

# Impact of Federal Incentives on Hybrid Electric Vehicle Adoption



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## Abstract

Hybrid electric vehicles (HEVs) have enjoyed continual increases in market share of vehicle sales since their introduction in 2000. A number of monetary incentives have been offered by the federal government to help boost sales of hybrid vehicles. The goal of this study is to assess the impact of these incentives on hybrid sales using econometric analysis from 2000 to 2010 as well as the resultant gasoline savings and emissions reductions.

## Data

Monthly sales data was collected by vehicle model over the past decade from the “Hybrid Market Dashboard” on hybridcars.com and the Data Center archives from autonews.com.

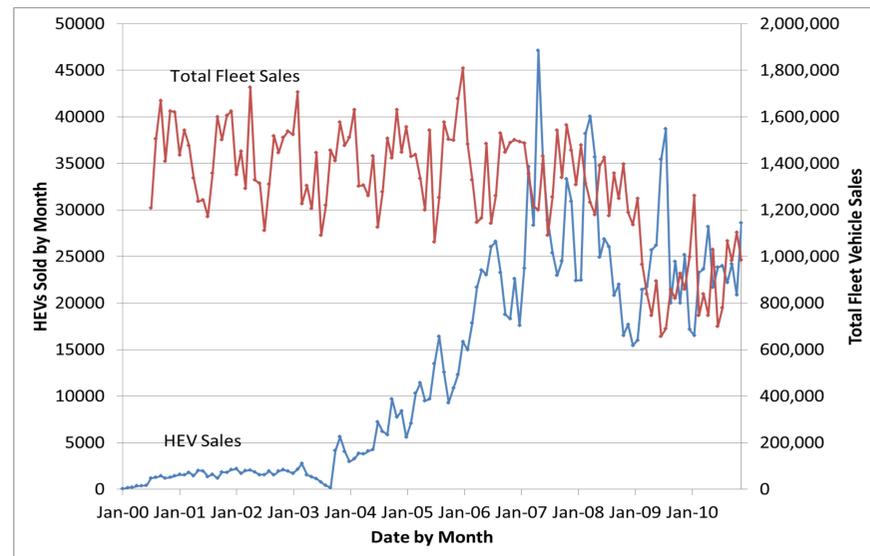


Figure 1: Monthly HEV Sales versus Total Fleet Sales  
Starting in 2004, hybrid sales drastically increased while total fleet sales stayed relatively constant. The economic downturn in 2008 coupled with high gas prices resulted in a severe decrease in overall vehicle sales, while hybrid sales decreased as well, their magnitude of decrease was not as large. Market share of sales has increased to 2.5-3% of total fleet sales in the past decade.

Federal incentives for HEVs included:

- HR 1308 Sec 319 Working Families Tax Relief Act of 2004: gave a flat \$2000 deduction from taxable income. Expired at end of 2005.

- Energy Policy Act of 2005, tax credit for all HEV purchases depending on fuel economy of vehicle. Expired at end of 2010.

## Methodology

An econometric regression model was estimated, setting HEV sales as the dependent variable. The model selection for the explanatory variables excluded the average manufacturer’s suggested retail price of HEVs as well as number of different models available based on statistical significance. The model inputs are shown in Table 1.

Table 1: Input Summary Statistics

Variable	Observations	Mean	Std. Dev.	Min	Max
HEV Sales	132	13,500	11,700	51	47,100
Total Fleet Sales	132	1,290,000	255,000	657,000	1,810,000
Gas Price	132	2.39	0.611	1.35	4.14
GDP (billions of \$)	132	12,500	1,700	9710	14,900

While tests for heteroskedasticity were barely not significant at the 10% level, robust errors were still used. Endogeneity has not yet been tested for in the model. In the regression model, the log-log form was used in order to identify elasticities.

## Results

Table 2: Summary of Regression Results

	Coefficient	Robust Std. Err.	t	p-val
Time Ind	-0.0148***	0.00512	-2.9	0.004
log(Total Fleet Sales)	0.69*	0.375	1.84	0.069
log(Gas Price)	67.7*	35.8	1.89	0.061
log(GDP)	82.5**	36.1	2.29	0.024
log(GDP*Gas Price)	-68.4*	35.9	-1.91	0.059
Federal Incentive Ind	0.401	0.25	1.61	0.111
Cash For Clunkers Ind	0.582***	0.104	5.59	0.000
Constant	-125***	18.3	-6.84	0.000

\*p<.10, \*\*p<.05, \*\*\*p<.01

While the variable of interest, the federal incentives indicator, was barely insignificant at the 10% level with a p-value of .111, it was still left in the analysis, resulting a 40% increase in sales of hybrids when present.

