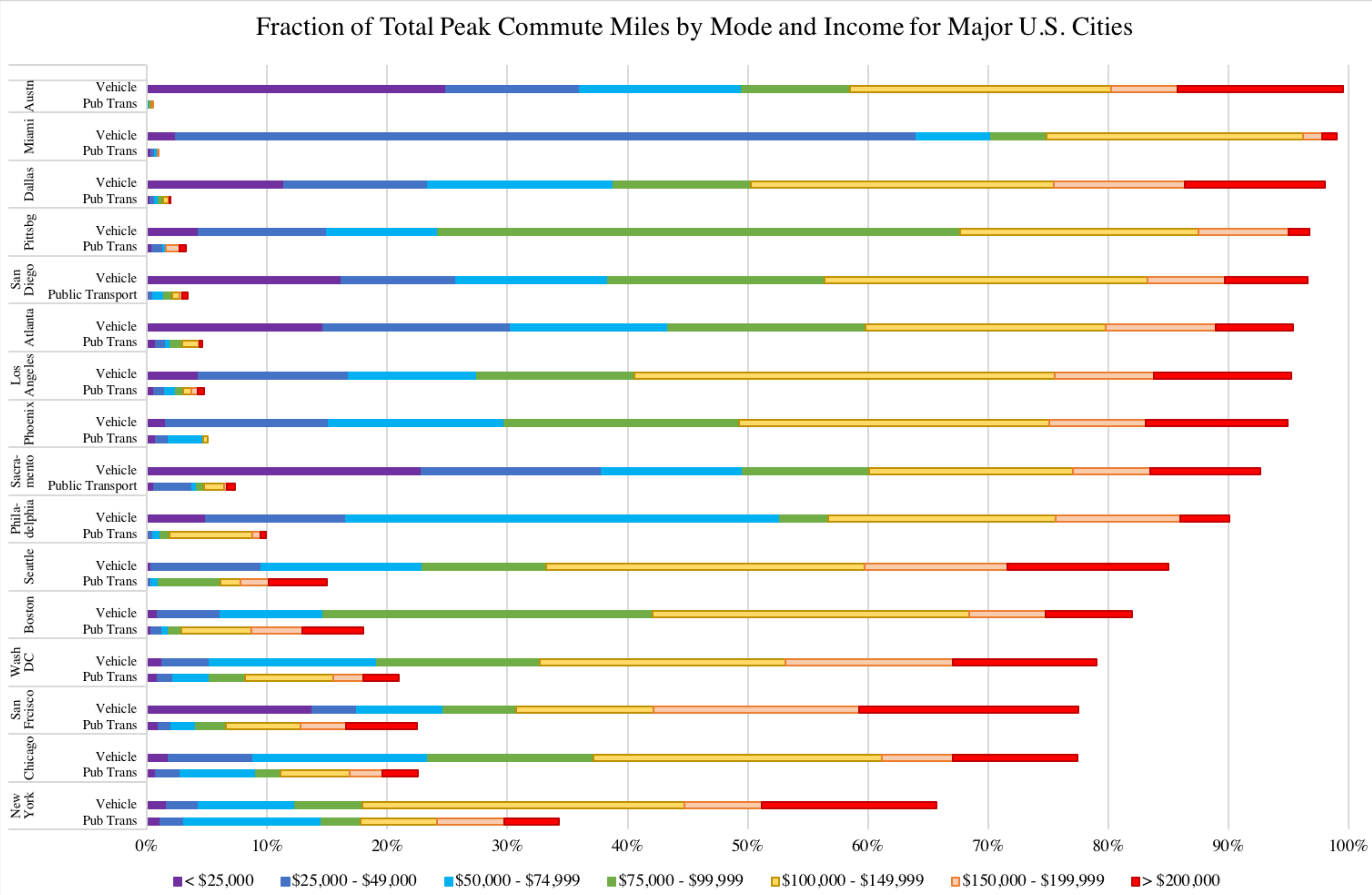
Most common observed:

Subaru Forester (2014+)
Subaru Outback (2013+)
Grand Cherokee (2012+)
Hyundai Sonata (2015+)
BMW 5-series (2007+)
Chevrolet Impala (2014+)
BMW 3-series (2013+)

Adaptive cruise control (**ACC**): automatically adjusts the vehicle speed to maintain a safe distance from vehicles ahead

