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Economic Analysis of Feebates to Reduce Greenhouse Gas Emissions from Light Vehicles for California

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1 Executive Summary

A growing majority of climate scientists are convinced that unless emissions are reduced, global warming would cause a number of adverse effects throughout the United States. In California, rising temperatures would reduce the snow pack in the Sierra—the state's primary source of water—and lead to less water for irrigating farms in the Central Valley. Global warming would increase the number of extreme heat days and greatly increase the risk of poor air quality across the state. California's 1,100 miles of coastline and coastal communities are vulnerable to rising sea levels. Concerted action could curb global warming, but all sectors would need to take immediate steps to reduce heat-trapping pollution.

In California, the transportation sector consumes well over half the oil used statewide, and passenger cars and trucks emit 20 to 30 percent of the state's global warming pollution. Vehicles therefore are a central focus of the immediate action required to reduce global warming.

The state of California's regulatory approach involves phasing in limits to average global warming emissions from passenger cars and trucks beginning in 2009 and culminating in 2016. This regulation is often called "Pavley," after its author, Assemblywoman Fran Pavley.

The federal government's approach provides tax incentives to buyers of hybrid vehicles, which emit significantly lower amounts of global warming pollution than most conventional vehicles. However, the hybrid incentive affects only a small portion of the vehicle market.

A third approach that could be used to enhance or replace existing regulations would be a feebates program. A feebates program creates a schedule of both fees and rebates that reflects the amount of global warming pollution that different vehicles emit. Purchasers of new vehicles that emit larger amounts of heat-trapping emissions pay a one-time surcharge at the point of purchase. These surcharges are then used to provide rebates to buyers of new vehicles that emit less pollution. A feebates program has several advantages over other approaches:

Market-oriented: A feebates program recognizes the power of price signals to change consumer behavior. That is, incentives spur consumers to purchase—and manufactures to produce—cleaner vehicles.

Self-financing: A feebates program can be designed so that the surcharges collected equal the rebates paid.

Affects entire market: A feebates program applies to all new vehicles—clean and dirty—spurring a transformation of the entire market.

Consumer choice: A feebates program can be designed so that consumers have the option to buy vehicles that carry no surcharge in each vehicle class, such as cars, trucks, sport utility vehicles (SUVs), and minivans.

This study explores the economic impacts on consumers and manufacturers of the existing Pavley regulation and a feebates program by analyzing four alternative scenarios, using information from 2002 as the base year.

Our findings show that a feebates program is an effective strategy to reduce global warming pollution by up to 25% more than Pavley alone. Also, under a feebates programs consumers will save thousands of dollars and retailers will see their revenue rise by as much as 6%.

Our Approach

As part of the Pavley regulation, the California Air Resources Board (CARB) reviewed 39 emission-reducing technologies. CARB then used modeling to determine how much pollution these technologies would actually eliminate, as well as the cost of different technology packages. In our study, we created marginal cost curves for these technology packages to determine the cost of reducing various amounts of global warming pollution.

In addition to this supply-side analysis, we also modeled how demand for specific vehicles depends on the value consumers place on the attributes of those vehicles, such as performance, size, and fuel economy. To estimate the value to consumers of reducing vehicles' heat-trapping emissions, we used California market data to revise a model developed by the University of Michigan Transportation Research Institute's (UMTRI) Automotive Analysis Division.

The Feebates Program

We also needed to define a hypothetical feebates program. As noted, such a program entails charging buyers of vehicles that emit large amounts of global warming pollution one-time fees, which are used to provide rebates to buyers of vehicles with lower emissions.

The graph below shows one potential feebates schedule. The horizontal axis measures the amount of global warming pollution that a vehicle produces in grams of carbon dioxide–equivalent per mile. The vertical axis measures surcharges (positive values) and rebates (negative values). The example schedule preserves consumer choice by incorporating a "zero-band": a range of emissions levels that do not require surcharges on vehicles that fall within the range.

