VEHICLE EFFICIENCY INCENTIVES: AN UPDATE ON FEEBATES FOR STATES

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EXECUTIVE SUMMARY

The lack of federal initiative on global warming and oil dependence has led states to consider their own options to address these problems. An approach that has been considered many times in the United States over the past fifteen years, but never implemented, is a feebate program, i.e. a sliding scale of fees and rebates for the purchase of new vehicles based on fuel consumption or emissions of greenhouse gases. The simplest structure sets the fee or rebate in proportion to the amount of fuel consumed by the vehicle per mile driven.

Feebates shift the market towards green vehicles by providing an incentive for manufacturers to adopt cost-effective efficiency technologies; by mitigating the market failure arising from consumer undervaluation of the fuel savings associated with efficient vehicles; and by raising consumer awareness of the relationship between fuel efficiency and greenhouse gas emissions. Market-based mechanisms and regulatory approaches each have advantages for reducing vehicles' environmental impacts, and a combination of the two is probably the best approach to reducing vehicle emissions and fuel consumption.

There is little experience on which to base a prediction of the outcome of a feebate policy, although various analyses have been done based on modeling of consumer choice and manufacturer behavior. The findings of these analyses support the conclusions that: (1) the effect of a national feebate could be quite large (over 20% reduction in vehicles' CO_2 emissions and fuel consumption, using technologies available today); (2) the dominant response to a national feebate would be on the part of the manufacturers, who would put more vehicle efficiency technologies into their new offerings; and (3) consumer response through changes in buying preferences would be limited. The models used may not capture all of the important elements of manufacturer and consumer behavior, however.

Much less analysis has been done of the effects of a state-level feebate. Consumer response may dominate in this case, especially if the state is small, as manufacturers will be less responsive to an incentive program that affects only a limited part of the vehicle market. A state feebate could nonetheless have a major impact by prompting other states, or the nation, to adopt similar programs. Several states, many of them in the Northeast, are now actively considering feebates as a tool for greenhouse gas reduction, as is Canada.

Recommendations for designing a feebate include:

- Keep the program simple.
- Maintain the integrity of the feebate structure; moderating the rate (dollars per lbs. carbon per mile) of the feebate may be the best response to concerns about the program's impacts.
- Provide for good data collection and documentation.
- Adopt measures to reduce vehicle miles traveled in tandem with the feebate to maximize benefits.
- Cover all cars and light trucks under the program to maximize consumer attention and ensure strong educational value for the public.

INTRODUCTION

The lack of federal initiative on global warming and oil dependence has led states to consider their own options for addressing these problems. Motor vehicles are central to both concerns, so reducing their fuel consumption and emissions of greenhouse gases are high priorities for states. Raising the gas tax remains an obvious approach to changing vehicle purchase and use patterns while raising revenues; but so unpopular has this idea been that states are increasingly turning to other tax measures to raise money, even for construction of transportation facilities. Better-received policies to make the transportation sector more sustainable have included smart growth measures and transit investments, as well as incentives for the purchase of green vehicles.

One tool receiving renewed attention is the feebate, which consists of a sliding scale of fees and rebates for new cars based on their emissions of greenhouse gases, fuel consumption, or some other measure of a vehicle's environmental impacts. Feebates have been proposed in many forms over the last fifteen years, but have not yet been implemented in the United States. The Connecticut Assembly recently passed a law directing the Commissioner of Environmental Protection to develop a feebate program by January 1, 2006, however, and several other states are actively considering feebates as well.

History of Feebates

Notable past feebate efforts were those in California and Maryland, both in the early 1990s. California's DRIVE+ program, based on a combination of fuel economy and pollutant emissions, passed the California legislature but then was vetoed by the governor. Maryland enacted the feebate law in 1991, where it stayed on the books for a decade, but was never implemented. The first Bush Administration took the position that the Maryland law conflicted with the federal government's sole authority to regulate fuel economy. The Maryland attorney general then issued an opinion that the only potential conflict with federal law stemmed from the state's requirement that feebate-related information appear on the vehicle label at the time of sale. Maryland never implemented or adjusted the program, however.

Feebates also have been introduced several times at the federal level, including by: Senator Wirth in the National Energy Efficiency and Development Act of 1991 (S.741); Rep. Synar in the Clean Domestic Fuels Enhancement Act of 1991 (H.R. 2960); and Senator Durbin in 2003 (Senate Amendment 1385 to S.14). A gas guzzler tax, which imposes a fee on a sliding scale on cars achieving under 22.5 miles per gallon (unadjusted, combined city/highway), has been in place since 1978. It applies only to cars, however, very few of which have such low fuel economy.

A feebate implemented in Ontario, Canada in 1991 is discussed later in this report. Several European countries have imposed fees based on energy consumption. Austria has a sliding scale for a portion up to 16% of its new vehicle tax that is tied to fuel consumption (Kagelson 2005). In addition, several EU countries have sales or registration taxes based on engine size. This is currently correlated to fuel consumption to a large degree, but the two parameters

could diverge as advanced technologies such as cylinder deactivation become more common. Therefore such a tax would not necessarily yield the same results as one based on efficiency. In any case, the EU countries with the largest car markets are lacking CO_2-based taxation schemes (Kagelson 2005).[1]

Over the years, an extensive feebate literature has developed. The purpose of this report is not to recapitulate that entire literature, but rather to highlight some of the main analyses and activities that should inform today's consideration of feebates, especially at the state level.

