How Regressive are Mobility-Related User Fees and Gas Taxes?

Edward L. Glaeser, Harvard University and NBER

Caitlin S. Gorback, University of Texas, McCombs School of Business

James M. Poterba, Massachusetts Institute of Technology and NBER

MIT CEEPR

Equity and Distributional Implications of Transportation

November 2022

Greener Transportation and Infrastructure Funding

Infrastructure Investment & Jobs Act (2021) & Inflation Reduction Act (2022) expand subsidies to green transportation technology:

- Electric busing, public transit infrastructure
- Green tech in personal vehicles

$$\Longrightarrow \textit{ Inadvertant impact of green technology adoption:}$$

- Decline or change in who pays user fees that fund highway system (gas & diesel taxes)

Distributional Consequences of Transportation User Fees

Environmental Pigouvian tax options: gas taxes, VMT taxes, carbon taxes

–Distributional concerns about these taxes often key impediments to adoption–

This paper: Study impact of VMT taxes as the vehicle fleet greens:

1. Document current distribution of fuel tax burdens and impact of substituing a revenue neutral VMT tax
2. Repeat analysis when EV/HV share of vehicle fleet is $\frac{1}{3}^{rd}$, with higher penetration at higher incomes
3. Analyze distributional impact of commercial VMT taxes using input-output tables to compute pass-through patterns

Literature Review

1. Distributional Impacts in User Fees and Externalities
   - Holmes (1976); Kasten and Sammartino (1988); Poterba (1991); Chernick and Reschovsky (1997); Metcalf (1999, 2022); Grainger & Kolstad (2009); Levinson (2019); Banzhaf, Ma and Timmins (2019)
2. Implications of VMT Adoption
   - Langer, Maheshri and Winston (2017); van Dender (2019); Bieder and Austin (2019); Davis and Sallee (2020)
3. Changing Vehicle Fleet Composition
   - Small and van Dender (2007); Fox (2020); Holland, Mansur, Muller, Yates (2020); Burlig, Bushnell, Rapson and Wolfram (2021); Rapson and Muehlegger (2022)
4. Infrastructure Funding
   - Brooks and Liscow (2019); Mehrotra, Turner and Uribe (2021)

How to Measure Distributional Burdens

We use a good or service's, c, share of household i's total expenditure, $\frac{Exp_{ci}}{TotalExp_i}$, as our primary measure of tax burden, as in Poterba (1991)

- Many studies use $\frac{Exp_{ci}}{Income_i}$
  - Chernick and Reschovsky (1997), Metcalf (1999, 2022), Levinson (2019)
- $Income_i$ quite noisy at top & bottom of distribution
- Expenditure better captures "permanent income" view

Regressivity: Analyze how $\frac{Exp_{ci}}{TotalExp_i}$ changes over expenditure distribution

Table

Data Sources

Main household-level analysis

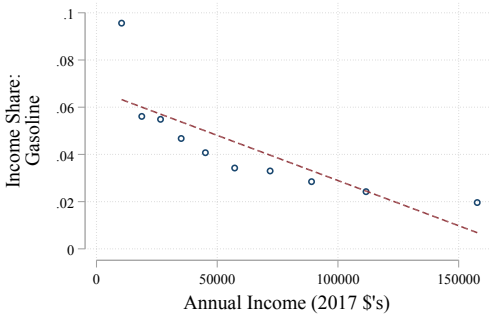
1. **CEX (2000-2019):** expenditure on gasoline, other goods and services
2. **NHTS (2001, 2009, 2017):** vehicle characteristics, driving behavior
3. **BEA Total Requirements Tables (2012):** trucking services required by final goods/services

Additional data from:

