Evidence of the Relationship Between Household Income and Transport Emissions

Key Takeaways

- Household emissions resulting from vehicle use increase with income at lower levels but reverse for the highest income households.
- Vehicle miles traveled increase by a factor of three between the lowest and highest income households.
- Total household emissions is related to total vehicle ownership and driving intensity, which saturates at higher income levels where intensity begins to decline with the relatively greater prevalence of electric vehicles and better fuel economy.

Passenger vehicles are a key economic sector and represent a growing share of energy consumption and emissions in many countries. Understanding how emissions from passenger vehicles are linked to household income is important for assessing distributional impacts of decarbonization policies, evaluating potential trajectories for energy consumption and emissions, and ensuring an equitable energy transition. The goal of this analysis is to investigate the income-pollution relationship for passenger vehicles using detailed U.S. survey data. Specifically, the analysis tests for evidence of an Environmental Kuznets Curve (EKC) for household passenger vehicle CO_2 emissions, which refers to a non-monotonic U-shaped relationship between income and emissions. Although the literature on economy-wide EKCs is vast, sector-specific analysis of household transport emissions is less common, is subject to considerable controversy, and is over a decade old in many instances, which does not account for recent trends in vehicle electrification and fuel economy. This analysis is the first to provide evidence for the U.S. transport, the highest-emitting sector in the world's second-highest emitting country. Over time, technological progress and regulatory standards can lower emissions of subsequent vehicle vintages, and higher-income households tend to have newer vehicles. At the same time, wealthier households are more likely to have a greater number of vehicles and drive them more, as this analysis demonstrates. More recently, electric vehicles are increasing as a fraction of new sales and may be correlated with income, which can lower emissions depending on the emissions intensity of the grid mix.

Methods

This analysis uses microdata from the U.S. National Household Travel Survey (NHTS) conducted by the Federal Highway Administration, which provides nationally representative information about travel behavior. Data come from a stratified random sample of U.S. households conducted in 2017. The NHTS has a large sample size across different U.S. regions with a more extensive set of demographic variables such as household income, mileage, and number of vehicles. To test whether a non-monotonic relationship exists between household income and CO_2 for passenger transport, this paper uses an ordinary least squares regression model. This analysis separately estimates the impacts of pollution intensity (i.e., emissions and fuel consumption per distance traveled) and polluting activity (i.e., vehicle miles traveled) on emissions with respect to income.

Figure 1: Household (HH) vehicle characteristics by income. Values are based on 2017 U.S. National Household Transportation Survey data. Averages are calculated using sample weights.

HH Income (USD/yr)	HH Car Count	HH Driving Intensity (mi/yr)	Emission Intensity ($g\text{-}CO_2/mi$)	HH Emissions ($kg\text{-}CO_2/yr$)	Electric Share (%)	HH Count
Less than $10,000	0.8	7,778	398	3,097	0.6%	6,317
$10,000 to $14,999	1	9,256	412	3,818	0.6%	6,508
$15,000 to $24,999	1.3	12,443	406	5,049	0.9%	11,444
$25,000 to $34,999	1.6	14,964	399	5,970	0.8%	12,182
$35,000 to $49,999	1.8	18,156	401	7,285	1.4%	15,600
$50,000 to $74,999	2.1	20,710	401	8,312	1.7%	22,390
$75,000 to $99,999	2.2	23,520	393	9,243	2.3%	16,689
$100,000 to $124,999	2.5	26,040	394	10,255	2.7%	12,714
$125,000 to $149,999	2.5	27,955	387	10,824	3.4%	7,066
$150,000 to $199,999	2.5	27,413	386	10,570	3.1%	6,953
$200,000 or more	2.6	27,345	382	10,439	5.0%	7,457

Household Pollution Intensity Follows an Inverse-U Shape with Income

The analysis provides support for both polluting activity and pollution intensity following an inverse-U shape in income, which leads total emissions to a similar non-monotonic EKC relationship, albeit with different income turning points. Emissions increase with income at lower levels but reverse for the highest-income households with incomes of $200,000 or more. Although this effect is statistically significant, the effect size is relatively small, as household emissions decline by 1.2% between the second-highest income households and the highest. Vehicle miles traveled (VMT) increases by more than a factor of three between the lowest- and highest-income households from about 7,800 mi/yr to 27,300 mi/yr, respectively, though this relationship is non-monotonic, as VMT declines for incomes greater than $125,000 to $149,999. The emissions intensity for the lowest-income households exceeds that for highest-income households (398 versus 382 g-CO_2/mi, respectively), indicating that wealthy households drive more fuel-efficient vehicles on average. However, fuel economy improvements are more than offset by the countervailing increase in driving intensity between income extremes. An important caveat is that 2017 data are at the beginning of a significant electrification trend, as electric vehicle costs decline and deployment increases. Given how emissions are generally lower for electric vehicles relative to conventional fossil-fueled ones, this trend could lead to a more prominent EKC relationship, especially if higher-income households are more likely to purchase electric vehicles. Data from this study indicate this is the case for purchases through 2017, as shares of electric vehicles increase from 0.6% of lowest-income households to 5.0% for the highest-income ones. This analysis has several policy implications. First, interventions that compress income distributions and increase income for the poorest households are not likely, by themselves, to reduce household transport emissions, given how this analysis finds that emissions increase in income across a large income range. Second, the small magnitudes of EKC effects indicate that emissions policies are likely more effective in reducing emissions rather than waiting for EKC effects from growing income, as wealthier households are not fully internalizing the social costs of emissions. Third, the evidence that electrification may be contributing to the decline in emissions for the highest-income households highlights the critical role of electric vehicles in lowering transport emissions. Finally, since poorer households spend a greater share of their income on energy, this analysis also has implications for the incidence of decarbonization policies, as the EKC relationship may slightly increase regressivity. The analysis also illustrates the substantial variation in household transport demand and emissions within income classes, which raises important horizontal equity issues for policymakers.

Source Research Paper

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