STRUCTURE

A feebate is a policy to strengthen the market for environmentally preferable vehicles by charging a fee or paying a rebate to purchasers, depending on features of the vehicle that affect environmental performance. Policy priorities will shape a feebate: whether it targets greenhouse gas emissions, oil consumption, or criteria pollutant emissions; the selection of the set of subject vehicles; revenue objectives; manufacturer impacts; and equity, to name a few.

A variety of structures have been analyzed for feebates to reduce greenhouse gas emissions and oil consumption (Davis et al.1995). The simplest approach is to set the fee or rebate in proportion to the amount of fuel consumed by the vehicle per mile driven.[2] The scheme then can be specified by two parameters: the rate, in dollars per gallons per mile, and the division ("pivot point") between those who pay and those who are paid. Devising a viable feebate that meets program goals requires the careful choice of both parameters, both initially and periodically as the vehicle market responds.

The location of the pivot point will determine the direction of net revenue flow between consumers and the government; a revenue-neutral feebate may be regarded as the most attractive choice from a political perspective, although a system that raises revenue could be feasible, depending on the proposed use of funds. As cars become more efficient under a feebate program, the pivot point must be raised to preserve revenue neutrality or revenue generation.

Many variations on this general structure have been proposed. They include replacing the pivot point with an entire range of vehicle emission rates for which no fee or rebate is imposed, so that only those consumers purchasing high- or low-emitting vehicles would be affected by the program. On the other hand, caps on feebate values for vehicles at either end of the emissions spectrum have also been suggested to prevent the imposition of onerous fees or overly generous rebates (Bernow 2003). A variation commonly proposed by states is to set a feebate rate as a multiplier for an excise tax, so that the fee or rebate is determined not only by the emissions rate of the vehicle, but by its price as well. Such variations may address

[1] In the United Kingdom, the vehicle excise duty ranges from £65 to £165 for gasoline vehicles, depending on the CO_2 emissions rate of the vehicle. (See http://www.dvla.gov.uk/vehicles/taxation.htm.) This fee is paid annually, rather than at purchase, however, and is therefore unlikely to have a substantial impact on purchases.

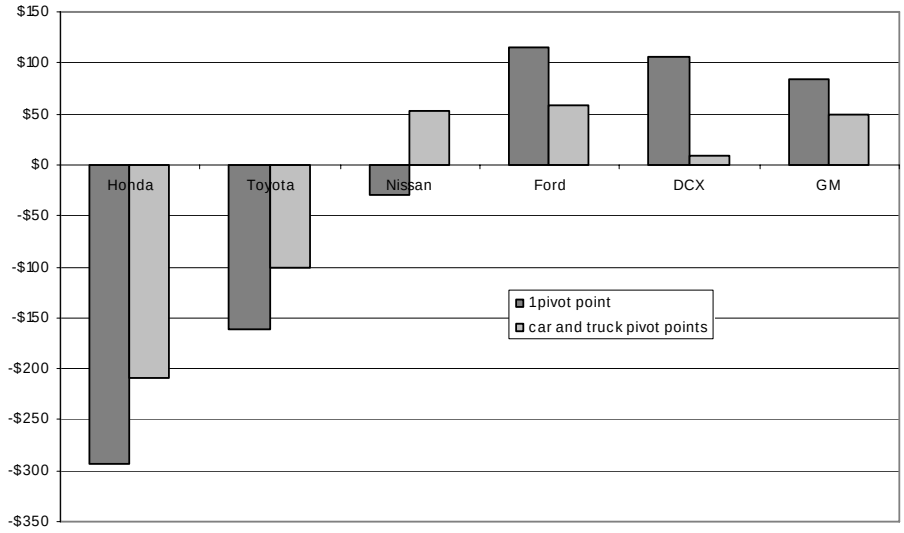
[2] For alternative fuel vehicles, adjustments would be made to reflect low petroleum usage and/or emissions of greenhouse gases.

political obstacles to the adoption of a feebate, but will certainly complicate the program and, in general, reduce its efficacy.

Manufacturer Impacts

A feebate as described above will have disparate impacts on manufacturers, given that average fuel economy varies substantially among manufacturers and that the feebate will promote sales of vehicles with higher fuel economy. These variations are due both to the relative efficiencies of the vehicles a manufacturer produces and to the distribution of its product lines among vehicle classes. To eliminate disparities in manufacturer impact based on product class distribution, structures involving multiple pivot points have been proposed. A vehicle's feebate would then be based on its fuel consumption relative only to others within its class. Average fee/rebate for the six largest manufacturers under a $500 per gallon per 100 mile feebate are shown in Figure 1 for both one pivot point and two pivot point systems.

Figure 1: Average Per-Vehicle Fee by Manufacturer, Model Year 2003 Data



Source: ACEEE analysis based on data from the National Highway Transportation Safety Administration 2003 CAFE database

While a multiple pivot point approach might mitigate some manufacturer objections, a class-based system has a serious drawback, namely that it could promote the purchase of a higher-emitting vehicle in one class at the expense of a lower-emitting vehicle in another. Table 1 below illustrates this point in the case of a two-point system based on the car/light truck classification currently used for the purpose of fuel economy regulation. The Ford Taurus pays a fee while the Jeep Grand Cherokee does not, even though the fuel economy of the Taurus is 5 miles per gallon higher. Thus a class-based approach could have unintended negative consequences and requires caution. In any case, no classification based on vehicle weight would be appropriate, since it would discourage manufacturers from using new high-strength, lightweight material to lower fuel consumption and encourage the upweighting of vehicles near weight boundaries.