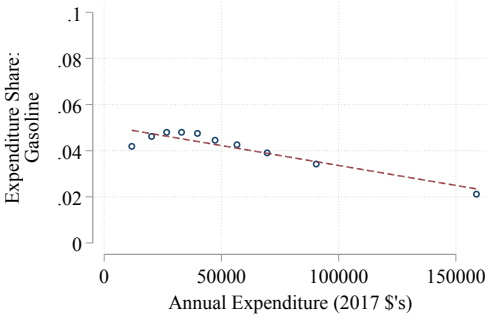
- Brookings-Urban Tax Policy Center: Gasoline taxes by year and state
- Energy Information Administration: Annual retail gasoline prices
- BTS-ORNL: national vehicle sales, registrations, by fuel type

NHTS Expenditure

Distribution of Gasoline Burden



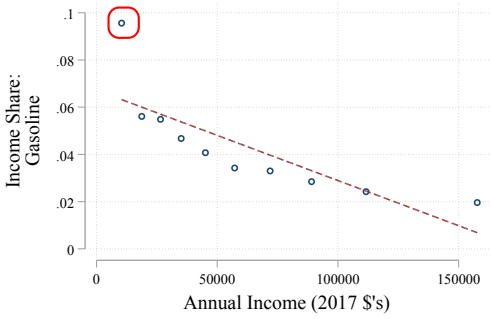
(a) $\frac{Exp_{ci}}{Income_i}$



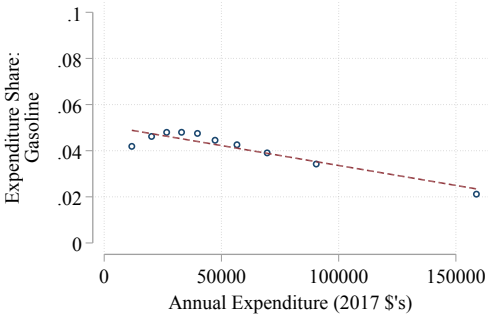
(b) $\frac{Exp_{ci}}{TotalExp_i}$

Expenditure/Income Ratios By City Size

Distribution of Gasoline Burden



(a) $\frac{Exp_{ci}}{Income_i}$

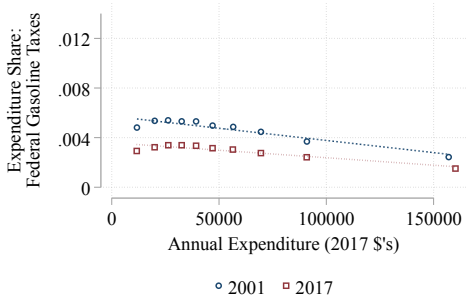


(b) $\frac{Exp_{ci}}{TotalExp_i}$

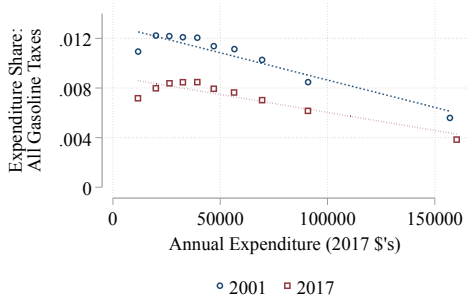
Expenditure/Income Ratios By City Size

Federal Gas Tax Burden, measured with $\frac{Exp_{ci}}{TotalExp_i}$

Level shift down between 2001 & 2017: decline in tax's real value



(a) Federal Taxes



(b) Federal + State Taxes

Income, Miles Driven and MPG

- $TaxBurden = \tau \times Miles \times \frac{gal}{mile} = \frac{\tau \times miles}{MPG}$

Income, Miles Driven and MPG

- $TaxBurden = \tau \times Miles \times \frac{gal}{mile} = \frac{\tau \times miles}{MPG}$
- Distributional burden depends on how **miles** and **MPG** vary across households

Income, Miles Driven and MPG

- $TaxBurden = \tau \times Miles \times \frac{gal}{mile} = \frac{\tau \times miles}{MPG}$
- Distributional burden depends on how **miles** and **MPG** vary across households
- Rich can switch technologies: $\downarrow$ emissions, $\uparrow$ regressivity

