Setting the second-best passenger vehicle GHG emissions standards

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Passenger vehicles are associated with multiple market failures. Consumers appear to undervalue fuel cost savings, meaning that they are willing to pay less for fuel economy than is privately optimal, which causes vehicle producers to underinvest in fuel economy. In addition, greenhouse gas (GHG) emissions and local air pollution, network externalities for public charging, learning spillovers for electric vehicles (EVs), and congestion and accident externalities from driving cause vehicle production, purchase, and driving to differ from socially optimal levels. A sizeable literature has characterized the magnitudes of these market failures, such as research on fuel economy undervaluation, the social cost of carbon, charging station network externalities, and congestion costs.

Although it would be economically efficient to scale policies to the magnitudes of the market failures, the policymaking process has yielded a different result. Many countries tax transportation fuels but rarely are these taxes linked to the extent of environmental or other market failures. Instead, new-vehicle performance standards play a central role in practice. Most vehicles sold globally are subject to fuel economy or GHG performance standards for new vehicles. Setting the stringency of these standards involves several trade-offs for the environment, households, and vehicle producers. Tightening standards reduces environmental costs of passenger vehicles but reduces manufacturer profits and may exacerbate congestion and accident externalities because tighter standards reduce per-mile travel costs and may induce greater travel (that is, the rebound effect). Relaxing standards gives manufacturers more flexibility in choosing vehicle prices and characteristics. Consumers may face lower purchase prices but higher lifetime fuel costs. These tradeoffs contribute to the political struggles over setting passenger vehicle standards, perhaps most prominently in the United States, where the stringency of federal standards has varied sharply across presidential administrations. The turmoil in the United States may be an outlier, but it is not unique. For example, European regulators have navigated tense struggles among vehicle manufacturers, environmental organizations, and other stakeholders.

With performance standards being the focus and other policies playing a secondary role, how stringent should the standards be? Although the literature has quantified the magnitudes of the relevant market failures and quantified welfare effects of particular standards in individual countries, the literature provides little guidance for the optimal stringency of the standards given the existence of multiple market failures partially or completely unaddressed by other policies.

This paper characterizes, both theoretically and empirically, the economically efficient level of standards given suboptimal policies affecting other market failures. Specifically, we consider performance standards for new vehicles, allowing for consumer undervaluation, pollution externalities, network externalities for charging, and congestion and accident externalities.

The first section characterizes optimal standards in a representative-agent model that assumes vehicles are priced at marginal cost, thereby abstracting from market power. The framework builds on Bento et al. (2020) by including undervaluation and network externalities. We show how the extent of undervaluation, pollution externalities, network externalities for EV charging, and congestion and accident externalities determine the optimal stringency of standards. We then consider how incomplete regulation affects optimal stringency.

The remainder of the paper uses a partial equilibrium model that relaxes the representative-agent and perfect-competition assumptions. We first estimate a structural model of consumer demand and manufacturer supply in the US auto industry, using vehicle registration and transaction data from 2010 through 2025. Consumer demand is modeled as a logit discrete choice over differentiated vehicles. The model builds on Leard et al. (Forthcoming) and, besides adding data for 2019-2025, we extend the model by characterizing consumer choices across new and used vehicles and endogenizing vehicle scrappage. Houseoholds scrap older vehicles by comparing their subjective valuation of those vehicles with expected market prices. The two extensions allow standards to affect used vehicle prices and scrappage rather than only new vehicle prices and sales. Accounting for these effects matters for distributional analysis because lower-income households are more likely to purchase used vehicles than new vehicles. It also matters for emissions because changes in used vehicle prices affect scrappage and the extent to which older, higher-emitting vehicles remain in use.

On the vehicle supply side, manufacturers simultaneously choose prices and vehicle characteristics under Nash–Bertrand competition. Manufacturers can introduce new electric vehicles and extend the range of existing electric vehicles. Households offer older vehicles to the used-vehicle

market based on expected market prices. New and used vehicle prices simultaneously balance supply and demand in the new and used vehicle markets.

We use a scenario with no GHG standards as the baseline and compare it with standards of varying stringency. We vary the stringency of standards over the next five years and hold stringency fixed in subsequent years. Across scenarios, we compare aggregate welfare, measured as the sum of consumer surplus and producer surplus, net of external costs associated with GHG emissions and local air pollution, congestion, and accidents. We quantify consumer welfare based on their realized fuel cost savings (that is, experience value) rather than their perceived value. We assess how the optimal stringency varies with parameters that determine the extent of the market failures and the existence of other vehicle policies such as fuel taxes.

We also examine distributional effects. Standards may raise vehicle purchase prices while reducing lifetime fuel costs, and households differ in whether they purchase new or used vehicles and how much they drive. We quantify the net consumer effects of standards and examine how they vary across groups.

A large literature evaluates the welfare effects of fuel economy and GHG standards using differentiated-product models of the vehicle market. These studies examine the effects of fuel economy and GHG standards on vehicle prices, sales, attributes, fuel consumption, driving, producer profits, and used vehicle markets, typically by evaluating observed standards or specified changes in stringency (Goldberg, 1998; Kleit, 2004; Austin and Dinan, 2005; Jacobsen, 2013; Whitefoot et al., 2017; Leard et al., Forthcoming). This paper contributes to the literature in two main ways. First, whereas much of the existing literature evaluates observed standards or specified changes in stringency, we characterize the welfare-maximizing stringency over a range of standards. We quantify the trade-offs involved in setting standards, accounting for consumer undervaluation of fuel cost savings, pollution externalities, and accident and congestion externalities associated with driving.

Second, our equilibrium model integrates several components of the automobile market, including manufacturers' choices over prices and vehicle characteristics; consumers' choices between new and used vehicles; driving; and vehicle scrappage. This structure allows standards to affect aggregate welfare and distributional outcomes through changes in new-vehicle prices and attributes, used-vehicle prices, driving, and the composition of the on-road fleet. The analysis also informs

benefit-cost analysis of vehicle standards by showing how estimated costs and benefits depend on interactions across these margins.

By quantifying aggregate welfare and distributional effects under no GHG standards and under standards of varying stringency, this paper provides evidence that can inform future passenger vehicle GHG policy, regardless of the outcome of ongoing litigation over the rescission of the endangerment finding. The analysis also provides a framework for examining similar trade-offs in setting vehicle standards in other countries.

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