Policy Brief: 
The Rebound Effect and the Rollback of Fuel Economy Standards

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Abstract
The August 2018 proposed rollback of 2020-2026 fuel economy standards by the Trump Administration is the subject of great controversy in the policy community. The rollback was justified based on an analysis indicating that the previous fuel economy standards would be associated with over 12,000 additional fatalities over the lifetime of the vehicles affected. The largest contributor to these fatalities is the rebound effect, which was changed from 10% in the previous rule to 20%. This article summarizes what we know about the rebound effect of fuel economy standards. A careful review indicates that the recent literature supports a central estimate closer to 10%, undermining a key argument used to support the rollback of the standards. Yet there are several poorly-understood factors that influence the magnitude of the rebound effect, widening our uncertainty bounds around the central estimate and emphasizing the need for further work in this policy-relevant area.

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In August 2018, the Trump Administration proposed a rollback of fuel economy standards. The rule finalized in 2012 and affirmed in a Technical Assessment Report in 2016 was set to substantially tighten standards through 2025, while the 2018 proposed rule freezes the standards at 2020 levels through 2026 (EPA/DOT 2018). The legal and political arguments for rolling back the standards were based on an analysis indicating that such an action would reduce crash fatalities by 12,700 lives over the lifetime of vehicles through model year 2029. This argument was in part underpinned by a doubling of the “rebound effect” of fuel economy standards from 10% in previous Administration analysis to 20% in the 2018 proposed rule.¹ In the analysis by the federal agencies, the rebound effect is defined as the percentage increase driving in driving that occurs when vehicles become more efficient and thus have a lower cost per mile of driving, but it is defined more broadly as an estimate of the market and behavioral responses to an energy efficiency policy that may reduce the energy savings from the policy (Gillingham et al. 2016). In short, the agencies argue that with more driving due to the rebound, there will be thousands more fatalities.²

This article reviews the recent literature on the rebound effect, assessing the decision to double the central estimate of the rebound effect to 20%. The review reveals that the recent literature on the fuel price elasticity of driving tends to point to an estimate around -0.1, which corresponds to a 10% rebound. Further, it highlights key factors that should be considered in the choice of a rebound effect in this context—some of which are specific to fuel economy standards and most of which are areas where future research is warranted. Finally, the article concludes with a brief discussion of how the choice of the rebound effect can be improved going forward.

Recent Literature Relevant to the Rebound Effect of Fuel Economy Standards

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¹ For example, in this context, a 10% rebound implies that there is a “rebound” in fuel use from increased driving that leads to 10% of the fuel savings from the improved fuel economy still being consumed, so that only 90% of the reduction in fuel savings would occur.
² Specifically, the 12,700 lives lost estimate is reduced by roughly one third when the rebound effect is 10% instead of 20%. Note that in both the 2016 and 2018 cost-benefit analysis, the welfare losses from the rebound are almost exactly offset by welfare gains from the additional driving, so the choice of the rebound is not pivotal to the net benefits in either analysis; it is instead of primary importance for the legal and political argument in the 2018 proposed rule.
Economists have long used estimates of fuel price elasticities to quantify the direct behavioral response by drivers to the lower cost per mile of driving due to fuel economy standards (this is often known as the “direct rebound effect”) (Gillingham et al. 2016). In the past decade, there has been a substantial growth in studies estimating the fuel price elasticity of driving. Some of these studies examine the relationship between the fuel price and driving decisions, while others examine the relationship between the cost per mile of driving (the fuel price divided by the fuel economy). There are only a few studies that directly examine the relationship between the fuel economy of the vehicle and driving, largely due to the difficulty in finding plausibly exogenous sources of variation in fuel economy. In order to use fuel price elasticities as estimates of the rebound effect, one must make the implicit assumption that consumers respond to reduced fuel prices in the same way that they respond to improved fuel economy, for both changes reduce the cost per mile of driving.

The most recent literature tends to be based on either survey data, largely from the National Household Transportation Survey, or odometer reading data from state vehicle inspection programs. In the 2018 proposed rule, the agencies argue that odometer reading data is the most reliable data when they are discussing the relationship between vehicle miles traveled and vehicle age, but do not make this distinction in the discussion of the rebound effect. Odometer readings can be considered more reliable because they are measured, rather than self-reported, and also typically cover the entire light duty fleet, which means they may be more representative.