Income, Miles Driven and MPG

- $TaxBurden = \tau \times Miles \times \frac{gal}{mile} = \frac{\tau \times miles}{MPG}$
- Distributional burden depends on how **miles** and **MPG** vary across households
- Rich can switch technologies: $\downarrow$ emissions, $\uparrow$ regressivity

1977 NPTS

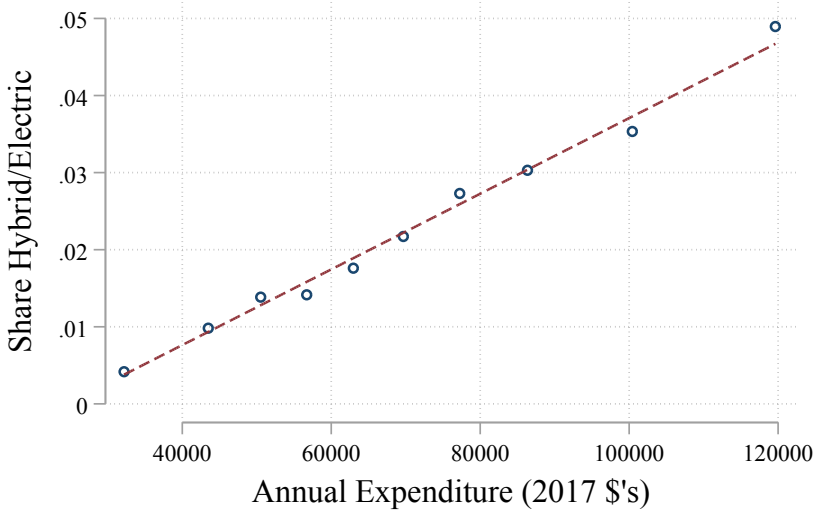
- MPG $\downarrow$, miles $\uparrow$ income
- $MPG^{high} = 17$, $MPG^{low} = 20$
- $MPV^{high} = 12k$, $MPV^{low} = 9k$

2017 NHTS

- MPG $\uparrow$, miles $\uparrow$ income
- $MPG^{high} = 23$, $MPG^{low} = 21$
- $MPV^{high} = 12k$, $MPV^{low} = 10k$