Another alternative is a hybrid system in which vehicles are compared to members of their class, but the pivot points are adjusted to increase the number of vehicles receiving rebates in the most efficient classes and the number charged fees in the least efficient classes. The effects of between-class differences would be moderated relative to a single pivot point approach.

Sample Feebate Values

A plausible range for fuel consumption-based feebates is $500–1,000 per gallon per 100 miles (Greene et al. 2005). The pivot point could be set at today's average fuel economy to start out and then raised to preserve revenue-neutrality as vehicles became more efficient. As an example, at the $1,000 per 0.01 gallon per mile rate, starting feebates for the best-selling vehicles thus far in 2005[3] and for hybrids is shown in Table 1.

CURRENT ACTIVITY

After years of limited interest, feebates are once again under discussion as a means of achieving environmental objectives in the transportation sector. Several states are actively exploring them, often as part of state greenhouse gas reduction plans. Transportation is responsible for 27% of greenhouse gas emissions nationally (EPA 2005) and much more in some states; 41% in California, for example (Bemis and Allen 2005). Yet strategies to reduce emissions from the transportation sector generally have lagged behind those for other sectors in states' greenhouse gas reduction plans. This began to change with California's adoption of the Pavley bill and subsequent implementing regulations requiring a 30% reduction in the greenhouse gas emissions of new vehicles by 2016. Several states, notably in the Northeast and Northwest, have begun to follow suit. A number of these same states have been discussing feebates as well, though this discussion is taking a back seat to adoption of California's program. Feebates may be regarded as a complement and backup to greenhouse gas tailpipe regulation.

In addition to new attention to global warming, other circumstances have changed since the first efforts at state feebates fifteen years ago. Gasoline prices are higher today, in real dollars, than they have been since the mid-1980s, and public concern about oil dependency is high. "Crossover" vehicles, designed to combine the advantages of cars with those of SUVs, are gaining in popularity, while the desirability and safety of high-consumption vehicles increasingly are being called into question. At the same time, advanced vehicle technologies are generating a great deal of public discussion; hybrid-electric vehicles, in particular, have grown in popularity faster than could have been anticipated from a standard value proposition.

[3] Sales data from *Automotive News,* based on sales in the first six months of 2005.

Table 1: Fees and Rebates for Most Popular Vehicles and Hybrids at $1,000 per 0.01 Gallons per Mile

		Est. MPG (lab 55/45)[4]	Single pivot point	Separate car and truck pivot points
Cars				
Toyota	Camry	31.4	$880	$275
Honda	Accord	30.7	$808	$203
Honda	Civic	38.9	$1,494	$890
Nissan	Altima	29.8	$709	$105
Chevrolet	Impala	28.1	$506	-$99
Toyota	Corolla	39	$1,501	$896
Ford	Taurus	26.3	$263	-$342
Chevrolet	Cobalt	33.1	$1,044	$439
Chevrolet	Malibu	31	$839	$234
Ford	Focus	32.9	$1,026	$421
Toyota	Prius	65.8	$2,545	$1,940
Honda	Civic Hybrid	56.3	$2,289	$1,684
Trucks				
Ford	F-150	19	-$1,198	-$568
Chevrolet	Silverado	20.8	-$743	-$113
Dodge	Ram	18.4	-$1,370	-$740
Ford	Explorer	19.2	-$1,143	-$513
Dodge	Caravan	24.8	$33	$663
GMC	Sierra	20.8	-$743	-$113
Chevrolet	TrailBlazer	19.3	-$1,116	-$487
Jeep	Grand Cherokee	21.3	-$630	$0
Chrysler	Town & Country	24.3	-$50	$580
Honda	Odyssey	25.7	$174	$804
Ford	Escape Hybrid	39.5	$1,533	$2,163

Negative numbers are fees.

Status of Efforts toward Incentives for Low-Emitting and Efficient Vehicles

1. Connecticut: The Governor signed a bill in June 2005 directing the Commissioner of Environmental Protection to "develop a plan for the implementation" of a feebate. The plan is to allow an increase or decrease of up to 3% in the state sales tax on vehicles, based on their emissions of greenhouse gases. The Commissioner is required to consult with stakeholders, including the auto industry, in developing a plan that is to be submitted to the General Assembly by the start of next year. The text of the bill can be found at http://www.cga.ct.gov/2005/act/sa/2005SA-00006-R00HB-06908-SA.htm. The bill was generally well received, but late in the legislative process, auto manufacturers, through their dealers, began to voice opposition. Preliminary information from the Commissioner's office indicates that the proposal may include a large "dead-zone," or band around the pivot point in which the feebate is zero, so that many vehicles would be unaffected by the program (Haxthausen 2005).

[4] Fuel economy data from EPA (Heavenrich 2005). All SUVs and pickups are 2WD. This table is illustrative only and does not reveal an important feature of the vehicle market, namely that variation in fuel economy may be large within a nameplate, especially in the case of trucks. Ford F-150 models, for instance, vary by as much as 3.6 mpg, which could mean a $900 difference in feebate value in the system described above.

