Vehicle and Road Taxing Schemes in the United States and its effects on greenhouse gas emission

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Overview

In recent years, U.S. road funding policies have received increasing attention due to two developments. First, vehicles are becoming increasingly fuel efficient which reduces the amount of gasoline and diesel consumed. Because many U.S. states employ a cents-per-gallon tax on gasoline and diesel, fuel tax revenue available for road infrastructure investment and maintenance is decreasing. According to the U.S. Energy Information Administration's (EIA) 2017 Annual Energy Outlook (EIA, 2016), this trend of reduced gasoline consumption will continue for light-duty gasoline vehicles with an average decline of 1.1% per year between 2016 and 2050. Since the fuel tax revenue derived from light-duty vehicles represent a large share of overall fuel tax revenue, U.S. states and the federal level will continue to see a decline in revenue (Dumortier et al., 2017). Second, the majority of states as well as the federal government do not adjust the fuel tax rate to inflation and hence, the purchasing power of the fuel tax is eroding over time amplifying the decrease in revenue caused by higher fuel efficiency.

To counter the fuel tax revenue decline, various policy have been proposed such as indexing fuel tax to inflation, imposing a sales tax on fuel sales in addition to the cents-per-gallon tax, implementing a vehicle miles travelled (VMT) fee, or taxing electric vehicles by applying an extra registration fee. The state-level and federal effects of those proposals have been analyzed under various macroeconomic conditions by Dumortier et al. (2017). They find that fuel tax revenue in real terms will decline by up to 50.5% for states that do not index fuel taxes to inflation and that the decline will be smaller, i.e., between 3.4% and 16%, for states that currently adjust for inflation. In addition, Dumortier et al. (2016) find that imposing a registration fee on electric vehicles has almost no impact on revenue.

The purpose of this paper is to assess the interaction between greenhouse gas (GHG) emissions and different taxation schemes in the United States at the state and federal level under multiple macroeconomic conditions. Incorporating GHG emissions into the model serves numerous purposes. First, increasing concerns about GHG emissions have led to policy proposals such as the 2007 Energy Independence and Security Act that spurred the development of the biofuel industry in the United States. Evaluating GHG emissions under different macroeconomic conditions and fuel tax schemes can inform policy makers under which circumstances GHG emissions differ among policy instruments. Second, the implementation of a carbon tax on vehicles in the United States is unlikely to happen in the future but an increase of the current rates or a switch to a different taxing scheme, e.g., VMT fee, is more likely because infrastructure investments are a priority in many states. Our paper answers the question which taxing schemes is resulting in a higher GHG emissions reduction depending on the macroeconomic conditions. Our analysis allows to calculate the implicit carbon pricing associated with different tax schemes and we examine under which circumstances the issues of declining road funding revenue and GHG emissions can be addressed with road taxation.

Methods

In this paper, we extend a stylized simulation model that was used previously by Dumortier et al. (2016) and Dumortier et al. (2017) to include GHG emissions and implicit carbon pricing. Through our analysis, we seek to project the tax revenue and GHG emissions associated with vehicle travel under various tax policies and macroeconomic conditions. The results can inform policy makers about the revenue that is potentially available for road and infrastructure funding as well as differences in GHG emissions with various taxing schemes.

Our model is based on projections from the EIA's 2017 Annual Energy Outlook that covers the period from 2015 to 2040. The EIA presents a reference case that projects transportation energy use under baseline oil prices and economic growth as well as side cases differentiating low and high oil prices/economic growth. Our model imposes different taxing scenarios on the EIA cases and compare those scenarios to the baseline. Using the EIA cases has the advantage that significant modeling has already been incorporated into the National Energy Modeling System (NEMS), thereby increasing the stability of the projections.

