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I would like to comment on the use of my publications in the Notice of Proposed Rulemaking by NHTSA and EPA, regarding fuel-efficiency standards of passenger cars and light trucks for Model Years 2021-2026, published August 24, 2018. I refer to Section E, subsection 7, "Accounting for the rebound effect caused by higher fuel economy," 83 Fed. Reg. 43099-43106 (August 24, 2018).

1. The proposed rule (p. 43103) cites my papers with Kurt Van Dender and Kent Hymel (2007, 2010, and 2015) as estimating a rebound effect that was 11% for 1997-2011 in the first study, 13% for 2001-04 in the second, and 18% for 2000-2009 in the last.

A better characterization of the most recent study would be that it finds a long-run rebound effect of 18% under a simpler model but 4.0 percent or 4.2 percent under two more realistic models that are supported by the data. All three of these estimates are contained in the summary table for the most recent paper (Hymel and Small 2015), labeled Table 8. That table shows a rebound effect of approximately 18% for what we call a "base model", which is the starting point for the models that are the main object of development of the paper; those two models yield estimates of 4.0% and 4.2%, respectively.

A minor note: in the proposed rule, the time period "1997-2011" attributed to a calculation done in the first study is apparently typographical error: the time period was actually 1997-2001, as reported in the study.

2. The main thrust of all three papers mentioned above is that *the rebound effect declines with income and increases with fuel price. Under most scenarios the impact of income dominates, and therefore we expect the rebound effect to decline significantly between the time period quoted and the time at which cars would be sold under any revisions to the fuel-efficiency standards.* In fact, I projected such future changes in a report to the EPA by the consulting firm ICF International, issued in 2015: "The Rebound Effect from Fuel Efficiency Standards: Measurement and Projection to 2035," Report EPA-420-R-15-012, July 2015. In that work, the "base model," which assumes symmetry in the response to price rises or declines, leads to a projected long-run rebound effect that declines from 17.8% in 2000-2009 to 10.2% in 2025, and declines further to 4.8% in 2035 (Table 5.1, panel (a)). The "asymmetric model," which allows for possible asymmetry in the response to price rises or declines, finds a long-run rebound effect of 4.2% in 2000-2009, and projects that it will decline to 1.0% in 2025 and to even lower values in later years (same table). This model finds that the response to fuel-price rises is greater in magnitude than the response to fuel-price declines; but it still assumes a symmetric response to rises or declines in fuel *efficiency*.

3. The long-run rebound effect reported in these papers is the change in annual fuel consumption to which the actual change would trend over an infinitely long time period, if the car were to last that

long. (Formally, it is the asymptotic limit as time continues indefinitely, assuming a one-time permanent change in fuel efficiency for the vehicle in question). The short-run rebound effect, also reported in these papers, refers to the first-year response; it is approximately one-sixth as large. (See for example Hymel and Small, 2015, Table 2). The effect that occurs over the actual lifetime of a vehicle is somewhere between these two values.

4. In the EPA report referred to above, I calculated a "dynamic rebound effect" to attempt a better approximation of the actual impact on vehicle-miles traveled over the life of a car purchased in any given year. It is called "dynamic" because it accounts for the fact that the underlying behavioral response is gradually changing (due to changes in income and fuel price), while simultaneously the consumer's responsiveness is increasing from its short-run value toward its long-run value. The projected dynamic rebound effect is shown in the same table mentioned above (EPA-420-R-15-012, Table 5.1, panel (a)). For the "base" (symmetric) model, it is 5.3% in year 2025. For the asymmetric model, which I think is more likely to be valid, it is 0.2% in year 2025.

5. The proposed rule (p. 258) notes that none of the three studies mentioned above "is able to detect whether the decline in response to rising income levels" is really a declining rebound effect or a decline in sensitivity to fuel prices. It is true that our studies, like almost all studies of the rebound effect, are unable to separately measure response to fuel efficiency and response to fuel price – hence the near-universal assumption that these two responses are equal and opposite. (That is, people care about fuel cost, not its two separate determinants.) But this point actually further undermines the case for a large rebound effect, because when we attempted to distinguish them, what we found was that the effect of fuel *price* is clearly measured, but that of fuel *economy* is statistically indistinguishable from zero. This is also true of the vast majority of other studies that have tried to measure separately these two responses. In other words, if one does not accept the underlying assumption that fuel cost is what matters, rather than its separate components, the most defensible result empirically is that people do respond to fuel price as expected, but that they do not respond to fuel economy at all. Small and Van Dender (2007) make this point explicitly, and point out that we are therefore assuming a positive rebound effect when actually we cannot prove that it's greater than zero.

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