2. District of Columbia: In 2004, the D.C. Council raised from 7 to 8% the excise tax on "luxury" SUVs, defined as those weighing 5,000 pounds or more, and increased registration fees for these vehicles by $40. Fees for hybrids were reduced by comparable amounts (Woodlee 2004).
3. Maine: Bill LD305, introduced in 2005, would levy a 5% surcharge on the purchase or lease of a new vehicle that does not achieve 27.5 mpg. It failed in the Senate in March.
4. Massachusetts: Feebates have been under consideration in Massachusetts for several years, and they were part of Governor Mitt Romney's 2002 campaign platform. Bill 2438, introduced in 2005, tied the sales tax to carbon dioxide emissions. As in Connecticut, the feebate would be defined as a percent of purchase price. Beginning in September 2007, consumers who purchased vehicles that emitted the lowest level of carbon dioxide would not pay any sales tax, while those who bought the most CO_2-polluting vehicles would be taxed at a rate of 10%. Any vehicle with a better-than-average CO_2 emission profile would be subject to less than 5% tax, the current sales tax rate. See http://www.mass.gov/legis/bills/house/ht02/ht02438.htm. Efficiency advocates have made appliance efficiency their top priority, allowing this legislation to languish (Breslow 2005); but a hearing on the bill before the Joint Committee on Revenue was held in September.
5. North Carolina: Senator Jenkins introduced Bill 1038, Mobile Source Emissions Reduction Program, which would charge vehicles a registration fee on a sliding scale, based on miles traveled, emissions of pollutants, and fuel consumption. In March, it was sent to the Agriculture/Environment/Natural Resources Committee. The legislative session is nearly over, and the bill will not be acted upon in 2005. See http://www.ncga.state.nc.us/gascripts/BillLookUp/BillLookUp.pl?Session=2005&BillID=S1038.
6. Rhode Island: Bills to establish a feebate based on CO_2 emissions were introduced in the 2003 and 2004 legislative sessions but did not pass. The 2004 bill set an initial rate of $2,400 per pound CO_2 per mile (about $470 per gallon per mile for gasoline vehicles) and a pivot point of 0.78 lbs. per mile (about 25.1 miles per gallon, using the EPA adjusted, combined city/highway fuel economy), along with prescriptions for adjusting both parameters annually on the basis of program results to ensure attainment of the state's CO_2 reduction targets. The pivot point in this case is set at a level that would require well over half of all vehicles to pay a fee. See www.rilin.state.ri.us/billtext/billtext04/senatetext04/s3024.pdf. Environmental groups focused on a renewable energy portfolio standard in the 2004 session and the feebate bill did not move forward. This year, no bill was introduced, as those same groups worked to adopt the California greenhouse gas emission standards (Ward 2005). The Rhode Island Greenhouse Gas Working Group has nonetheless continued its exploration of feebates at length; see relevant documents at http://righg.raabassociates.org/events.asp?type=grp&event=Transportation/Land%20Use.
7. Vermont: In 1999, the Vermont legislature passed out of committee a bill containing a feebate provision (Center for a Sustainable Economy 1999), but it was never passed by the full legislature. A similar bill was introduced in the 2005 legislative session as H-444 but has not emerged from the House transportation committee. H-444 proposes

charging a guzzler tax of $500 on each vehicle under 10,000 lbs. that achieves under 21 MPG in city driving. Those who purchased vehicles over 35 MPG in city driving could receive an energy conservation rebate of up to $5,000. The state would finance the rebate using 95% of the guzzler tax revenue. See http://www.leg.state.vt.us/ docs/legdoc.cfm?URL=/docs/2006/ bills/intro/H-444.HTM for the text of the bill.

8. Canada: Feebates have been under consideration at the national level in Canada for many years. The government has announced its intention to investigate adoption of a feebate to complement an agreement reached with automakers on CO_2 reduction in March 2005. The National Round Table on the Environment and the Economy has been asked to develop feebate options for the next budget cycle. The government is also interested in extending the concept of feebates beyond vehicles to home appliances. See http://www.fin.gc.ca/budget05/bp/bpc5e.htm. As discussed below, Ontario has had a feebate in place for many years.
9. E.U.: The environment ministry of France has proposed a feebate, based on CO_2 emissions, ranging from a fee of €3,500 to a rebate of €700 (Henley 2004).

ANALYSES OF FEEBATE EFFECTIVENESS

There is little experience on which to base a prediction of the outcome of a feebate policy. The lone example of a real-world feebate, in Ontario, does not seem to have been analyzed, but several commentators regard the program as ineffectual (Bernow 2002; Lovins et al. 2004; Michaelis 1997). The Ontario program suffers from a number of flaws that could be remedied, however, including: (1) the program is invisible to consumers; (2) the vast majority of vehicles fall in the range of a $75 tax to a $100 rebate, amounts too small to strongly influence purchasing; and (3) many high-emitting vehicles are not covered by the program.

The consequences of European tax policies for vehicles, also not well-documented, would be in any case difficult to translate to the U.S. context. An analysis of these experiences would be useful nonetheless because, due to the size of the national vehicle markets there, the results may provide insights into likely state-level response in the United States.

A Brief Survey of Feebate Analyses

While the lack of real-world experience makes forecasting response to a vehicle feebate speculative, various models have been run to gain insights on the matter. These analyses typically separate out two distinct aspects of the response: manufacturer (supply) and consumer (demand) response. Manufacturers are assumed to adopt efficiency technologies that cost less than the reduction in fee or increase in rebate plus the discounted value of the fuel savings that they bring about.[5] Analysis of their response involves an assessment of the availability and cost of technologies to improve fuel economy. Consumer response is modeled by various means on the basis of elasticities and cross-elasticities of demand for all vehicle types with respect to price, as determined by historical data on buying behavior.

[5] Some analysts appear to omit fuel cost savings.

