ABSTRACT

Impacts of State-Level Limits on Greenhouse Gases per Mile In the Presence of National CAFE Standards

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As of the present time, 14 U.S. states have formally adopted limits on greenhouse gases (GHGs) per mile of light-duty automobiles. These "Pavley" limits (named after California Assemblywoman Fran Pavley, whose bill establishing such limits was passed in California) require manufacturers to reduce per-mile GHG emissions starting in 2009 and by 30 percent by 2016. The limits are projected to contribute importantly to these states' overall GHG emissions-reduction goals.[1] For example, the California Air Resources Board estimated that the limits will account for over 18 percent of the reductions needed to meet the state's GHG emissions target for 2020.

The few existing analyses of the impacts of these limits do not recognize a crucial set of interactions between the state initiatives and existing Federal corporate average fuel economy (CAFE) standards. These interactions have the potential to completely undo the intended impact of the state policies. Since CO_2 emissions and gasoline use are nearly proportional, the Pavley limits effectively raise the fuel economy requirement for manufacturers in the states adopting such limits. Consider an auto manufacturer that, prior to the imposition of the Pavley limits, was just meeting the U.S. CAFE standard. Now it must meet the (tougher) Pavley requirement through its sales of cars registered in the adopting states. In meeting the tougher Pavley requirements, its overall U.S. average fuel economy now exceeds the national requirement: *the national constraint no longer binds*. This means that the manufacturer is now able to change the composition of its sales outside of the Pavley states, where it can now sell more larger or low fuel-economy cars. Indeed, if all manufacturers were initially constrained by the national CAFE standard, and there were no offsetting beneficial technological spillovers, the introduction of the Pavley requirements would lead to "emissions leakage" of 100 percent at the margin[2]: the reductions within the Pavley states would be completely offset by emissions increases outside of those states![3]

This paper develops a numerical simulation model to assess the impact of the new Pavley standards on gasoline consumption and GHG emissions. It also compares the impact of this particular energy-environmental initiative with alternative approaches to reduce GHGs per mile

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[1] For the Pavley limits to go into effect, California must obtain a waiver from the U.S. EPA enabling the state to exceed the Federal Clean Air Act standards. The Obama Administration has pledged to grant the waiver. Once granted, the Pavley limits will go into effect not only in California but also in the 13 other states that support the initiative.

[2] "At the margin" is inserted because large for increments to manufacturers' fuel-economy requirements, price-impacts can dampen the leakage effect. The numerical model addresses the price effects.

[3] The newly-introduced trading component of the U.S. CAFE regulations works toward further leakage. It does so by increasing the number of manufacturers that will be constrained by the Federal requirements. This is the case because manufacturers previously not constrained by CAFE may now find it profitable to sell credits up to the point where CAFE binds.

in the U.S. This research aims to shed light on how problems of overlapping regulatory constraints at the state- and Federal levels can be productively addressed.

The model accounts for various factors that determine the extent of leakage. Besides the extent to which various manufacturers are already constrained by the CAFE standard, a second key factor is the extent to which the tighter requirements in the adopting states lead to technological spillovers applying to cars sold in the non-adopting states, in which there is no direct incentive to improve fuel-economy from the Pavley rules. If manufactures are limited in their ability to differentiate fuel economy of given models across the two regions, there will be a beneficial technological spillover. If manufacturers can offer different engine technologies for the same car model, depending on whether the model is being sold inside or outside a Pavley state, "technological spillovers" are subdued.

Model Structure

Automobile Types. The model distinguishes cars by manufacturer, age, vehicle class, and region, which yields 1064 combinations (vehicle types):

- manufacturing groups: Ford, Chrysler, GM, Honda, Toyota, Other Asian, and European
- age categories: new, 1 year old, 2 years old, …, 18 years old
- vehicle classes: small passenger car, large passenger car, small light truck, large light truck
- regions of registration: adopting (Pavley) states, non-adopting (non-Pavley) states

Producer Behavior. The specification on the production side accounts for the imperfectly competitive nature of the new car market. Oligopolistic producers engage in Bertrand competition, setting prices of each manufactured automobile to maximize profits subject to the CAFE and Pavley constraints and accounting for the influence of their prices on consumer demand. Producers also determine the level of fuel-economy of individual models, taking into account the cost of fuel-economy improvements and the impact of improved fuel-economy on consumer demand. The model also contains a used car market. The supply of used cars in a given period consists of the used cars and new cars from the previous period net of scrappage at the end of the previous period.

Consumer Behavior. The model aims to mimic the *aggregate* behavior of consumers in the Pavley and non-Pavley regions, rather than the behavior of individual consumers. Since the model aims to focus on changes in fleet composition, aggregate emissions, and aggregate costs (rather than the distribution of outcomes across consumer groups), this seems a reasonable approach. This "macro" approach enables us to employ a continuous choice model for consumer behavior, which (compared with discrete choice models) is much more flexible.[4] We employ two aggregate demand functions for consumers both within and outside the Pavley states. Each demand function expresses the demands for the various types of vehicle, as well as (all) other goods, as a function of purchase prices and expected operating costs, where operating costs (as well as purchase prices) depend on fuel economy. Aggregate income (to be spent on vehicle ownership and other goods) is exogenous.

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[4] A discrete choice formulation seems the appropriate choice for modeling micro-level decisions, but is not necessarily the best choice for modeling aggregate outcomes. The discrete choice formulation involves several restrictions. In particular the mixed logit discrete choice formulation that was used in earlier, micro-level work by Bento *et al*. (2005, 2008) and Jacobsen (2007) imposes significant structural restrictions on cross-price elasticities.

Dynamics. The model solves at yearly intervals over the simulation period 2009-2020. The dynamics are simple. Net of scrappage, the stock of cars of age *a* in period *t* becomes the stock of cars of age *a+1* in period *t*+1. Similarly, the stock of new cars in period *t* becomes the stock of one year old cars in period *t*+1.

Results

The simulations reveal the impact of the state-level GHG limits on the regional and national GHG emissions over the simulation period 2009-2020. The model outputs include the changes in fleet composition, in the fuel-economy of individual models, and in total fleet size that underlie the changes in emissions. Model outputs also include the economic costs of the state-level initiatives and the distribution of these costs between producers and consumers. Simulations to date indicate that:

- Leakage of 100 percent or more is plausible.
- Leakage results not only from increased emissions from new cars in the non-Pavley regions but also from changes in the used car market. Initially, significant leakage stems from households switching to relatively fuel-inefficient used cars and retaining (rather than scrapping) these cars longer than they would in the absence of regulation. However, the contribution of the used car market to leakage declines through time as once-new cars become used.
- The cost per gallon saved under the Pavley standard is much higher than for an equivalent increase in the Federal CAFE standard.

Conclusions

This research examines a particular example of a general issue of policy significance – namely, problems from overlapping environmental constraints.[5] The paper aims to reveal the economic and environmental outcomes under such conditions, and thereby provide information that can promote a better integration of state- and Federal-level environmental policy.

References

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[5] Similar issues arise with the overlap of the California Low Carbon Fuel Standard and proposed Federal Renewable Fuels Standard, and with the overlap of state-level cap-and-trade policies and a potential Federal cap-and-trade system.