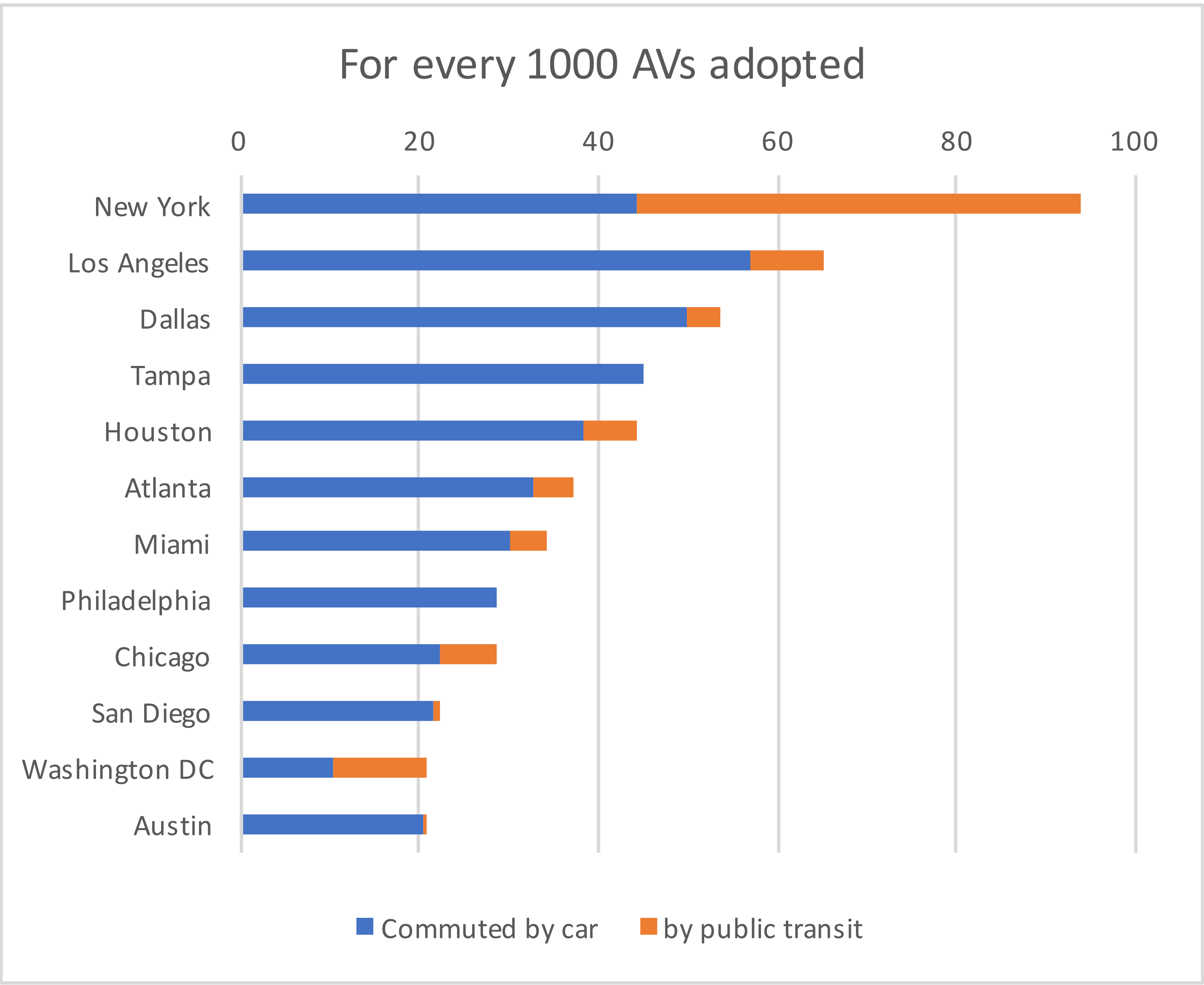
Note: modeling as vehicle ownership,
similar income effect also likely in trip-level rental

