The Inadequacy of the gas tax & Highway Trust Fund

Historical Highway Trust Fund Accounts

Highway Trust Fund revenues and interest have been insufficient to pay for outlays from the fund.

Source: Figure created by CRS based on CBO, Highway Trust Fund Projections: May 2023 HTF Baseline 2022-2033. Data for FY2021 and FY2022 are actual revenues and outlays.
Figure 8: Date of sticker price parity in key markets

Source: BNEF. Note: S = small, M = medium, L = large, SUV = sports utility vehicle
# EV Registration Fees

<table>
<thead>
<tr>
<th>State</th>
<th>Average annual gas taxes paid per vehicle</th>
<th>Annual EV registration fees</th>
</tr>
</thead>
<tbody>
<tr>
<td>Alabama</td>
<td>$247</td>
<td>$200 EV/$100 PHEV</td>
</tr>
<tr>
<td>Alaska</td>
<td>$142</td>
<td></td>
</tr>
<tr>
<td>Arizona</td>
<td>$194</td>
<td></td>
</tr>
<tr>
<td>Arkansas</td>
<td>$224</td>
<td>$200 EV/$100 HEV</td>
</tr>
<tr>
<td>California</td>
<td>$433</td>
<td>$100 EV (increase in accordance with the consumer price index)</td>
</tr>
<tr>
<td>Colorado</td>
<td>$216</td>
<td>$50 EV/$50 PHEV</td>
</tr>
<tr>
<td>Connecticut</td>
<td>$225</td>
<td></td>
</tr>
<tr>
<td>Delaware</td>
<td>$215</td>
<td></td>
</tr>
<tr>
<td>District of Columbia</td>
<td>$271</td>
<td></td>
</tr>
<tr>
<td>Florida</td>
<td>$280</td>
<td></td>
</tr>
<tr>
<td>Georgia</td>
<td>$250</td>
<td>$212.78 EV</td>
</tr>
<tr>
<td>Hawaii</td>
<td>$191</td>
<td>$50 EV and PHEV and HEV</td>
</tr>
<tr>
<td>Idaho</td>
<td>$267</td>
<td>$140 EV/$75 PHEV</td>
</tr>
<tr>
<td>Illinois</td>
<td>$424</td>
<td>$100 EV</td>
</tr>
<tr>
<td>Indiana</td>
<td>$423</td>
<td>$150 EV/$50 PHEV and HEV</td>
</tr>
<tr>
<td>Iowa</td>
<td>$251</td>
<td>$130 EV/$65 PHEV</td>
</tr>
<tr>
<td>Kansas</td>
<td>$225</td>
<td>$100 EV/$50 PHEV and HEV</td>
</tr>
<tr>
<td>Kentucky</td>
<td>$230</td>
<td></td>
</tr>
<tr>
<td>Louisiana</td>
<td>$204</td>
<td>$110 EV/$60 HEV</td>
</tr>
<tr>
<td>Maine</td>
<td>$258</td>
<td></td>
</tr>
<tr>
<td>Maryland</td>
<td>$318</td>
<td></td>
</tr>
<tr>
<td>Massachusetts</td>
<td>$235</td>
<td></td>
</tr>
<tr>
<td>Michigan</td>