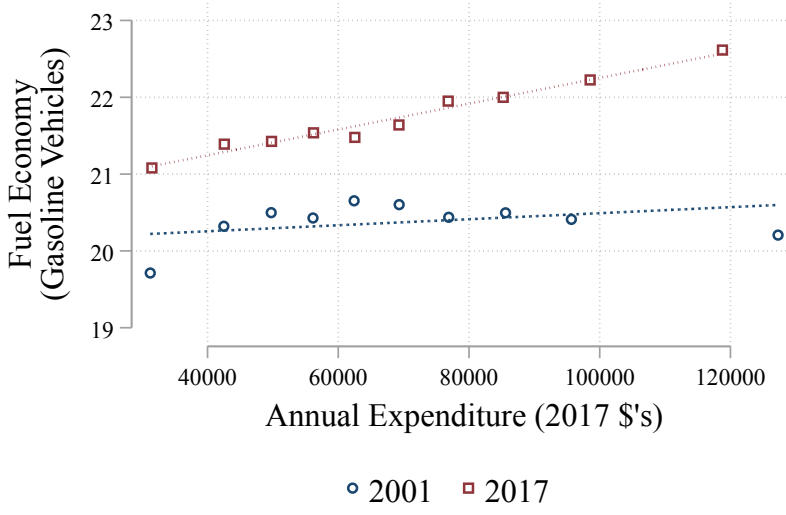
Model | Detailed NPTS, NHTS

HEV Ownership in 2017, by Expenditure



Income

Fuel Economy over Time, by Expenditure



Household Driving Responses to VMT vs. Gasoline Tax

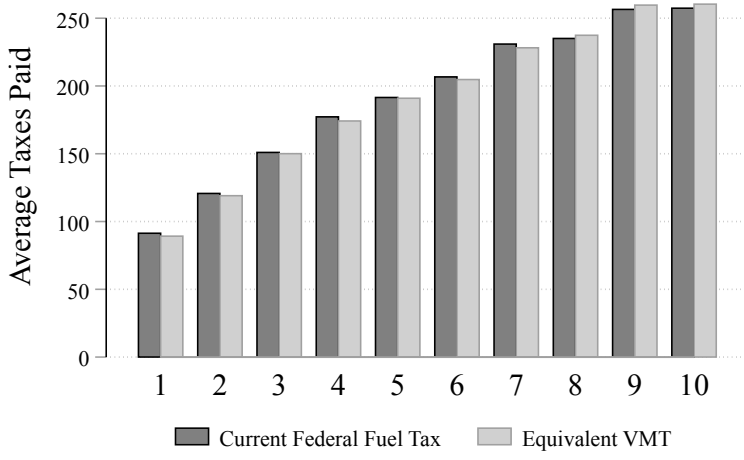
Assume households have quasilinear separable utilities w/ power function for miles traveled, T_i:

$$U_i(T_i) = Y_i - pT_i + AT_i^{\sigma} \tag{1}$$

$$T_i^* = T_i \times \left(1 + \frac{t_i - \tau_i}{p_i}\varepsilon_g\right) \tag{2}$$

- Y_i: income
- p_i: per mile price of travel (inclusive of taxes if applicable)
- $\varepsilon_g = \frac{1}{1-\sigma}$: price elasticity of gasoline demand, -0.31 (Levin, Lewis and Wolak (2017))
- τ_i: current effective gasoline tax per mile (depends on vehicle's fuel efficiency)

Comparing Equal-Revenue VMT Tax to Current Gas Tax



$\varepsilon_g = 0$

What happens with increased HEV Penetration?

Current HEV penetration doesn't change distribution of tax burden:

- 2017 HEV share: 2%
- 2017 HEV share, highest expenditure decile: 5%

What happens with increased HEV Penetration?

Current HEV penetration doesn't change distribution of tax burden:

- 2017 HEV share: 2%
- 2017 HEV share, highest expenditure decile: 5%

We compare the distributional burden of gas tax and VMT tax in a *future economy*:

- HEV adoption remains highest among high income/expenditure groups
- All other characteristics of households/vehicles remain the same
- Revenue raised per vehicle remains the same

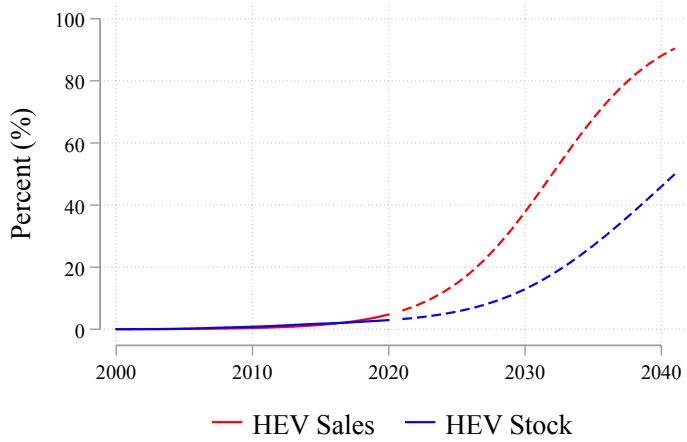
Adoption Forecasts: Stock Lags Sales

Recent sales:

- 2020: 5.4% HEV
- 2021: 8.0% HEV

Sales forecasts, 2030:

- Deloitte: 27% HEV
- Ford: 40% EV
- KPMG: 52% EV



How we forecast

Projecting Distribution of HEV Ownership when HEVs $\sim \frac{1}{3}^{rd}$ of Fleet

We observe 229,324 surveyed vehicles in the 2017 NHTS.