Mode use by income



Source: NHTS 2017

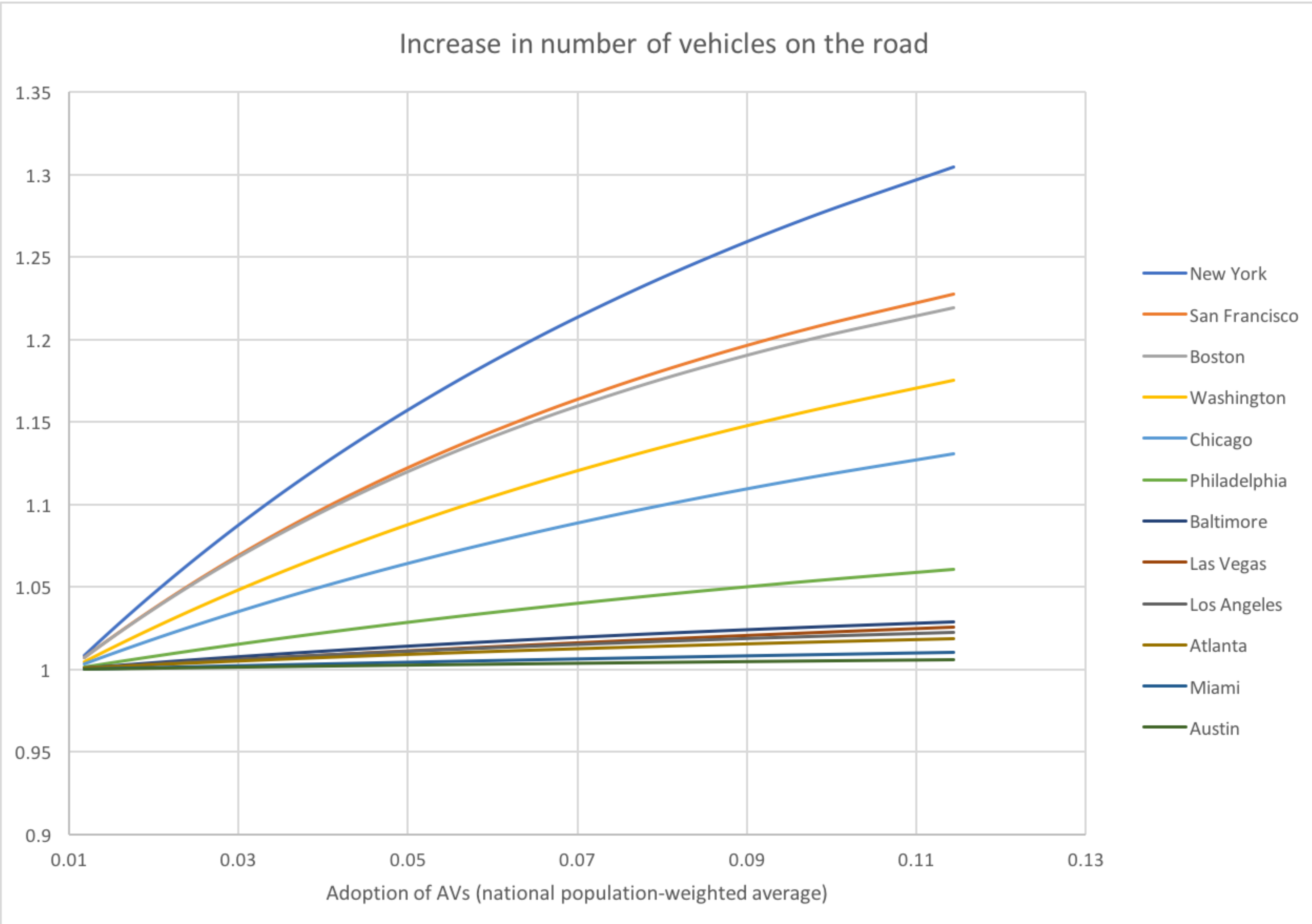
Allocate vehicles to cities based on income distribution



Assume within city-income bucket adoption equally likely across modes

Note: more congested cities, all else equal, are likely to have greater demand for AVs, which is likely to make increase in delays worse