Oak Ridge and Lawrence Berkeley National Laboratories

A widely cited analysis from Oak Ridge National Laboratory (Greene et al. 2005) analyzes feebates with one or more pivot points. The ORNL analysis takes the findings of the 2002 National Academy of Sciences CAFE study (NRC 2002) as the basis for the costs and effectiveness of the technologies available to increase efficiency. The analysis projects the fuel economy increase that will occur once manufacturers have had time to retool; short-term response is not reflected in the results. To predict consumer response, the analysis uses a discrete choice model that assigns a utility to each vehicle based on purchase price, fuel economy (which in turn determines fuel costs and any applicable feebate), and a package of other features that affect the vehicle's value to the purchaser, and then uses these utilities to estimate each vehicle's share of the market.

The ORNL analysis concludes that, accepting the common assertion that consumers consider only three years' fuel expenditures when they purchase a vehicle (NRC 2002), a feebate of $500 per 0.01 gallon per mile would reduce new vehicle fuel consumption by 14% relative to a reference case with no feebate, and a $1,000 rate would bring about a 22% reduction. If consumers value fuel savings for more than three years, both the reference case and the feebate scenario fuel consumption are lower than if savings are valued for three years only, but the benefit of the feebate is less in this case.

The feebate can serve to compensate for a market failure, namely that consumers do not factor full-life fuel costs into their purchasing decisions. At gasoline prices of $2.50 per gallon and average miles traveled, the discounted (at 6%) fuel savings of a more efficient vehicle in years 4 to the end of its life would be close to $2,000 for each gallon-per-hundred mile improvement.[6] That is, if only three years of fuel costs are considered, a feebate rate of $2,000 would be required to cause the consumer to make the same buying decisions s/he would make if s/he fully valued the fuel savings of the vehicle throughout its life.

A key finding of the ORNL study is that the dominant effect of a national feebate would be through manufacturers' improvements to fuel economy, rather than through changes in consumers' buying preferences. A related conclusion is that a feebate would promote market shifts among vehicle classes only to a small degree, even in a single pivot point scheme.[7] This would imply that the benefits of the feebate would be largely independent of the number of pivot points that define it. This finding, if correct, would mitigate the concern raised above that using multiple, class-specific pivot points would increase purchases in the higher-emitting classes and thereby undermine the feebate. At the same time, the finding suggests that, to the extent that disparities among manufacturer fuel economies are due to product distribution by class, the feebate will not to any large degree increase sales of some manufacturers' vehicles at the expense of others'.

[6] Assumes 15,600 miles traveled in year 1, and declining at 4% annually thereafter.

[7] The conclusion that feebates would in fact produce a negligible mix shift will be regarded by some as a favorable characteristic: if they did produce market shifts, feebates could be construed as choice-limiting meddling with the market. At least to the extent that manufacturer response dominates the effects, however, a feebate is clearly a policy that enhances rather than limits consumer options.

The ORNL study draws upon an earlier paper from the Lawrence Berkeley National Lab that also analyzes feebates using a similar approach (Davis et al. 1995). Unlike the ORNL analysis, the LBNL study considered the impact of the feebate from the time of adoption. This provides insights into the short-term response to the feebate, a crucial issue for any real-world program. In addition, the consumer choice analysis differs from ORNL's in that it was structured to reflect household characteristics. The LBNL model predicted vehicle choice contributes 10% to feebate effects, rather than the 5% ORNL finds. This may relate to LBNL's consideration of household characteristics including income and size; but it is sufficient for this discussion to note that neither analysis predicts a major role for shifts in vehicle selection vs. technology improvement.

Rocky Mountain Institute

The Rocky Mountain Institute, in its book *Winning the Oil End Game* (Lovins et al. 2004), put forward feebates as the centerpiece of its plan to reduce oil use by highway vehicles. On the strength of ORNL's finding that consumer response is a minor part of the benefit of a feebate, RMI limited its analysis of feebate effects to manufacturer response through adoption of efficiency technologies. Because RMI analyzed a more aggressive technology package than ORNL did, the resulting fuel economy increase was far greater.

RMI advocated a feebate with a separate pivot point for each size class so as to (1) minimize differences in impacts among manufacturers and (2) avoid distortions in the vehicle market (i.e., shifts of customer choices among vehicle classes). The report asserted that "feebates would best be adopted federally for uniformity," but that states could take action if the federal government failed to do so. No account is offered, however, of how manufacturer response would change if feebates were adopted at the state level only.

California Energy Commission

The California Energy Commission analyzed feebates as a measure to reduce states' petroleum demand (CEC 2002). The analysis of the effects on consumer behavior was based on the Commission's CALCARS vehicle choice model, while the analysis of manufacturer response relied upon a consultant's assessment of available technologies. An element of the Commission's approach of particular interest was the means of determining what the consequences would be of California's adopting a feebate on its own. The Commission assumed that manufacturers' response to a California-only program would be determined by the number of vehicles for which the state's market attains a certain size threshold that is, from the manufacturers' perspective, worth designing for.

The CEC found that a national feebate at the level of $1,825 per gallon per 100 miles would reduce new vehicle fuel consumption by about 16% by 2010 and 28% by 2020. A California-only feebate would bring a response about 30% as large as would a national feebate of the same magnitude, according to this analysis.

Natural Resources Canada

A 1999 report for the Canadian government compared the effect of a Canada-only policy to that of a "harmonized" Canada-U.S. policy (NR Canada 1999). Like the CEC study, this is of interest for its assessment of how restricting the feebate to a submarket affects the efficacy of the program. The report concluded that, in 2020, greenhouse gas reductions of the Canada-only program would be 39% of the reductions (in Canada) from the Canada-U.S. program. Given that Canada's market, like California's, is about 10% of the size of the U.S. market, this conclusion is roughly consistent with the CEC's conclusions. The analysis also considered response to the feebate over time; one prediction of note was that the announcement of a feebate program would cause consumers to accelerate purchase of inefficient vehicles prior to the program start date and delay purchase of efficient vehicles.