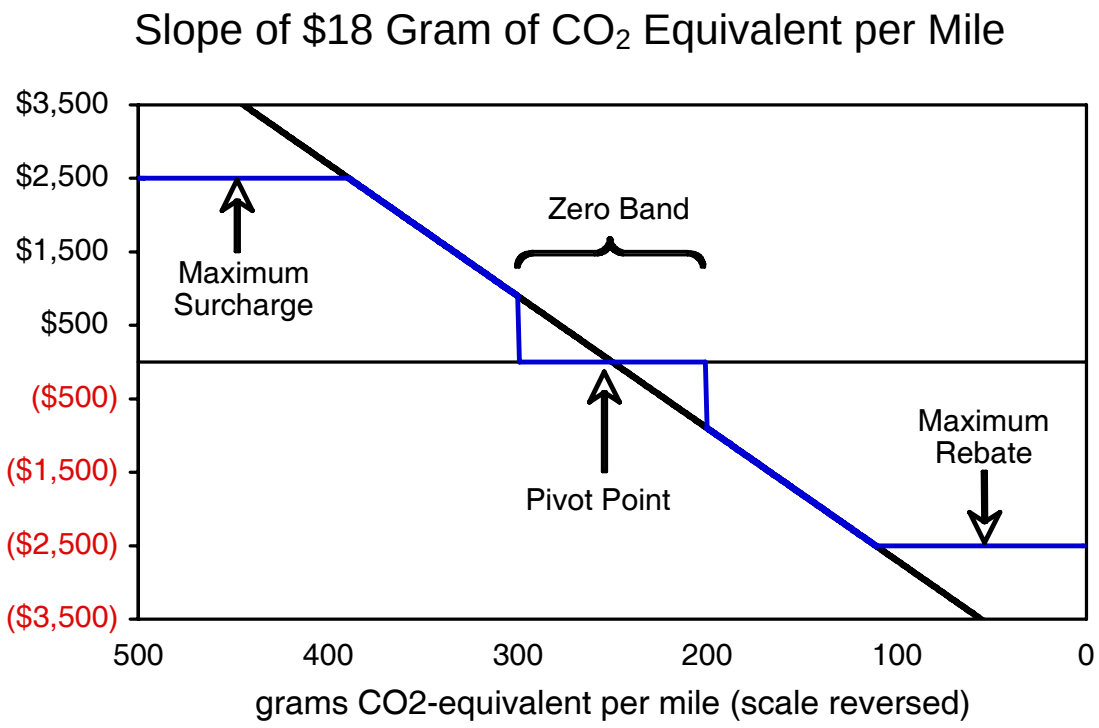
A feebates program is usually defined according to the change in surcharge or rebate for each additional amount of pollution a vehicle produces. In Figure 1, this amount is $18 per gram of CO_2-equivalent emissions per mile. This is known as the slope of the feebates schedule. The pivot point, another element defining a program, is the point on the schedule where it crosses the horizontal (emissions) axis.

For the program shown in **Figure** 1, the pivot point is 250 grams per mile. Thus a vehicle that produces 350 grams per mile would incur a surcharge of $1,800. As the slope of a feebates program increases, the incentive to reduce emissions also increases. For example, if the slope were $25 per gram per mile, the surcharge for that vehicle would be $2,500.

The feebates program in our study has three constraints:

- Surcharges and rebates are limited to $2,500.
- The program is self-financing.
- The zero-band—where vehicles neither incur a surcharge nor earn a rebate—includes 20–25 percent of the fleet.

Figure 1: Hypothetical Feebates Program with



The Four Scenarios

We compared four different scenarios with the 2002 baseline:

Pavley alone: Each automaker meets its Pavley target.

Feebates alone ($18 per gram of CO_2-equivalent per mile): The feebates program has an $18 slope.

Feebates alone ($36 per gram of CO_2-equivalent per mile): The feebates program has a $36 slope. (This program is designed to achieve the same overall emission reductions as Pavley alone.)

Pavley plus feebates ($18 per gram of CO_2-equivalent per mile): Automakers meet their Pavley targets, and vehicles are subject to a feebates program with an $18 slope.