In our model, we look at two distinct ways of taxing driving in the United States. A tax is either implemented on the amount of gasoline and diesel purchased or on the number of miles driven, i.e., a mileage fee. The tax on the amount of fuel purchased can be a per-unit tax that is either fixed, indexed to inflation, or supplemented by a sales tax. In all cases, tax revenue is a function of vehicle miles traveled, the vehicle fuel economy, and the number of vehicles. We will look at three different tax policies for states and the federal government: (1) Indexing gasoline and diesel taxes to inflation, (2) applying state sales taxes to fuel prices in addition to an inflation-adjusted excise tax, and (3) implementing a VMT fee. We compare those tax policies with the current taxing schemes and assess under which circumstances a particular tax outperforms in terms of reduction in GHG emissions and revenue generation. All our calculations are based on a cost-per-mile approach to determine how many vehicle miles the average car travels based on cost. We assume that vehicle fuel economy is exogenous to the model but that the vehicle composition changes based on the cost-per-mile driven, which depends on fuel cost and the tax rate. The specification of the cost per mile driven is flexible enough to incorporate a cents-per-gallon tax, a sales tax, a VMT fee, or a carbon tax. We will determine what tax rate/scheme will be equivalent to a carbon tax. Our model is based on vehicle data from the EIA Annual Energy Outlook and GHG data from the VISION Model.[1]

We cover 19 different vehicle types in our simulation model. For gasoline and diesel vehicles, we have cars, light trucks, and light tractors, medium tractors, and heavy tractors. Gasoline vehicles also includes hybrids, plug-in hybrid vehicles (i.e., PHEV10 and PHEV40)[2] and diesel vehicles include diesel hybrids. Flex fuel E85 vehicle types are limited to cars and light trucks. We also include battery electric vehicles that currently do not contribute to road maintenance but will be charged under the VMT fee scenarios. The model includes supply functions for gasoline, diesel, and E85. The solution to the simulation model consists of a temporal series of wholesale prices, i.e., net of any tax, for gasoline, diesel, and E85 at the national level. We use a price transmission function based on historic data to translate the national wholesale prices for the three fuel types into state wholesale prices.

Results

Our preliminary results show that for all EIA cases and all states, the states' tax revenue under the current policies will decrease significantly. In the reference case, the median decrease is 46% with a maximum median decrease of 68% in the low economic growth case and a minimum median decrease of 36% in the low oil price case. This results in GHG emission reduction from road transportation by the same magnitude. There are variations among the states depending on whether fuel taxes are adjusted to inflation or not. In the second policy scenario where we adjust fuel taxes to inflation in all states, we find it represents a considerable improvement for most states compared to the baseline scenarios. The median decrease in the reference case is 7% and as in the baseline scenarios, the median change in revenue is minimal in the low oil price case (2% increase).

In the scenario where we impose a VMT fee in the amount of the current states' excise tax, the increase in revenue is linked to the number of vehicles on the road and the amount of miles driven. Our results show that imposing a VMT fee is not as effective at reducing GHG emissions since passenger vehicles are now grouped together and there is no differentiation between gasoline, diesel, and E85. This could potentially be solved by imposing a VMT fee that is vehicle specific in terms of size, fuel, etc. but would increase the administrative burden significantly. The VMT fee has the advantage that it is the only scenario that is sustainable form a revenue perspective in the long-run since it is not linked to fuel economy.

Linking the fuel tax to inflation does not disconnect the motor fuel tax revenue from the increase in fuel efficiency. The tax revenue from imposing the states' sales taxes on top of the inflation-adjusted excise taxes will lead to a significant increase in tax revenue in 2040 compared to 2015. In the reference scenario, the median tax revenue is 59% and 51% higher under a federal inflation-adjusted tax and VMT-fee, respectively. At the end of the projection period, the additional median revenue from the VMT fee exceeds the revenue derived from a inflation adjusted excise tax coupled with a sales tax for all EIA cases except in the scenario of high oil prices. This result is straightforward since the sales tax on motor fuel is highest under high gasoline and diesel prices. In the case of low fuel prices resulting from a low oil price, revenue is modest. Hence, coupling a CPI-adjusted tax with a sales tax has some short- to medium-run benefits if the oil price is high but in the long-run it faces the exact same issue as the current taxing scheme in the sense that it is declining with increasing fuel efficiency.

Conclusions

Our paper shows that some GHG emissions reduction can be achieved through adding an implicit carbon tax to the current fuel taxes. Since emissions are caused by the consumption of fuel, increasing the fuel tax is more effective at reducing emissions than a VMT fee that taxes miles driven and is an imperfect measure of fuel consumption and GHG emissions.

References

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[1] The VISION Model is built and maintained by the Argonne National Lab (www.anl.gov/energy-systems/project/vision-model).

[2] The numbers 10/40 for the PHEV10/PHEV40 refer to the all-electric range in miles before switching to gasoline.