The NR Canada report does not reveal certain key aspects of the analysis methodology and results. In particular, it is hard to determine the size of the feebate analyzed and the resulting efficiency increases; the role of available technology is unclear; and the prices in the supply and demand functions appear to omit fuel expenditures. The treatment of manufacturer response is also problematic, as discussed below.

Transport Canada has undertaken a new feebate analysis, full results of which are not yet available. Preliminary results indicate that the Canada-only feebate is roughly half as effective as a feebate applying to both the United States and Canada (Greene, Bourbeau, and Dumas 2005). The analysis is based on a modification of the ORNL model.

Discussion

Consumer Choice Modeling

Models necessarily simplify buying behavior; and the effects of these simplifications on projected outcomes can be large. For example, the models that have been applied to feebates typically assume that a fee or rebate will affect consumer decisions the same way that a change in sticker price of the same magnitude will affect them. This assumption discounts the importance of the buyer's response to what is perceived as a penalty or a "bargain," either of which might provoke a range of reactions beyond what a simple price adjustment might do. Indeed, automakers use a complex array of incentive, pricing, and advertising mechanisms to promote vehicle sales, which suggests that the monetary equivalence of such mechanisms does not produce equivalent results. According to Automotive News, "regardless of what the sticker says, customers are going to want big incentives and rebates" (Crain 2005).

The failure of cost-effective fuel economy technologies to make their way into the vehicle market is often explained in part by consumers' failure to value lifetime fuel savings, which is in turn represented in models as the three-year-savings rule invoked above. But, in fact, the notion that fuel economy enters consumers' valuation of a vehicle exclusively, or even largely, as a monetary consideration is suspect. Recent research indicates that, when choosing a vehicle, consumers generally do not even attempt to translate fuel economy into an element of total vehicle cost through fuel savings (Kurani and Turrentine 2004). Even in

the aggregate, consumers would not be expected to behave according to the predictions of standard rational choice models because, according to this recent work, many consumers treat high fuel economy as an indicator of poor vehicle value due to an historical correlation between cheap, unappealing cars and high fuel economy.[8] The significance of this is not that the feebate would be ineffectual in causing consumers to choose lower-emitting vehicles, but rather that the shift comes about to a large degree through the non-economic elements of consumers' valuation of vehicles.

Another aspect of feebate response not captured by the analyses discussed here is the feebate's role in calling buyers' attention to vehicles' fuel consumption and global warming emissions. Consumer research consistently has shown these issues to be secondary factors, at best, in car purchase decisions, but this may be changing. Indeed, part of the motivation for a feebate program is to accelerate this change. The car market is a very complex one, in which the features determining popularity change relatively quickly and go well beyond monetary or other pragmatic concerns. Making efficiency a popular feature for cars would be an enormous achievement; and a skillfully-marketed feebate program could help bring this about.

Manufacturer Response

It is not clear that any of the analyses capture the opaque logic of manufacturers' vehicle pricing practices and consumers' response to them. For example, it is often claimed that some auto manufacturers today are constrained by CAFE standards, and that this causes them to sell small, high-efficiency cars at a loss (see, for example, German 2002). This leads to a concern that the lessening of that constraint through a feebate could lead those manufacturers to increase sales of the least efficient vehicles, presumably by reducing prices (Becker 2004). Though all vehicles would then be more efficient, no net gain in fuel economy would be guaranteed. This scenario becomes more plausible in a multi-pivot point scheme. In effect, this would be a shift in the market that is not addressed by the ORNL model, for instance, because that model does not anticipate any such changes in pricing induced by relief of the CAFE constraint. While the current softening of the market for large SUVs may mute this concern for the time being, this could indeed be an issue in the future.

Another point of contention about manufacturer response relates to placement of the pivot point. The NR Canada report assumed that manufacturers respond only to the fees, not to rebates. It is difficult to justify this assumption, and manufacturers' strong interest in the advanced vehicle tax credits included in the Energy Policy Act of 2005 suggests this is not the case. The ORNL study assumed that it is the differences in feebates among vehicles, rather than their absolute levels, that determine responses. This implies that the response to the feebate will be independent of the location of the pivot point, assuming the program is defined by a single pivot point.

[8] This already outdated notion will presumably fade from consumer decision-making as efficiency technologies such as cylinder cut-off, continuously variable transmission, hybridization, and diesel engines increasingly appear in high-end vehicles.

State vs. National Program

In spite of the uncertainties about the adequacy of models to predict consumer response to a feebate, the evidence is strong that response to a national program will come predominantly from the manufacturers. This is by no means clear in the case of a feebate at the state level, however. First, manufacturers would be expected to be less responsive to an incentive program affecting only a small part of the vehicle market, while consumers would be no less responsive to a state program than to a national one. Second, consumer response might in fact be substantially greater for a state program precisely because, to the degree that manufacturer response is diminished, fewer new efficiency technologies will appear in the vehicle market, and consumers will be more inclined to alter their selections in favor of low-consuming vehicles already on the market.

The ORNL and LBNL studies do not address the effects of a program below the national level, and it is unclear how the results of that work, particularly the assessment of manufacturer response, should be applied to the state or regional level. Two approaches that have been proposed to determine the effect on manufacturer response of limiting to a geographical submarket are: (1) to assume the manufacturer response is proportional to the size of the submarket; and (2) to assume the response is the same at the national level for those vehicle models having sales meeting a certain threshold in that submarket. If the threshold is taken to be 20,000 vehicles, as in the CEC analysis, a first-order characterization of the U.S. vehicle market shows that the two approaches give markedly different results (see Table 2).