Under the Pavley scenario, we assume that each automaker installs technologies on its vehicles to exactly meet the average fleet wide emissions required in 2016, at the lowest-

possible cost. Under a feebates program, we assume that automakers install emission-reducing technologies until the cost of those technologies, plus the feebates, equals the value to consumers (marginal cost equals marginal revenue). That is, the prospect of lower fees encourages manufacturers of dirtier vehicles to make them cleaner, while the prospect of higher rebates encourages manufacturers of cleaner vehicles to make them even cleaner.

We then simulated the impacts of these scenarios on the light vehicle market in California. We assumed that the cost of the additional technologies designed to reduce emissions, lower fees, and raise rebates changes the cost of the vehicles. This, in turn, changes consumer demand for the vehicles and retailers' revenue, according to UMTRI's market model. We then evaluated the impact of the four scenarios on emission reductions, retailers, and consumers—including lifetime savings to consumers from more fuel-efficient and thus cleaner vehicles.

The model used a fuel price of $1.74 per gallon—the average in 2002—and a 5 percent discount rate, to estimate the present value of future savings to consumers. However, the U.S. Department of Energy reported an average retail gasoline price of $3.30 in California in April 2007. If our study had used today's higher fuel prices, it would have found significantly higher demand for more fuel-efficient vehicles. Such a market shift would reduce emissions even further, and improve lifetime savings to consumers.

Results

Reductions in Emissions

Our study shows that a feebates program is effective in reducing global warming pollution from vehicles.

The amount of such emission cuts depends on the slope of the feebates curve. Thus the reductions ranged from a market average of 17 percent under the modest feebates program ($18 per grams of CO_2-equivalent per mile) to 33 percent under Pavley and feebates combined (see
Table 1). In fact:

The combination of Pavley plus feebates achieves a 33% reduction in global warming pollution—25 percent more than Pavley alone.

Table 1: Emissions Reductions under Different Scenarios and Their Source

	Fleet-wide Emissions (g CO^2-eq/mi)	Reduction in Emissions (g CO^2-eq/mi)	Total %Change in Emissions	% Change in Emissions from Technology	% Change in Emissions from Market Shift
Base	352				
Pavley Only	258	-94	-26.7%	101.0%	-1.0%
Feebates Only ($18 slope)	292	-60	-17.1%	98.2%	1.8%
Feebates Only ($36 slope)	258	-94	-26.7%	98.8%	1.2%
Pavley plus Feebates ($18)	235	-117	-33.3%	100.1%	-0.1%

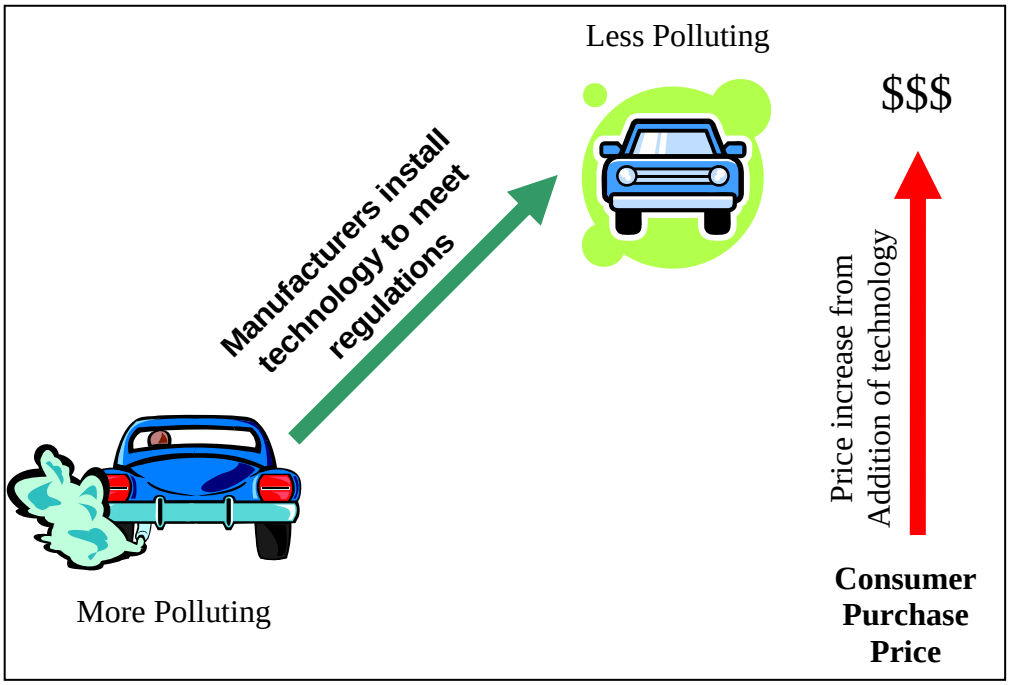
Emission reductions can stem from the addition of technologies by automakers, or from a market shift that occurs as feebates spur consumers to buy cleaner vehicles. The two right-hand columns in

