Environmental and socio-economic aspects of autonomous, connected, electric and shared vehicles (ACES)

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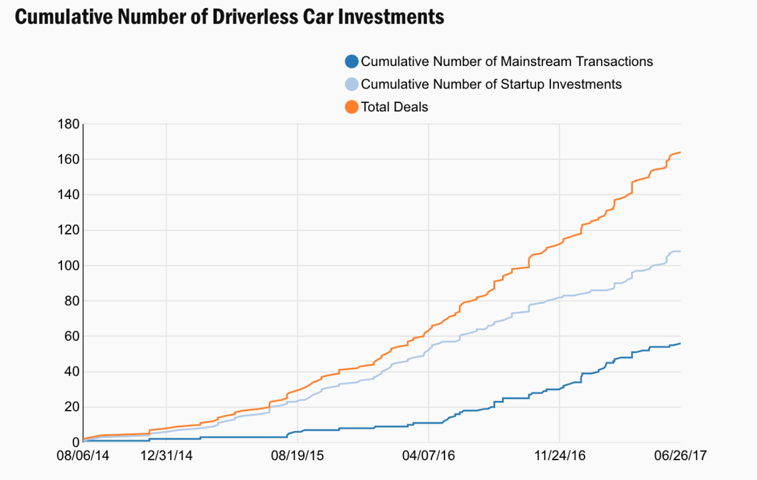
May 23, 2018

4 recent major developments in transportation

- automation (AVs)
- connectivity and digitalization (CVs)
- electrification (EVs)
- shared ownership (SVs)

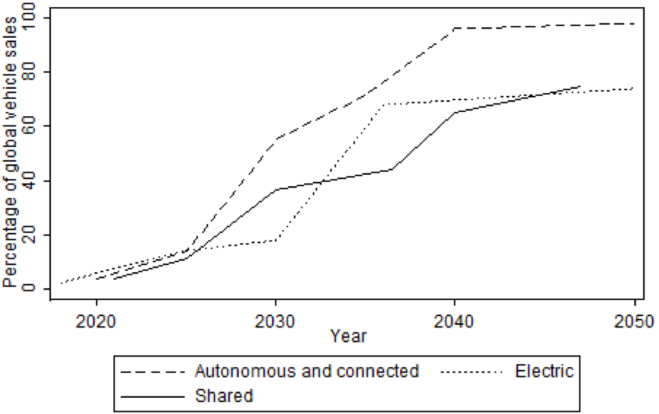
$\rightarrow$ Autonomous, connected, electric and shared vehicles (ACES)

Disruptive changes in the transport sector? So far 80+ billion investments in driverless technologies



Source: The Brookings Institution
(`https://www.brookings.edu/research/gauging-investment-in-self-driving-cars/`)

Aggregated forecast ACES



Sources: 24 forecasts from 19 articles on autonmous, connected, electric and shared vehicle sales.

Adler, Peer & Sinozic: Public finance implications of autonomous, connected, electric and shared (ACES) transport, Working Paper

Overview

1. Starting point(s):
   - Advent of ACES very likely
   - Environmental and socio-economic effects of ACES strongly policy-dependent
     - Economic instruments (taxes/charges/fees)
     - Infrastructure investments
     - Spatial planning
     - Regulatory measures
     - Public vs. private ownership
   - Near-term action important due to strong path dependencies
2. Research agenda

What do we "know"?

- Decrease in the (private) costs of mobility due to ACES undisputed (estimates: 1/3 to 1/2 of current price)
  - Fleet ownership & ride-sharing (especially in urban areas)
  - Higher efficiency (cars are now standing still for about 95% of time)
  - Current steering instruments (fuel taxes, parking charges) will become mostly irrelevant

→ Demand for mobility will increase
→ Similar case can be made for freight transport

More demand – more congestion?

- Expected increase in vehicle miles and congestion due to lower costs and higher comfort, as well as from new user groups and adapted travel and location patterns
  - Estimates VMT: +3 – 25%; Kaddoura, 2017: Smith 2012; Citymetrics, 2017)
  - Elasticities: SR: -0.15 to -0.05; LR: -0.5 to -0.3
- ACES have no “value of time" (leading to idle rides)
- But: cruising for parking will disappear to a large extent; infrastructure can be used more efficiently; parking space is freed up; ACES are expected to reduce accident numbers (which are responsible for ca. 25% of congestion)