<td>$364</td>
<td>$135 EV up to 8,000 lb; $235 EV over 8,000 lb; $47.50 HEV up to 8,000 lb; $117.50 HEV over 8,000 lb</td>
</tr>
<tr>
<td>Minnesota</td>
<td>$244</td>
<td>$75 EV</td>
</tr>
<tr>
<td>Mississippi</td>
<td>$191</td>
<td>$150 EV/$75 HEV</td>
</tr>
<tr>
<td>Missouri</td>
<td>$212</td>
<td>$75 EV/$37.50 PHEV</td>
</tr>
<tr>
<td>Montana</td>
<td>$271</td>
<td></td>
</tr>
<tr>
<td>Nebraska</td>
<td>$229</td>
<td>$75 EV</td>
</tr>
<tr>
<td>Nevada</td>
<td>$219</td>
<td></td>
</tr>
<tr>
<td>New Hampshire</td>
<td>$219</td>
<td></td>
</tr>
<tr>
<td>New Jersey</td>
<td>$316</td>
<td></td>
</tr>
<tr>
<td>New Mexico</td>
<td>$193</td>
<td></td>
</tr>
<tr>
<td>New York</td>
<td>$187</td>
<td></td>
</tr>
<tr>
<td>North Carolina</td>
<td>$297</td>
<td>$130 EV</td>
</tr>
<tr>
<td>North Dakota</td>
<td>$215</td>
<td>$120 EV/$50 PHEV</td>
</tr>
<tr>
<td>Ohio</td>
<td>$295</td>
<td>$200 EV and PHEV/$100 HEV</td>
</tr>
<tr>
<td>Oklahoma</td>
<td>$199</td>
<td>$110 EV/$82 PHEV up to 6,000 lbs; $158 EV/$118 PHEV; 6,000 - 10,000 lbs; $363 EV/$272 PHEV; 10,000 - 26,000 lbs; $2250 EV/$1687 PHEV, over 26,000 lbs</td>
</tr>
<tr>
<td>Oregon</td>
<td>$293</td>
<td>$110 EV</td>
</tr>
<tr>
<td>Pennsylvania</td>
<td>$400</td>
<td></td>
</tr>
<tr>
<td>Rhode Island</td>
<td>$278</td>
<td></td>
</tr>
<tr>
<td>South Carolina</td>
<td>$245</td>
<td>$120 biennial fee EV/$80 biennial fee HEV</td>
</tr>
<tr>
<td>South Dakota</td>
<td>$251</td>
<td>$50 EV</td>
</tr>
<tr>
<td>Tennessee</td>
<td>$238</td>
<td>$100 EV</td>
</tr>
<tr>
<td>Texas</td>
<td>$199</td>
<td></td>
</tr>
<tr>
<td>Utah</td>
<td>$264</td>
<td>$90 EV/$15 HEV/$39 PHEV</td>
</tr>
<tr>
<td>Vermont</td>
<td>$287</td>
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</tr>
<tr>
<td>Virginia</td>
<td>$286</td>
<td>$64 EV</td>
</tr>
<tr>
<td>Washington</td>
<td>$367</td>
<td>$225 EV/$75 PHEV and HEV</td>
</tr>
<tr>
<td>West Virginia</td>
<td>$281</td>
<td>$200 EV/$100 PHEV</td>
</tr>
<tr>
<td>Wisconsin</td>
<td>$266</td>
<td>$100 EV/$75 HEV</td>
</tr>
<tr>
<td>Wyoming</td>
<td>$220</td>
<td>$50 EV annual</td>
</tr>
</tbody>
</table>