Table 1 below summarizes the literature relevant for a central estimate of the rebound effect of fuel economy standards in the United States. I restrict my review to literature from the past decade based in the United States. This review differs from the discussion in the proposed rulemaking in that it excludes estimates from Europe, excludes estimates from unpublished work that is inaccessible, and excludes estimates that the authors argue are inappropriate for using as an estimate of the rebound effect (including one by this author).

<table>
<thead>
<tr>
<th>Study</th>
<th>Data</th>
<th>Rebound Estimate</th>
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<tbody>
<tr>
<td>Bento et al. (2009)</td>
<td>2001 survey</td>
<td>34%</td>
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<tr>
<td>Study</td>
<td>Methodology</td>
<td>Time Period</td>
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<td>Hymel et al. (2010)</td>
<td>State-level</td>
<td>1966-2004</td>
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<tr>
<td>Gillingham (2011)</td>
<td>Odometer; CA</td>
<td>2001-2009</td>
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<tr>
<td>Greene (2012)</td>
<td>Aggregate</td>
<td>1966-2007</td>
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<tr>
<td>Su (2012)</td>
<td>2009 survey</td>
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<tr>
<td>Liu et al. (2014)</td>
<td>2009 survey; MD/DC/VA</td>
<td></td>
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<tr>
<td>Gillingham et al. (2015)</td>
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<td>2000-2010</td>
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<tr>
<td>Leung (2015)</td>
<td>2009 survey</td>
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<tr>
<td>Linn (2016)</td>
<td>2009 survey</td>
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<td>West et al. (2017)</td>
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<tr>
<td>Knittel &amp; Sandler (2018)</td>
<td>Odometer; CA</td>
<td>1998-2010</td>
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<tr>
<td>Wenzel &amp; Fujita (2018)</td>
<td>Odometer; TX</td>
<td>2005-2010</td>
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Notes: These studies used for the rebound effect estimate the elasticity of vehicle-miles-traveled with respect to fuel economy, fuel prices, or the cost per mile of driving. This table converts these elasticity estimates to percentage rebound effects. For studies with a range, the average is taken over the range. The 2018 proposed rule references the following papers that are excluded: Wadud et al. (2009), which estimates an elasticity of gasoline consumption, Gillingham (2014), which is a study focused on a gasoline price shock, and West and Pickrell (2011), which is not a publicly available study. The 2018 proposed rule incorrectly references Linn (2013) as Linn (2013). Bento et al. (2009) give the average VMT elasticity with respect to the price of gasoline as -0.34 on p.685 (implying a 34% rebound); the 2018 proposed rule reports a range of 21-38%, but it is unclear where this range comes from. The 9% estimate from Hymel et al. (2009) was taken from the authors’ preferred estimate in the conclusion (p.1235) with the calculation of variables at 2004 values, but a variety of other estimates were reported. The 4-18% estimates from Hymel and Small (2015) is from the authors’ preferred estimates in Table 8; the 2018 proposed rule chooses only the high estimate. The 7.5%-15.9% range for Wenzel & Fujita (2018) is based a conversation with the authors, who suggest considering both the estimate based on fuel prices and the estimate based on the cost per mile to be consistent with the rest of the literature, which use both.

A few clear findings are apparent from Table 1. First, there is a relatively wide range of estimates. In general, studies using survey data tend to have much higher rebound effect estimates than those using odometer reading data. Second, while one should be cautious in taking a simple average over studies (due to differences in regions, time periods, and methodologies), in doing so, we see that the average over all studies is 14.1%, and the average over all studies using the more reliable odometer readings is 8.1%. Third, all of the studies in boldface are not included in the 2018 proposed rule, and in general these studies not only tend to be studies using odometer readings, but also tend to show smaller rebound effects than those that are included in the 2018 proposed rule. Indeed, excluding all of these studies and including studies from Europe is how the agencies are able to argue for a 20% rebound.

These findings cast doubt on the argument for a central case estimate of 20% for the rebound effect of fuel economy standards.
Further Considerations Not Addressed in The Above Rebound Estimates

The above estimates form the core of the evidence base available to provide guidance on the rebound effect of fuel economy standards. However, the actual effect may be influenced by several other factors that are not all included in any of the estimates. The ideal estimate of the rebound effect quantifies the consumer response in the amount driven to all of the changes that occur due to fuel economy standards: higher fuel economy vehicles, higher priced vehicles, vehicles with different attributes (some of which are valued by consumers). Further, for policy analysis, we are interested in both the short-run rebound effect and the long-run rebound effect, which accounts for all longer-term margins of adjustment by consumers to the different vehicles (e.g., if it is less expensive to commute, some households may choose to live further away in the long-run). Thus, there are important caveats in order when using the rebound estimates given above.