Environmental aspects

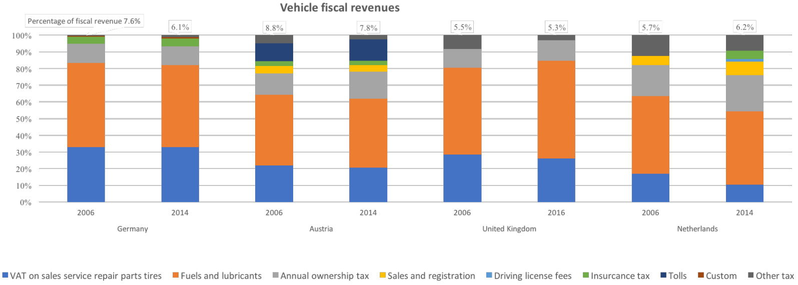
- Reduction of air and noise pollution as well as greenhouse gas emissions due to electrification (clearly, share of renewables matters strongly)
- But: up to 50% of local air pollution from vehicle use is due to other sources than fuel combustion (Grigoratos and Martini, 2014)
- Production & recycling of batteries very energy intensive
- Road space can be saved due to lower demand for parking (e.g. Ambühl et al. (2016): -12%)
  - Green space? Possibly reducing urban heat

Macro-economic effects

- Changes in labor supply & demand and productivity affect tax revenues
  - Unemployment is predicted to increase substantially in specific sectors (drivers; car industry; 5% of all employees in EU can be attributed to logistics sector)
  - More disposable income due to cheaper mobility
  - More disposable leisure time (Bertoncello & Wee (2015): + 50min/day)
  - Improved matching in labor market (counterbalanced by increase in commuting distances?)
- Predictions very uncertain at this point
  - Karpilow & Winston (2016): ACES will increase US annual growth rate by 1.8 percentage points from a 2010 baseline GDP
  - Morgan Stanley (2013): GDP US +8%, Clements & Kockelmann (2017): +5%

Fiscal aspects (I)

In OECD countries, ca. 5-10% of fiscal revenues are transport-related (and ca. 1.5-5% of fiscal expenditures)



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Fiscal aspects (II)

- Decline in fuel tax revenues
  - Due to expected electrification of car fleet
  - Electricity taxed at much lower ($<$1/10) rates than oil products
- Decrease in registration & circulation tax revenues
  - Fewer cars required to serve demand if car- and ride-sharing become more common
  - In metropolitan areas, 95% of trips are in principle shareable (Tachet, 2017)
  - 10% of current fleet needed to serve demand, even if (likely) increase in vehicle miles is accounted for (based on simulation studies for Austin, Lisbon, Helsinki, etc.)

Fiscal aspects (III)

- Transport
  - Short and medium run: large investments required
  - Long-run: expected decline in infrastructure spending (KPMG, 2012: -10%)
  - Public transport: predictions highly uncertain & strongly dependent on (local) public policy
- Energy
  - Smart grids
- Telecommunication networks will require large investments

Research agenda: overview

- Policies
  - Pricing policies
  - Dynamic policy setting
  - Ecological/environmental aspects
  - Socio-economic aspects (public finance, distributional impacts)
- Micro-simulation model for Vienna (ACRP project "SimSAEV")

Pricing

Main point: ACES are likely to require (and enable) differentiated road tolls

- Revenue motives
- Steering motives
  - In line with theory (Vickrey, 1969; etc.)
- Technology allows for highly differentiated road tolls
  - By road type, time of day, car occupancy etc.
  - Lower transaction costs than existing schemes
  - Higher user acceptance? (taxes can be part of the total fare)

Dynamic policy setting

Main point: Local (urban) governments are likely to gain more power in transport-related policy making

- Most likely to be affected by negative externalities
- ACES penetration will likely be led by dense high-income cities
- Better knowledge of local circumstances
- Gain first-mover advantage
- Tax revenues from vehicle-related taxes at the national level are likely to decline

Micro-simulation model for Vienna (ACRP project "SimSAEV") (I)

- Agent-based transport model using MATSIM (www.matsim.org)
- Has been done for several cities: Austin, Helsinki, Lissabon, Berlin, Zurich, Paris (example: https://www.youtube.com/watch?v=7vR7yFOzcgA)
- Connect transport model with socio-economic and environmental indicators (identify synergies and trade-offs)
  - Socio-economic: inequality, accessibility, affordability of mobility, freed-up parking space, tax revenues
  - Environmental: CO_2 and PM2.5 emissions, urban heat

Micro-simulation model for Vienna (ACRP project "SimSAEV") (II)

We simulate:

- Preference structures (in particular regarding sharing)
- Technologies
- Market structures
- Policy scenarios:
  - Pricing & taxation: e.g., applying user- and polluter-pays principles
  - Regulation: e.g., zoning laws, speed limits, dedicated lanes
  - Infrastructure investment: e.g., changes in (road) capacity, dynamic traffic lights to improve traffic flows

Outlook

- ACES will remain an important issue in the next years/decades
- Substantial environmental and socio-economic implications
- Near term policy action strongly preferable
- Large research potential: general/partial equilibrium models, optimal adaptation path, IO, political economy, etc.

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