To create our forecast, we draw on projections for total vehicle fleet growth:

- vehicle type $\in \{HEV, Gas\}$
- expenditure decile, d

Projecting Distribution of HEV Ownership when HEVs $\sim \frac{1}{3}^{rd}$ of Fleet

We observe 229,324 surveyed vehicles in the 2017 NHTS.

To create our forecast, we draw on projections for total vehicle fleet growth:

- vehicle type $\in \{HEV, Gas\}$
- expenditure decile, d

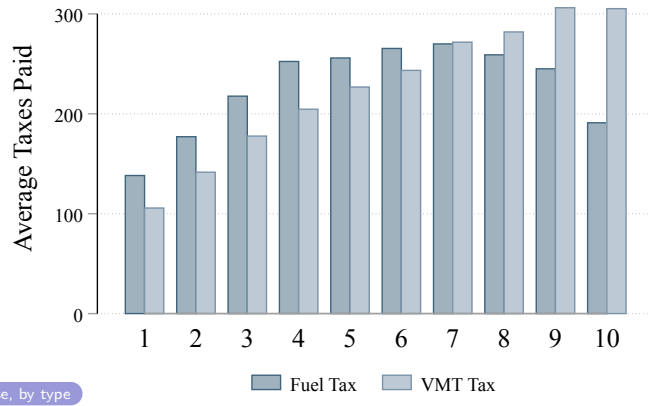
Overview of algorithm:

1. Each current vehicle is cloned into 1.15 vehicles
2. Allocate HEV's across deciles based on fraction of HEV's in each decile today
3. Yields how many gas vehicles to add/take away, how many HEV's to add to each decile
4. Randomly replace gas vehicles with HEV's until we achieve the target mix

Future Ownership vs. 2017

Comparing the VMT Tax vs. Gasoline Tax with Future Fleet

- Fuel taxes paid ↓ for 30% highest expenditure hholds
- VMT tax ↑ taxes for high deciles, while ↓ for low deciles



Without behavioral response, by type

A Commercial VMT Tax on Trucking

Current Federal Diesel Tax: \$0.24/gallon, assuming mean MPG of 6.4 $\implies$ diesel tax of \$0.038/mile

There are no personal VMT taxes in the U.S., but there are commercial:

- 4 states have adopted commercial VMTs (cVMTs)
- NM, NY and OR range by truck weight and axle count (\$0.01-0.29/mile)
- KY set a flat cVMT at \$0.03/mile

What is the distribution of adding a federal cVMT tax at \$0.03/mile?

- Commercial vehicle fleet not greening as quickly as personal fleet
- $\therefore$ *we add cVMT top of the current diesel tax*

Federal Diesel Tax's Share of Household Expenditure

We use data from BEA's Total Requirements Table (TRT) and CEX:

1. \$'s commercial trucking $\rightarrow$ \$1 of commodity c: γ_c, $TruckExp_i = \sum_c \gamma_c \times Exp_{ic}$
2. We estimate consumers indirectly pay about $\frac{1}{3}^{rd}$ of diesel revenues $\approx$ \$3.5 billion

Federal Diesel Tax's Share of Household Expenditure

We use data from BEA's Total Requirements Table (TRT) and CEX:

1. \$'s commercial trucking $\rightarrow$ \$1 of commodity c: γ_c, $TruckExp_i = \sum_c \gamma_c \times Exp_{ic}$
2. We estimate consumers indirectly pay about $\frac{1}{3}^{rd}$ of diesel revenues $\approx$ \$3.5 billion

Calculate household i's expenditure on diesel taxes, e_i^{diesel}, as:

$$e_i^{diesel} = \frac{TruckExp_i}{\sum_i TruckExp_i} \times \frac{3.5}{w_i}$$

Federal Diesel Tax's Share of Household Expenditure

We use data from BEA's Total Requirements Table (TRT) and CEX:

1. \$'s commercial trucking $\rightarrow$ \$1 of commodity c: γ_c, $TruckExp_i = \sum_c \gamma_c \times Exp_{ic}$
2. We estimate consumers indirectly pay about $\frac{1}{3}^{rd}$ of diesel revenues $\approx$ \$3.5 billion

Calculate household i's expenditure on diesel taxes, e_i^{diesel}, as:

$$e_i^{diesel} = \frac{TruckExp_i}{\sum_i TruckExp_i} \times \frac{3.5}{w_i}$$

– Indirect diesel expenditures account for $0.02 - 0.03\%$ of household expenditures

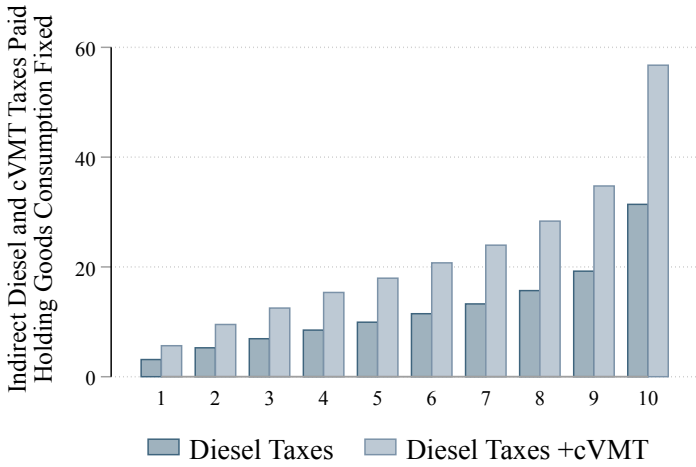
$\Longrightarrow$ **Annual diesel tax costs: \$3 (1^{st} dec.) to \$31 (10^{th} dec.)**

Implications of Adopting a $0.03/mile CVMT Tax

Calculate the chance in expenditures needed to purchase a hhold's original consumption bundle:

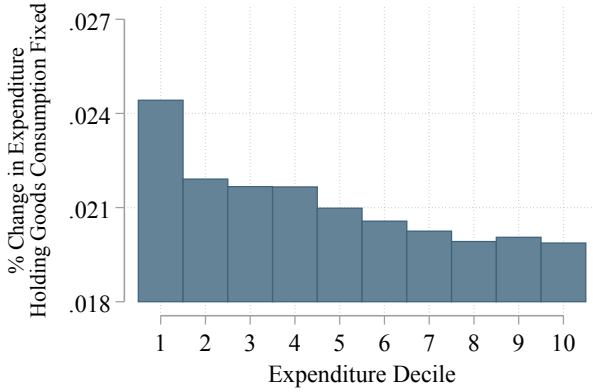
- Expenditure decomposed into a goods outlay and a tax outlay, for each item: $e_{ic}^t = good_{ic}^t + tax_{ic}^t = (1 - \alpha^t)e_{ic}^t + \alpha^t e_{ic}^t$
- Each household spends a portion of its bundle on taxes: α^t
- New tax burden calculated from changing α^0 to α^1
- We calculate $\alpha^0 = 4\%$ of trucking costs, and $\alpha^1 = 7\%$; trucking costs vary by good

Diesel Tax Burdens with and without cVMT Tax



Higher expenditure households buy more tradables...

Expenditure Change, Holding Consumption Fixed



... but they also spend much larger shares on non-tradable outlays.

Conclusion

While real gas taxes have fallen, they will become more regressive if EV adoption continues to be highest among the rich:

- Adopting a VMT tax on EVs would broaden the tax base
- Income-based EV subsidies would mitigate regressivity concerns
- cVMT taxes have potential to raise revenues for highway maintenance, but incidence depends on the passthrough to consumers

We have a system of taxes we can combine to lower regressivity:

- Gas tax + other transfers
- VMT+ Carbon tax (carbon tax not very regressive, (Granger & Kolstad, 2009))

Thanks!

caitlin.gorback@mccombs.utexas.edu