Table 1 show that at full implementation nearly all the emissions reductions in our scenarios come from the addition of technologies, and not from a significant change in the types of vehicles consumers buy.

Under closer examination, the market in the two scenarios with Pavley regulations actually shifts a small fraction of consumers' purchases (<2%) toward vehicles with higher emissions after new technologies have been applied. This results in a change of emissions from technology greater than 100 percent. However, in the feebates-only scenarios, the market shifts toward cleaner vehicles.

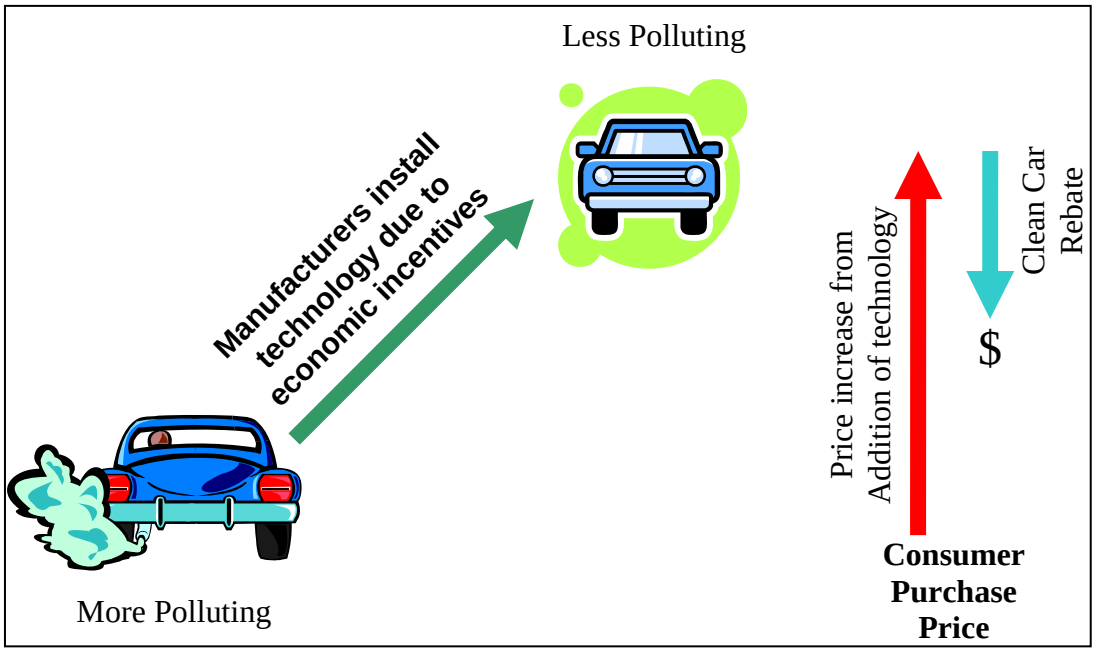
This is one advantage of a feebates program. Under a regulation scenario (Pavley Only) in our model, vehicle manufacturers install technologies on all vehicles, clean and dirty, to reduce global warming pollution to the required level. The prices consumers pay to purchase the vehicles rise, because of the cost of the additional technologies (Figure 2).