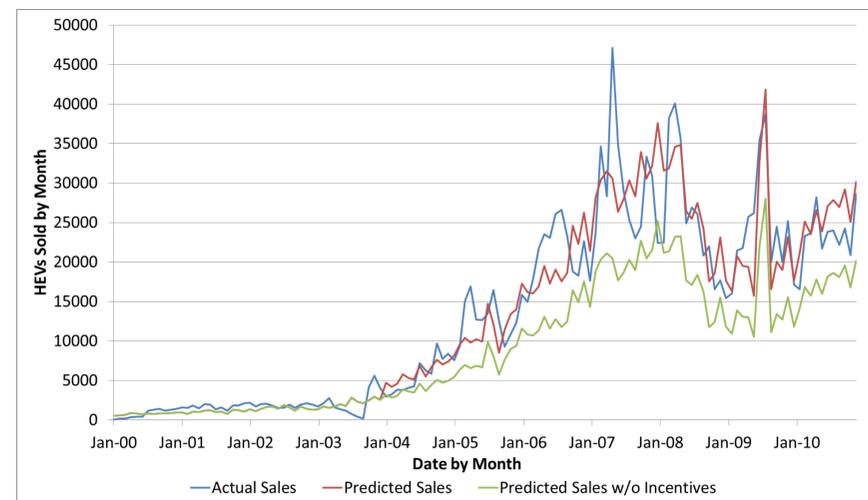


Figure 2: Monthly HEV Sales, Predicted with and without Federal Incentives

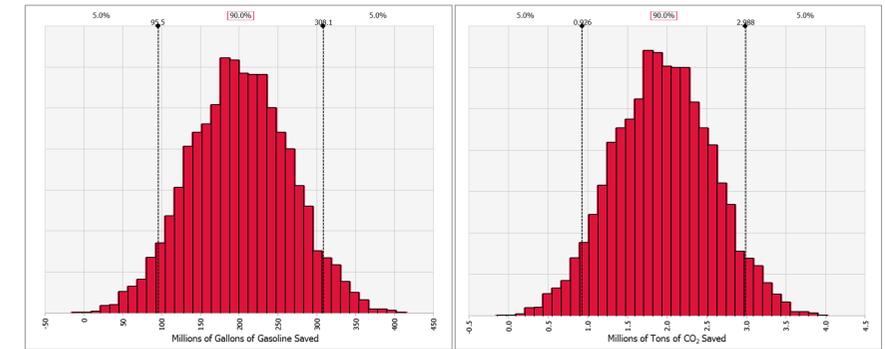


Figure 3: PDFs of Gasoline Saved and Tons of CO<sub>2</sub> Emissions Reduction  
Assuming a 100% hybrid replacement of ICE vehicles as a result of added incentives, the regression model predicts approximately 500,000 vehicle switch from ICE to HEV. The results of this vehicle use over the past decade yields approximately 200 million gallons of gasoline saved and 2 million tons of CO<sub>2</sub> reduction.

The hybrid replacement rate represents the percentage of additional HEVs (resulting from the incentives) that replace an ICE vehicle that would otherwise have been purchased by a consumer. Decreased replacement rate represents fewer ICE vehicles replaced by HEVs and a, increase in total vehicle demand. If the assumption of 100% hybrid replacement rate is relaxed, the emissions model finds that when 22% of the increased sales in hybrid represent increased demand rather than replacing demand for ICE, the breakeven point is reached.

While the regression model shows an increase in sales of hybrid vehicles, actual emission reductions as an indirect result of federal incentives requires further study into the demand increase in total vehicles.

## Future Work

Further potential research includes paneling data across different car models and regions. Data at this resolution allows for analysis of specific incentive amounts for different vehicle models as well as regional differences in sales. In addition, state incentives can be incorporated into the model which will allow the regression model to distinguish differences in different types of incentives (ie sales tax rebates versus income tax credits).

Another study would involve an extension of this model to PHEVs and EVs. This is particularly relevant to President Obama’s stated goal of putting 1 million PHEVs and EVs on the road by 2015 and the incentives that will be required for this level of vehicle adoption to occur.