Additional vehicles on the road



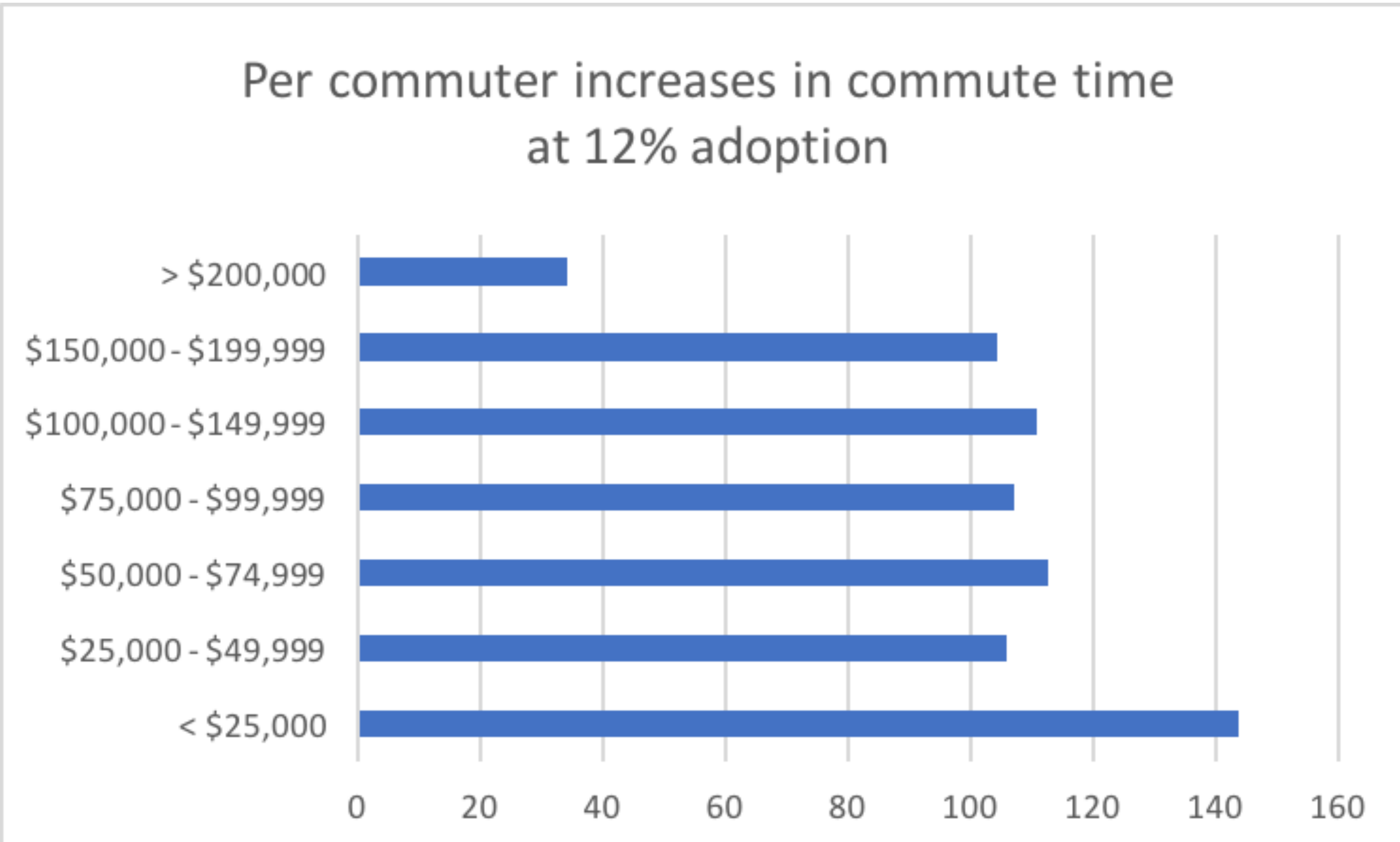
Carrying capacity for additional vehicles?

Historical changes in congestion delays:
- TomTom city-level 2008-2016

Historical changes in vehicles commuting:
- 2010 and 2016 ACS county to MSA vehicle commutes

Note: crude linear extrapolation from historical experience
Does not control for historical in-migration, road expansion, increase in ride share, etc.
or take into account their potential to accentuate future congestion

Overall: additional commute time 4 times higher for lowest income than for highest



Pop density

NHTS HH-specific income

Increases so large for a few cities that unlikely policy environment would stay unchanged

Additional minutes per day time spent commuting for LOWEST income group varies widely across cities

Ratio of additional time spent, lowest to highest group, consistently 5-8 times higher

	Lowest	Ratio
New York	100+	8.3
San Francisco	100+	11.1
Chicago	100+	7.8
Boston	100+	6.4
Seattle	70	4.5
Philadelphia	50	9.7
Los Angeles	48	7.4
Washington	45	5.2
San Diego	17	6.7
Portland	12	2.2
Miami	8	7.6
Houston	5	6.9
Austin	2	7.2

Should we value traffic delays equally across all incomes?