Figure 2: Effect of Regulations on Emissions and Consumer Purchase Prices



However, under a feebates scenario in our model, manufacturers install technologies on all vehicles, clean and dirty, to reduce emissions *and* to reduce surcharges and increase rebates. Rebates compensate consumers for some of the costs of the technologies, making clean vehicles less expensive (Figure 3). Surcharges on high-polluting vehicles increase the cost of those vehicles even further. This accounts for the small market shift.

Figure 3: Effect of Feebates Program on Emissions and Consumer Purchases



More importantly:

Although emission-reducing technologies raise the cost of vehicles, a feebates program makes cleaner vehicles more affordable to consumers.

1.1.1 Impact on Consumers

The price of vehicles, including feebates, is just one aspect of how a feebates policy would affect consumers' pocketbooks. Some technologies that reduce global warming pollution also improve the efficiency of vehicles, thereby reducing fuel costs over their lifetime. Table 2 combines retail prices and lifetime fuel savings to show the impact on consumers over the lifetime of their vehicles.

Under all scenarios and all vehicle types, consumers save up to $2,544 over the lifetime of their vehicles. The most cost savings in the Market category is realized under Feebates alone with $36 g Per g/mi.

Table 2: Lifetime Consumer Savings under Each Scenario and Vehicle Type

Scenario		Car	Van	Pickup	SUV	Market
Pavley Alone	Lifetime Fuel Cost	($2,432)	($3,090)	($3,712)	($3,786)	($2,928)
	Retail Price	$1,253	$989	$1,367	$1,242	$1,275
	Total Change	($1,178)	($2,100)	($2,344)	($2,544)	($1,652)
Feebates Alone ($18 g per g/mi)	Lifetime Fuel Cost	($1,428)	($2,117)	($2,456)	($2,429)	($1,892)
	Retail Price	$536	$743	$959	$920	$658
	Net Feebates	($652)	$172	$1,187	$928	$0
	Total Change	($1,544)	($1,203)	($311)	($581)	($1,234)
Feebates Alone ($36 g per g/mi)	Lifetime Fuel Cost	($2,281)	($3,254)	($3,812)	($3,817)	($2,957)
	Retail Price	$979	$1,270	$1,633	$1,516	$1,164
	Net Feebates	($877)	$235	$1,444	$1,353	$0
	Total Change	($2,179)	($1,748)	($735)	($948)	($1,793)
Pavley plus Feebates ($18 g per g/mi)	Lifetime Fuel Cost	($2,904)	($3,949)	($4,817)	($4,770)	($3,670)
	Retail Price	$2,618	$2,726	$3,514	$3,227	$2,866
	Net Feebates	($541)	$280	$966	$673	$0
	Total Change	($287)	($1,222)	($1,303)	($1,543)	($804)

1.1.2 Impact on Retailers

We also examined the impact of the different scenarios on retailers. Although sales decline no more than 4 percent because of higher costs stemming from additional technology:

Retailers' revenue rises under all scenarios, and the feebates program boosts the sale of cleaner vehicles.

Table 3: Retailer Revenue under Different Scenarios

	Retailers' Revenue ($ Billions)	Revenue Change from Base ($ Billions)	% Change Revenue from Base
Base	$52.2		
Pavley Only	$54.9	$2.8	5.3%
Feebates Only ($18 slope)	$53.2	$1.1	2.1%
Feebates Only ($36 slope)	$54.1	$1.9	3.7%
Pavley plus Feebates ($18)	$55.7	$3.5	6.7%

Overall, while policy designers can adjust a feebates program to achieve different reductions in global warming pollution:

We found that a feebates program is an effective strategy to reduce global warming pollution while benefiting both consumers and retailers. The combination of the existing Pavley regulation with a modest feebates program would achieve a 25 percent greater drop in emissions than a regulatory system alone. Feebates create incentives to both manufacturers and consumers to produce and purchase cleaner vehicles. Furthermore, consumers can save thousands of dollars over the lifetime of their vehicles because of lower operating costs. Also, retailers' revenues can rise more than 6 percent when feebates are combined with the existing Pavley regulation.