First, consumers may respond differently to changes in fuel economy than changes in fuel prices. For instance, there are several papers in the literature suggesting that the response to fuel economy may be less than the response to fuel prices, implying that the evidence above overestimates the rebound effect (West et al. 2017, De Borger et al. 2016, Greene 2012, Gillingham 2011). One rationale for this is that gasoline prices are more visible and thus more salient to consumers. In contrast, there is one paper providing evidence suggesting that the response to fuel economy may be greater than the response to fuel prices, suggesting an underestimate of the rebound effect (Linn 2016). A rationale for this finding is that changes in fuel economy are more permanent than fuel price changes. It is possible the sign depends on the exact circumstances.

Second, there is likely to be a larger response to fuel economy standards in the long-run. As most of the estimates above are short-run or medium-run, they are appropriate for policy analysis for the first few years of the policy but may miss longer-run responses. Thus, they would underestimate the rebound effect in the long-run. Unfortunately, it is extremely difficult to directly identify long-run effects. The limited evidence available suggests that long-run rebound
effects are only modestly larger than short-run effects (e.g., Hymel and Small 2015), but this is an area worthy of further research.

Third, as households get wealthier and roads more congested, the rebound is likely to be smaller. This follows because as households become wealthier, the time value of driving becomes more important than the cost of fuel (Hymel and Small 2015, Hymel et al. 2010, Small and Van Dender 2007). Similarly, as roads become more congested, consumers may care less about fuel and more about the time spent in traffic. These factors both suggest that the above studies may provide useful guidance for today but are overestimating the rebound effect in the future.

Fourth, fuel economy will change along with a bundle of attributes, and some of these changes may mean that driving is less appealing. West et al. (2015) show that drivers induced into higher fuel economy vehicles that are lower performing do not drive any more than they had previously. This would imply that the above studies (besides West et al.) overestimate the rebound effect.

Fifth, if fuel economy standards are met by adding costly technology to vehicles, then vehicle prices might increase, reducing the budget available for driving. This would imply that the above studies overestimate the rebound.

Sixth, there may be an indirect rebound effect, whereby money saved at the pump due to higher fuel economy vehicles may be diverted to other uses that use fuel and create emissions. However, this effect could work in the opposite direction, in that more expensive vehicles may divert money away from other uses. Thus, the net effect could be positive or negative (Borenstein 2015, Gillingham et al. 2016). Fullerton and Ta (2018) argue that in general equilibrium, the effect can easily be negative. Importantly, this indirect effect could influence emissions, but would not influence driving, and thus would not lead to additional crash fatalities.

Finally, there may be a macroeconomic rebound effect if fuel economy standards reduce the global demand for oil, lowering the global oil price and leading to more consumption globally in
equilibrium (and possibly influencing the direction of innovation). On net, these effects may be positive or negative, but are usually expected to be positive (Gillingham et al. 2016). Thus, the effect will influence emissions elsewhere in the world, and a small portion would influence driving in the United States just as any fall in gasoline prices would, implying that the above studies are an *underestimate* of the rebound.

The magnitudes of these seven additional considerations are quite uncertain and should increase the uncertainty bounds around any central case estimate of the rebound effect. However, what is critical for interpretation is that these factors do not point in a single direction—a roughly equal number suggest an upward bias of the studies above as suggest a downward bias. Given the current state of evidence, it would be difficult to argue for a higher or lower central case rebound effect based on these factors. Notably, the 2018 proposed rule is not relying on any of these factors to justify the decision to use a 20% rebound.

**Concluding Remarks**

The rebound effect is playing a major role in the justification of the proposed rollback of fuel economy standards, yet the choice of the rebound effect does not appear to be based on a careful review of the latest literature. This literature review indicates that a rebound estimate on the order of 10% is more justifiable as a central case estimate than a 20% estimate. However, it also underscores seven channels that are relatively poorly understood and work in diverging directions. The existence of these channels not only underscores the importance of sensitivity analysis of the rebound parameter, but also highlights research needs going forward to better inform fuel economy policy.

**References**