Table 2: Percentage of Vehicles Exceeding Sales Threshold of 20,000 in Vehicle Submarkets of Various Sizes

Submarket as percent of national market	2%	5%	10%	15%	20%	25%
Percent of vehicles sold for which model sales exceed 20,000	0%	12%	34%	49%	66%	71%

Source: ACEEE analysis based on data from the National Highway Transportation Safety Administration 2003 CAFE database

Following the second approach described above, these figures suggest that, in a region capturing 20% of the vehicle market, for example, a feebate would draw two-thirds as large a response from manufacturers, on a per-vehicle basis, as a national feebate.[9]

Neither approach suggests that a feebate in a small state is likely to provoke a substantial manufacturer response, but the consumer response could be considerable, as discussed above. Such a program also could have a large indirect impact by attracting other states to adopt similar programs. Ultimately, state efforts can lead to a national program as well, as experiences with both appliance and vehicle standards have shown.

[9] In reality, the distribution of sales of a given vehicle model is far from uniform geographically, which is not reflected in this estimate. Moreover, vehicle classes vary dramatically in how concentrated sales of the best-selling models are; for example, over 80% of standard-size pickup truck sales in California are of models that have sales of over 20,000 (CEC 2002)

Rebound

Measures to improve the fuel economy of vehicles have the potential to increase driving by lowering the cost of driving, an effect termed "rebound." The magnitude of the effect is generally believed to be on the order of 20% in the long term, although recent research indicates that, at today's income levels, the effect is substantially lower (Small and Van Dender 2005). As a consequence of the rebound effect, the oil savings and GHG reductions of the feebate will be somewhat lower than the projected decrease in per-mile fuel consumption. Furthermore, the environmental costs of an increase in vehicle miles traveled go well beyond oil and greenhouse gas impacts, and will offset some of the benefit of a policy to improve fuel efficiency absent complementary measures to control vehicle miles traveled (Litman 2005).

POLICY CONSIDERATIONS

Feebates vs. other Mechanisms to Promote Green Vehicles

The relative merits of various policy mechanisms to reduce petroleum consumption or greenhouse gas emissions on motor vehicles is the subject of an extensive literature; see, e.g., CEC 2003; Fischer 2004; Kagelson 2005; and Michaelis 1997. Here we mention a few points on this subject that are relevant to states' consideration of feebates.

Increasing the gasoline tax is perhaps the most obvious feebate competitor when the objective is reducing petroleum consumption. A gas tax will reduce vehicle miles traveled as well as reducing per-mile gasoline consumption, an important factor in ensuring net environmental benefits. On the other hand, feebates offer the advantage that they transfer the fuel economy savings achieved by an efficient vehicle over its lifetime to the time of purchase. The importance of this is that, as mentioned earlier, consumers are thought to take into account fuel savings only over the first few years of vehicle life, if at all. Feebates are also typically designed to be revenue neutral, potentially an advantage over a tax increase.

With regard to non-pricing mechanisms designed to achieve similar ends, regulatory measures can provide certainty of attaining a specific level of progress but no guarantee of the price of getting there. Market measures such as feebates provide greater certainty in the cost of achieving their ends. Feebates have the additional advantage of creating incentives for continuing improvement. Standards must be revisited periodically to achieve this effect, and, as the history of fuel economy regulation demonstrates, this is not a minor drawback. Feebates also draw the attention of the consumer directly to the problem of high energy consumption, while standards are not visible to the consumer.

Feebate Audience

Feebates may be applied at any stage of the automotive production and sales chain: to manufacturers, dealers, or consumers. Fischer (2004) examined manufacturer feebates alongside a CAFE program that allows trading of credits among manufacturers and concludes that the two are essentially equivalent, aside from the feebate's built-in incentive for continuing improvement. Calwell (2004) has observed that feebates become more

efficient as you move up the sales chain; in particular, a manufacturer feebate is much less expensive than a consumer feebate, as there is less implementation to be done and many fewer players. Indeed, if the LBNL and ORNL analyses are correct in concluding that 90% to 95% of the response to a national feebate is due to manufacturers' adoption of improved technologies, the value of addressing this program to consumers is limited. At the state level, however, where most activity is occurring at this time, manufacturer-based feebates may not work. Furthermore, one cannot ignore the added value of a program with direct impact on consumers, both from a public education perspective and in terms of the non-economic impacts on purchasing behavior.

Hardy et al. (2004) evaluate the feasibility of a fuel efficiency-based incentive scheme applied to dealers, which could be adopted at the state level. This assessment is inconclusive regarding the cost-effectiveness, net benefits, and viability of a dealer incentive relative to a manufacturer incentive. Two findings of interest, however, are that dealers are open to discussing a scheme of this kind, and that recognition for sales of green vehicles may be at least as important to them as monetary incentives. Response to consumer incentives could similarly be dominated by non-economic considerations.

Other Issues

While states may choose to adopt a revenue-neutral feebate program, questions of who benefits and who pays remain. The analyses discussed above vary a great deal in their conclusions regarding consumer surplus, manufacturer revenue, and net societal benefits. The ORNL analysis predicted a gain in manufacturer revenues and a slight loss in consumer surplus, which is offset by fuel savings unrecognized by the consumer, while the LBNL study showed gains in consumer surplus. The NR Canada paper concluded that total cost per ton GHG reduced is highly dependent on whether there is a U.S. program in place, but the cost is high in either case. Given the wide range of cost criteria that can be applied here and approaches to evaluating them, states will need to make their own decisions on which are most appropriate to their circumstances.