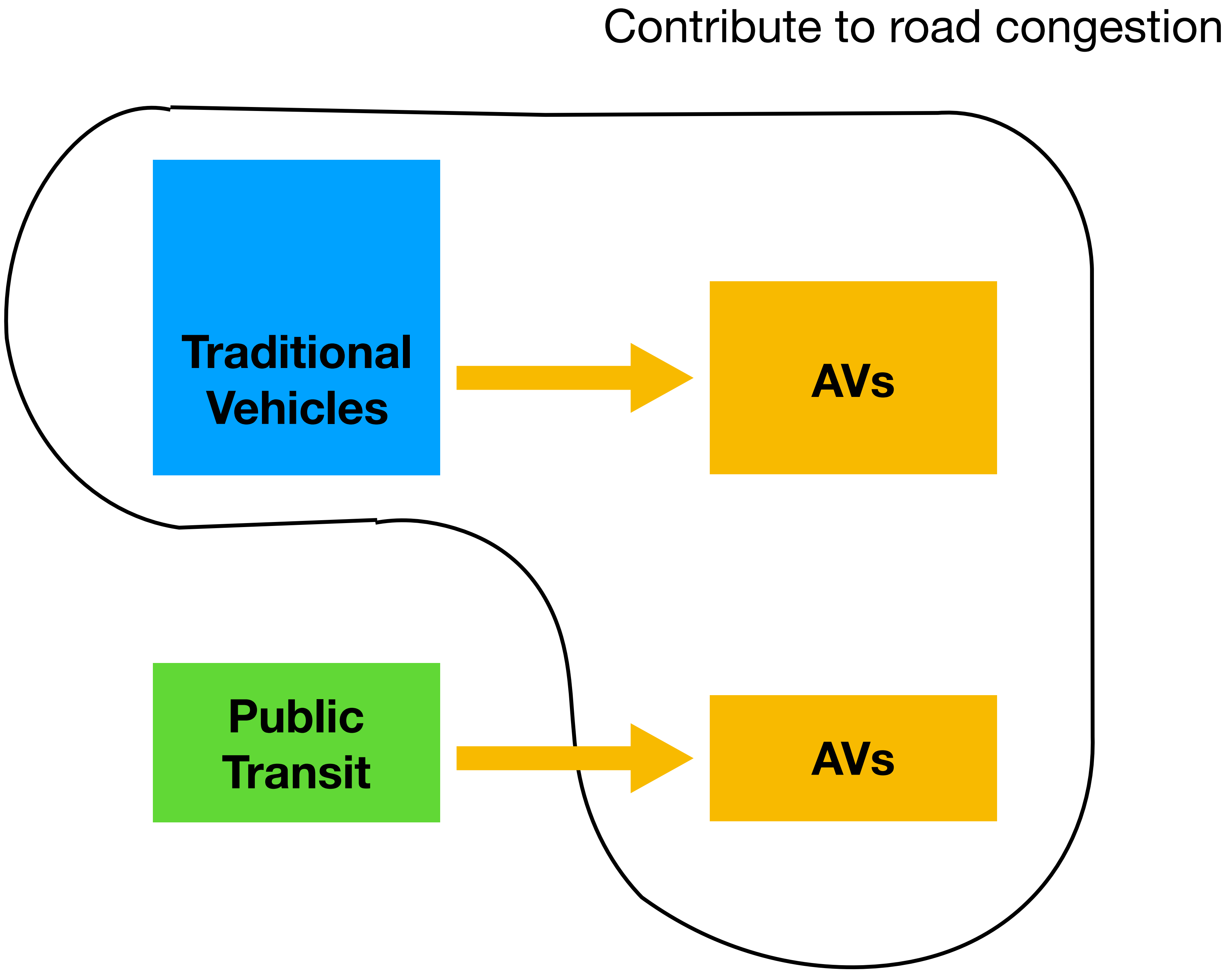
Time cost: wealthier driver earns higher wage

Schedule cost: low income drivers could esp. value being on time

- Less flexible work schedules? multiple part-time shifts, physical presence required, potentially more likely to get fired if late

Public transit as viable alternative?

