HETEROGENEOUS RESPONSES AND DIFFERENTIATED TAXES

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Overview

The trucking industry hauls about 70% of all freight in the United States. Although medium- and heavy-duty trucks only account for about 5% of all the on-road vehicles, they contribute about 20% of the greenhouse gas emissions and oil use in 2015. Existing policies intending to reduce fuel consumption and greenhouse gas emissions have been mostly technology-based and targeted to manufacturers, such as engine emission standards and fuel economy standards. Emissions pricing policies, however, have been rarely considered as policy instruments to reduce greenhouse gas emissions. Such policies, such as emission taxes, provide a combination of incentives with flexibility - a merit lacked in other alternatives. The flexibility allows manufacturers and drivers to choose the most cost-effective ways to reduce fuel consumption while taking into consideration of the negative externalities caused by the operation, which include local and global air pollution, noise pollution, traffic congestion, road deterioration and vehicle accidents. Ideally, we would design a tax for each category of externalities, but such policy would be impractical. Instead, fuel taxes can be used to address the sum of all externalities on a per-gallon basis. The challenge lies in the possible inequality due to the difference in truckers' responses to changes in fuel cost. Imposing a uniform tax is potentially detrimental for truckers who reduce driving more than the average level. Such heterogeneity calls for the optimally differentiated fuel taxes.

In this study, I exploit a rich vehicle-level micro dataset of the U.S. heavy-duty trucking fleets to examine how truckers' decisions respond to the changes in per-mile fuel cost, and more importantly, the heterogeneity in responsiveness among trucks of different weight classes and business sectors. I incorporate the estimates to the optimal tax analytical framework and derive the differentiated fuel taxes that maximize the social welfare.

Methods

I focus on two trucking decisions, in particular, vehicle-miles traveled (VMT) and payload distance (PD. VMT measures the total distance a vehicle travels within a year. The value of PD is derived from multiplying VMT by the average cargo weight. To quantify the responsiveness of VMT and PD to fuel cost, I estimate the elasticities of both decisions with respect to per-mile fuel cost, using truck-level micro data. To control for the potential endogeneity of the explanatory variable, I use instrumental variable (IV) as my main identification strategy. The local fuel price is instrumented by the average fuel price in its non-neighboring states. Crude oil price is chosen as an alternative IV and discussed in the robustness check section. Two-way fixed effects are included in the estimation to account for the time-invariant and nationwide influences. The heterogeneity in elasticities is estimated for different vehicle weight classes and business sectors by interacting each category with the fuel cost variable.

The analytical framework for assessing the optimal diesel taxes builds on a general equilibrium model, taking into account of the externalities created by trucking operation and their interactions with other sectors. Such externalities include air pollution, road congestion, pavement damage, vehicle accidents, energy insecurity, and noise pollution. The second-best optimal fuel taxes are derived when the overall welfare is maximized.

Results

The primary empirical results show that the medium-run elasticities of vehicle-miles traveled are -0.23 for combination trucks and -0.28 for vocational vehicles; the elasticities of payload distance are -0.42 for combination trucks and -0.36 for vocational vehicles. It is also evident that there is significant heterogeneity in elasticities among different vehicle weight classes and business sectors. The optimally differentiated fuel taxes ranges from 81 cents to 4.55 dollars per gallon. Comparing to the case in which uniform taxes are imposed, the overall welfare effects of imposing the optimally differentiated fuel taxes by weight class is 8.53 billion per annum and 0.08 billion per annum by business sectors.

Conclusions

Using truck level micro data, I estimate how trucking decisions, vehicle-miles traveled and payload distance, are affected by the fuel cost of per-mile driving. I also show significant heterogeneity in responsiveness among trucks of different weight classes and business sectors. Applying the estimates to an analytical framework, I derive the optimally differentiated fuel taxes in the second-best setting. The welfare analysis shows that differentiating taxes based on vehicle weight classes brings in a larger welfare gain due to 1) higher discrepancies of externalities associated with vehicle weight classes and 2) relatively similar distribution of vehicle weight across business sectors. Admittedly, there are administration costs associated with such tax structure. It can be an effective policy tool nonetheless, as the differentiated fuel taxes show great potential to reduce fuel consumption in an incentive-compatible way while achieving high welfare gain.