Note: The average annual gas taxes paid per vehicle is calculated based on a vehicle with an average fuel economy of 22.2 mpg driven 11,520 miles in 2019. Gas taxes include federal and state gasoline tax, along with other per-gallon fees, such as leaking underground storage tank fees in July 2022.
Our framework: what are the policy objectives?

Possible policy goals

Dollar-for-dollar replacement of gas tax

Dollar-for-dollar replacement + new revenue to fill funding gaps

Dollar-for-dollar replacement + pricing to address traffic congestion

Dollar-for-dollar replacement + new revenue to fund sustainable non-auto transport projects

Annual cost of the vehicle economy in Massachusetts

Our framework: what are the sources?

Transportation sources or non?

Non transport sector sources like the sales tax or income tax are highly unpopular politically & place the transport sector in competition with other worthy governmental & societal needs.

Possible transport sector revenue sources

Assess ownership

- Fees scaled by weight
- Flat fees
  - Parking assessments

Assess use

- Vehicle miles traveled (VMT) charge
- Road pricing (conventional tolls and/or congestion charge)
- Tax electricity used for charging
## Summary of Alternatives Evaluation

<table>
<thead>
<tr>
<th></th>
<th>Ease of administration</th>
<th>Potential for evasion</th>
<th>Stability over time</th>
<th>Fairness</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Gas tax</strong></td>
<td>Easy</td>
<td>Low</td>
<td>Low</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Flat fees</strong></td>
<td>Easy</td>
<td>Low</td>
<td>High</td>
<td>Low</td>
</tr>
<tr>
<td><strong>Parking pricing</strong></td>
<td>Easy</td>
<td>Medium</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>VMT charge</strong></td>
<td>Medium</td>
<td>Medium</td>
<td>High</td>
<td>High</td>
</tr>
<tr>
<td><strong>Road pricing</strong></td>
<td>Medium</td>
<td>Low</td>
<td>Medium</td>
<td>Medium</td>
</tr>
<tr>
<td><strong>Charging tax</strong></td>
<td>Hard</td>
<td>High</td>
<td>High</td>
<td>Medium</td>
</tr>
</tbody>
</table>

How does each implementation tool respond to key externalities of vehicular mobility?
Why Model?

- Cannot look at variables independently
- Need a systems perspective on the impacts of:
  - Policy & Regulation
  - Consumer behaviour and choice
  - Industry Challenges & Preference
  - Environment
    - Not looking at battery minerals availability and emissions impact in this analysis

Why didn’t you use Excel?
- Excel is the 2nd best tool for any analysis
- Interdependency of variables makes it unsuitable for Excel
  - Circular reference error
Overlying Assumptions & Simplifications

- Looking only at Light Duty Vehicles (LDVs) – 90% of US VMT
- Only looking at Gas vehicles – no diesel (3.7% of LDVs), fuel cell etc.
- US LDV Fleet – 266 million
  - New sales annually – 16.68M
  - 28% of new car buyers are first car buyers
  - Not replacing a car
- 6% of new car sales assumed to be BEV currently
- 100% BEV new car sale Mandate – 2035 – can be edited on the fly
- 17-year average life of an LDV in the US
- Avg ICE Car weight = 4094 pounds, EV Car = 5094 pounds
Overlying Assumptions & Simplifications

- 13,475 miles driven on average annually - can be edited on the fly
- 22.8 mpg current LDV efficiency – CAFÉ standards can be edited, and fuel efficiency trends can be changed on the fly
- Federal + state gas tax collection used for deficit calculations = $105B ($90B for LDVs)
  - Can be edited to model different states
- Volume weighted average of state gas taxes is added to the 18.4 cents per gallon federal gas tax to give a total of 57.09 cents per gallon
  - Can be edited to model different states
- $331.4 Average annual federal + state gas tax paid per LDV per year
  - 2.5 cents per mile
- Year 1 is 2023 and the simulation runs till 2050
What does the model tell us?

- Under most scenarios it takes 14-17 years for the EV fleet market share to cross 50%
  - Most of this is driven by the 2035 mandate
  - Can be even slower (maybe faster?)

- Reducing ICE vehicles and increasing fuel efficiency standards means the gas tax collection will fall by half in 14-17 years
  - Land at between 20-30% of current collections by 2050

- 2.9 cent/mile VMT fee and weight-based fees are the most promising measure to counter this fall.
LDV Fleet Transition to EVs is Slow - [https://web.mit.edu/gastaxmodel/](https://web.mit.edu/gastaxmodel/)
DEMAND-RESPONSIVE MICROTRANSIT

Alexandre Jacquillat

Associate Professor of Operations Research and Statistics

MIT Sloan School of Management
A research agenda in large-scale optimization to promote efficient, reliable and sustainable mobility

**Air traffic management**

**Demand-responsive transit**

**Logistics decarbonization**

**Transportation for social good**
Analytics and optimization across demand-responsive microtransit landscape, in collaboration with Via

Virtual bus stops  Paratransit  Microtransit  Multi-modality

Benefits of optimization to support emerging operating models

Benefits of even a little flexibility in demand-responsive operations

Win-win outcomes of demand-responsive operations: coverage, level of service, operating costs, and environmental footprint
Microtransit as an array of solutions in the mobility landscape from fixed-route transit to ride-sharing

“The New York Times
Who’s Afraid of a Transit Desert?
October 11, 2019

CURBEd
Why Your Uber Ride Is Suddenly Costing a Fortune
June 4, 2021

“Shared transportation system(s) that can offer fixed routes and schedules, as well as flexible routes and on-demand scheduling” (DoT)
Core objective: bringing on-demand flexibility into the realm of transit, with limited detours and delays