States must also take into account the fact that the U.S. government has claimed in the past that a state feebate program was preempted by CAFE standards. Maryland's Attorney General determined that, if the labeling requirements of the state's feebate program were altered, this would no longer be the case. A more recent legal analysis (Chanin 2003[10]) concurred that a federal challenge to the feebate itself would not have been sustained.

CONCLUSIONS AND RECOMMENDATIONS

Feebates could be a valuable instrument to reduce greenhouse gas emissions and petroleum consumption at the state level. While the benefits are difficult to quantify at this point, a feebate would help improve vehicle efficiency in multiple ways: by mitigating the market failure arising from consumer undervaluation of the fuel savings associated with efficient vehicles; by raising consumer awareness of the relationship between fuel efficiency and

[10] As cited in Lovins et al 2004, 189.

greenhouse gas emissions; and by providing an incentive for manufacturers to adopt cost-effective efficiency technologies.

Market-based measures such as feebates are regarded by some as intrinsically less viable than other approaches. This skepticism may not be warranted in view of many state legislators' interest in feebates today, but the political viability of a feebate large enough to achieve all cost-effective vehicle efficiency improvements is questionable. Assuming the objective is to maximize reductions in petroleum consumption or in greenhouse gas emissions, a feebate is not likely to achieve as much as a strong regulation phasing in vehicle performance targets over several years.

Pricing and regulatory mechanisms each have advantages, and a combination of the two is probably the best approach to reducing vehicle emissions. A feebate could provide valuable support to a regulatory program such as California's vehicle greenhouse gas reduction regulation by shifting the market toward the low-emitting vehicles manufacturers will need to sell to meet the standards.

Feebate Benefits

While there is essentially no real-world experience to reveal the impacts of a feebate, much sophisticated modeling using detailed vehicle data has been done to project them. Uncertainty remains, however, on how manufacturers and consumers would respond to a feebate, given that the models do not reflect certain crucial considerations. These include the complex mix of issues that make up the real-world context: manufacturers' vehicle pricing strategies; uncertainly regarding the future trajectory of gasoline prices; growing public concern about both oil consumption and global warming; and enthusiasm for hybrids and other relatively new vehicle technologies.

Most importantly, analysis of programs affecting a limited part of the U.S. market is particularly sparse, and its results could be far off the mark. States therefore should not rely too heavily on existing analyses of feebate results, and particularly not on a single such analysis, in deciding whether to adopt a feebate. There is little doubt that manufacturer response will be smaller for a state feebate than for a national one; but consumer response may in fact be stronger at the state level than at the national level.

With regard to the rebound effect, the phenomenon should be accounted for, but not exaggerated, in considering the benefits of a feebate. States should adopt measures to manage growth in vehicle miles traveled in tandem with a feebate or any other policy that improves fuel economy.

Feebate Design

Designing a sound feebate program requires clarity regarding the desired outcome and in particular whether any shift in consumer's choice of vehicle class is desirable. At the national level, there is good evidence that technological improvements will prove far more significant than consumer response; but this may not be true at the state level.

States may have various rationales for choosing feebate rate, such as achieving a given percentage of a state greenhouse gas reduction target, compensating for consumers' undervaluation of lifetime fuel savings, or offsetting the externalities of vehicle fuel use. As a practical matter, however, the rate is likely to be set according to what is perceived as acceptable to the public. In fact, moderating the rate of the feebate to some degree is perhaps the most effective response to the pressures that will undoubtedly be brought to bear on any state feebate proposal. Vehicle markets are now in flux, due in large part to concerns about oil prices, and a moderate feebate could be sufficient to translate these changes into a major and lasting shift in consumer attitudes.

Maintaining integrity of design, on the other hand, should be given highest priority. A feebate program should:

- Be simple. The structure should be easily understandable to consumers and easy to assess, so there must be a clear association between the feebate amount and the particular vehicle at the time of sale. At the same time, labeling must be designed to minimize the danger of a legal challenge to the program. Other states in the region may be inclined to join in to a well-received program, increasing impacts and laying the groundwork for acceptance of a national program.
- Moderate feebate impacts through the choice of feebate rate, not by setting cut-off points to lessen fees and rebates for the highest- and lowest-emitting vehicles.
- Minimize the number of pivot points. While the ORNL study found that a class-based feebate, using multiple pivot points, would be only slightly less effective than a single point program in the case of a national feebate, the conclusion does not carry over to the state level.
- Be well-documented. Data from a well-run state program would be tremendously helpful in understanding feebates and improving upon the design.
- Be designed to maximize, not minimize, consumer attention to the program. In fact, consumer awareness may be the primary benefit of some single-state programs. Creating a "dead zone" so that consumers purchasing vehicles near the average emissions rate are unaffected is counterproductive.

Equity concerns may call for some departures from the principle of simplicity. Indexing the fee or rebate to vehicle price, for example, as has been proposed in Connecticut, will detract from the efficacy of the program and complicate analysis of its impacts; but charging a higher fee for a more expensive vehicle takes advantage of the relationship between consumer behavior and income levels, an important consideration that is often ignored in the feebate literature.

Finally, prospects for feebates might be improved by the choice of a more appealing name. The working name for these programs in the Northeastern states is "clean car incentive" or "vehicle efficiency incentive."

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