- lower income more likely to live in areas with less access
- wealthier commuters more likely to take commuter rail (unaffected by road traffic), lower income to take bus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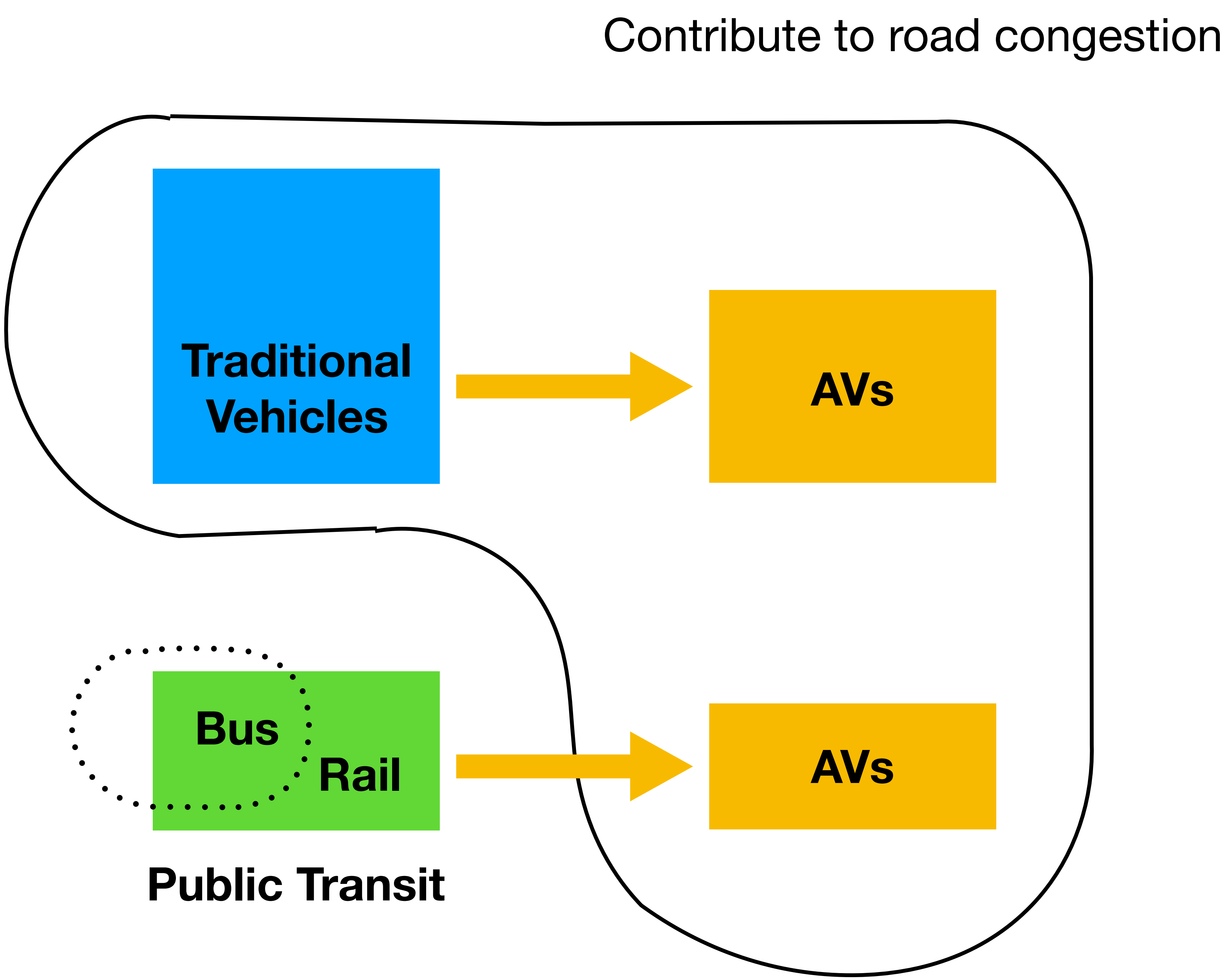
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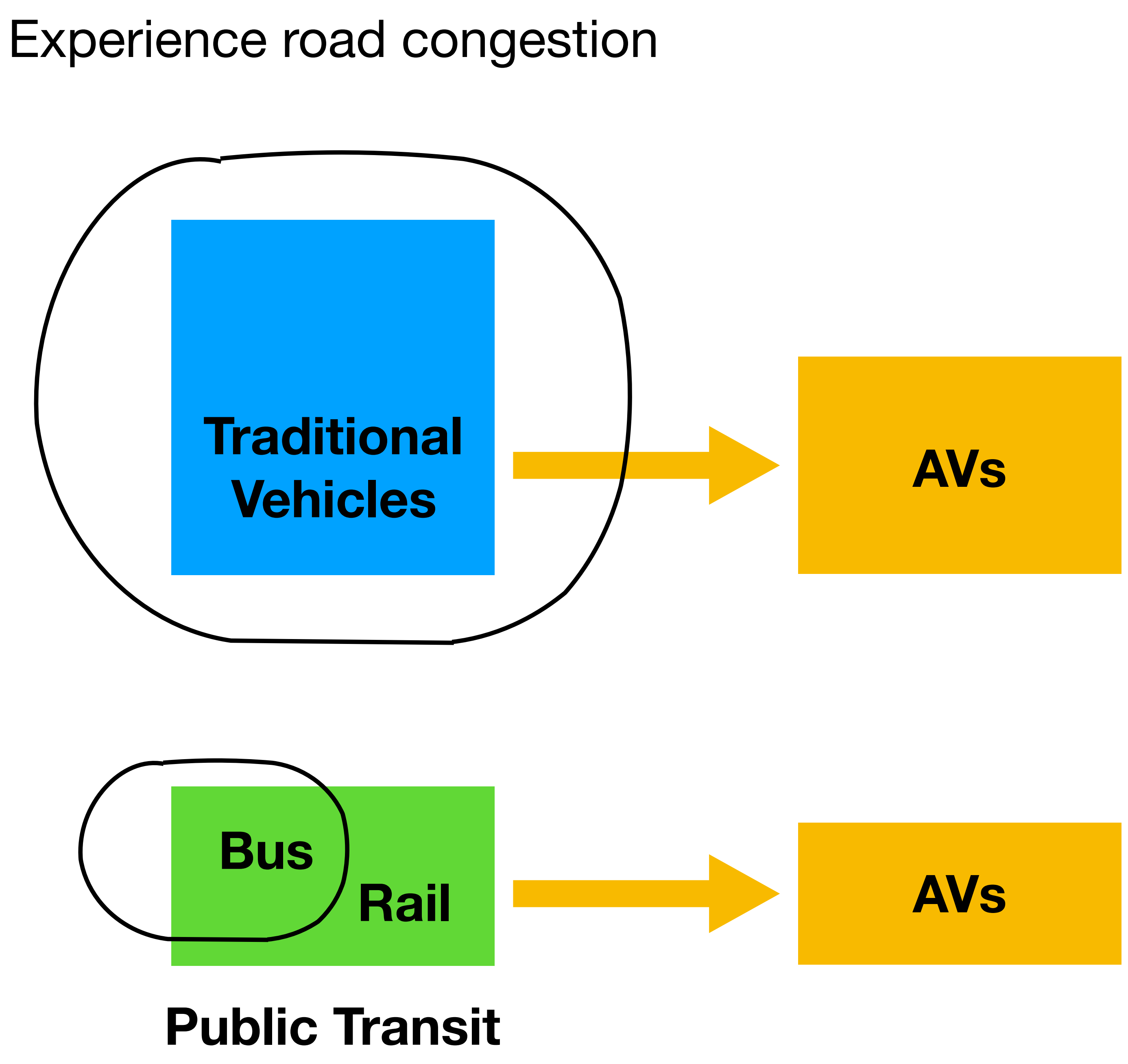
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But aren't AVs supposed to reduce congestion?

- Improved traffic throughput: reduce buffer, remove stop signs
- Fewer accident-related delays
- Road supply: free up inner city lanes from street parking

But most benefits accrue when AVs are only cars on the road

Lower MC of driving induces demand immediately

This discussion is about the transition

And in the longer run?

- Commutes more elastic: adopters who previously drove may increase VMT by changing home-work locations
- Public transport needs may change
- Funding for public transport may be at risk if disproportionately used by lower income
- Endogenous demand for more flexible working hours, even congestion charges?

In summary

AVs may provide dramatic improvements in quality of life for those who can afford them

In some key markets AVs likely to increase experienced commute times disproportionately for middle and lower incomes

Cities that will see largest distributional cost:

- Are already at or near congested road conditions at peak times, and
- Have many high-income commuters who are currently on public transit, and
- Have many low-income commuters who are currently on the road

Thank you

leslie.martin@unimelb.edu.au