Small-occupancy ride-pooling

Zone-based regularization

Small service region

Line-based regularization

Alexandre Jacquillat — Demand-responsive microtransit
This research: models and algorithms to optimize the design and operations of line-based microtransit

Strategic optimization: network and frequency planning

Tactical optimization: demand-responsive operations

How to design and operate emerging hybrid microtransit systems, enabled by mobility-as-a-service technology platforms?
Line-based microtransit defines a true middle ground between fixed-line transit and ride-sharing

Benefits of demand-responsive flexibility vs. fixed-line transit: less walk, shorter wait times, higher demand coverage

Demand consolidation in high-occupancy vehicles vs. ride-sharing
Win-win-win outcomes of microtransit toward more efficient, equitable and sustainable urban mobility

**Efficiency**

Operating benefits: demand coverage, high vehicle loads

**Equity**

Impact on network planning: broader geographic reach

**Sustainability**

Consolidation: environmental footprint mitigation
Thank you!
Flexibility & Coordination in On-Demand Mobility: From Micromobility to Ridehail

Daniel Freund
Assistant Professor of Operations Management
Sloan School of Management
Research Interests
Exploiting flexibility in ride-hailing (WP)

Optimizing ride-hail driver incentives (IJAA’20, OR’22)
Research Interests

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Optimizing ride-hail driver incentives (IJAA’20, OR’22)

Exploiting flexibility in bike-sharing (IJAA, ’19)

Optimizing Bike-sharing station sizes (OR,’22)
Research Interests

- Optimizing ride-hail driver incentives ($IJAA’20$, $OR’22$)
- Coordinating AV deployments on platforms ($WP$)
- Exploiting flexibility in bike-sharing ($IJAA, '19$)
- Optimizing bike-sharing station sizes ($OR,'22$)
- Optimizing EV charging infrastructure ($MMI Grant$)
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- Optimizing Refugee resettlement (*WP*)
- Optimal online resource allocation (*MOR’23, OR’23, MS’23*)
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Managing flexibility on platforms

Demand side

- Bike Angels
- Wait & Save
- Scheduled ride

Willingness to try AVs
Managing flexibility on platforms

Demand side

- Bike Angels
- Wait & Save
- Scheduled ride
- Willingness to try AVs

How to leverage these operational tools?
Managing flexibility on platforms

Supply side
- Bike valets
- Car seats
- Green cars
- Safety drivers in AVs

How to leverage these operational tools?
Managing flexibility on platforms

Demand side

- Bike Angels
- Wait & Save
- Scheduled ride
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Supply side

- Bike valets
- Car seats
- Green cars
- Safety drivers in AVs

Holistically optimizing flexibility on both market sides
Managing flexibility on platforms

1) Flexibilities interact in complicated manners
2) Even with just two perfectly symmetric flexibility types!
Coordinating AV Deployments in Hybrid Fleets

Contracting

1. Aligning interests of platforms (Uber/Lyft) & AV owners (???)

2. Fleet size, vehicle utilization, AV capabilities
Coordinating AV Deployments in Hybrid Fleets

**Contracting**

1. Aligning interests of platforms (Uber/Lyft) & AV owners (???)

2. Fleet size, vehicle utilization, AV capabilities

**Capabilities**

1. Optimizing new AV capabilities

2. For a standalone AV platform (Waymo One) or by taking into account an external platform’s (Uber/Lyft) dispatch policy
Coordinating AV Deployments in Hybrid Fleets

1. Aligning interests of platforms (Uber/Lyft) & AV owners (Waymo)
2. Fleet size, vehicle utilization, AV capabilities

Capabilities

- Optimizing new AV capabilities
- For a standalone AV platform (Waymo One) or by taking into account an external platform’s (Uber/Lyft) dispatch policy

Contracting

Holistically optimizing the deployment by incorporating capabilities, fleet size, and contracting
Coordinating AV Deployments in Hybrid Fleets

Utilization

Contracts need to include utilization guarantees!