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Analysis of Manufacturer Plug-In Electric Vehicle Incentives

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Summary

Vehicle manufacturers offer incentives in an attempt to encourage consumers to purchase or lease new vehicles. Similarly federal and local governments offer incentives to help build and maintain a market for plug-in electric vehicles (1). This paper analyzes manufacturer cash rebates and special lease offers and presents a comparison of plug-in electric vehicle incentives by manufacturer, technology, geographic area, and time period. How these manufacturer plug-in electric vehicle incentives relate to vehicle sales as well as state and federal government incentives is also investigated.

Keywords: Incentive, EREV (extended range electric vehicle), EV (electric vehicle)

1 INTRODUCTION

Vehicle manufacturers offer a variety of incentives to in an attempt encourage consumers to purchase or lease new vehicles. These incentives usually appear in the form of cash rebates, low interest financing, and special lease offers. One goal of this analysis is to provide a general understanding of the scale and allocation of manufacturer plug-in electric vehicle (PEV) incentives. In addition the compiled data and analysis could provide insight to several key questions. For example, what role have manufacturer incentives played in either stimulating or maintaining PEV sales? How do manufacturer, state and federal government PEV incentives compare by state, by manufacturer, and by technology?

Currently, PEVs are generally more expensive than gasoline, diesel, or hybrid counterparts, and the high up-front purchase cost has long been considered a major barrier for market adoption of PEVs [2-4]. Incentives such as rebates or tax credits and other financial products are provided by federal and local government agencies, local utilities, automotive manufacturers, and other third parties that aim to bring down the purchase cost for PEV buyers thereby decreasing consumer risk associated with technology uncertainty. Many studies have examined the impacts of purchase incentive and/or tax credits on PEV adoption based on either registration data or survey results. All these studies recognized either purchase rebate or tax credits as a very effective promotion action and having a positive effect on PEV adoption rates [3-16].

BEV sales in Georgia fell over 80% from June 2015, the last month state tax credit ($5,000) was in effect, to August (2). To our best knowledge, only one study analyzed the impact of manufacturer rebates on plug-in hybrid electric vehicle (PHEV) adoption in (3). Based on survey results this study underscored the importance of tax incentives and manufacturer rebates for promoting early PHEV adoption, and suggested

that raising consumer awareness of these up-front incentives (e.g., through advertising or public service announcements) could have a greater impact than raising awareness of future fuel savings.

Few studies differentiate between BEVs and PHEVs in their analysis. Many consumers view BEVs and PHEVs very differently and, therefore, believe rebates or credits have differing levels of effectiveness at promoting increased market adoption of these two vehicle types. This shortcoming is highlighted by Vergis and Chen (4), noting that several states offer different rebates or tax credits for PHEVs and/or BEVs. For example, New Jersey offers a full sales tax exemption (7%) for BEVs, but no incentives for PHEVs. Effective evaluation needs to analyze PHEVs and BEVs separately, rather than treating them as a single vehicle type (PEVs).

Moreover, other social-economic factors could also impact the effectiveness of incentives. One study (5) found that incentives had a smaller impact on Tesla buyers, implying that income may play a role. Hardman and Tal (6) also found in their survey analysis that financial purchase incentives are not important in consumer's decision to adopt a Tesla Model S.

Understanding manufacturer PEV incentives and their impact on sales could be critical to drawing conclusions on how to stimulate market acceptance of these advanced vehicles. When doing so, one must consider the manufacturer incentives in the context of state and federal government incentives, and in comparison to hybrid electric vehicles (HEV) and conventional (CONV) vehicles. Therefore, the incentives and how they vary by geographic area and vehicle technology type must be investigated in detail.

2 APPROACH

The approach to understanding PEV incentives and their impact on sales is multi-prong, consisting of two major steps.

1. **Vehicle Characterization:** Based on current PEV attributes determine the relevant population of comparable HEV and CONV vehicles.
2. **Application and Impact of Manufacturer Incentives – Current and Historical:** Attempt to characterize the magnitude and distribution of manufacturer PEV incentives by comparing manufacturer, state and federal government PEV incentives by manufacturer, vehicle technology type, and geographic area.

3 VEHICLE CHARACTERIZATION

Manufacturer incentive data was collected from several sources to provide a characterization of incentives over time as well as a detailed view of current incentives by model across the U.S. 127 vehicle models from 22 manufacturers over 12 different size class / segments and luxury/non-luxury classifications were chosen based on those models which are comparable to currently available PEVs. Luxury vehicles were defined as those that provide desirable features beyond necessity at a premium price. These comparable models are vehicles that would be in direct competition for sales with PEV models based on the vehicle attributes listed in Table 1.

Table 1: Example of PEVs and comparable vehicles and their attributes [19-21]

Make/Model	Powertrain	Base MSRP ($) [a]	Combined MPG [b]	Interior Volume (cu.ft.) [b]	Luggage Volume (cu.ft.) [b]	Power To Weight (hp/lb) [c]	Combined Range (miles) [b]
2015 Nissan LEAF	BEV	29,010	114*	92	24	0.033	84
2015 Nissan Sentra	CONV	16,480	33	96	15	0.045	435
2015 Chevrolet Volt	PHEV	35,170	98*	90	18	0.038	380
2015 Chevrolet Cruze	CONV	16,995	27	94	16	0.045	421
2015 Toyota Prius	HEV	24,200	50	94	22	0.044	595
2015 Toyota Prius Plug-In	PHEV	29,990	95*	94	22	0.042	540

a MSRP Data Compiled from Vehicle Manufacturer Websites.
b MPG, Interior/ Luggage Volume, and Range from www.fueleconomy.gov
c Peak vehicle system power and curb weight from www.edmunds.com
* MPGe

Based on the data in Table 1 the aforementioned vehicles have similar interior and cargo volume, power to weight ratio, and (with the exception of the LEAF) combined range. The major difference evident in price, with roughly $15,000 separating CONV from PEV for the sample vehicles listed in Table 1.

4 Application and Impact of OEM Incentives

This section attempts to characterize the magnitude and distribution of manufacturer PEV incentives by comparing incentives over time, by manufacturer and technology type, as well as against state and federal government incentives.

4.1 Current Incentives

To further investigate PEV incentives at a regional or state level and to capture special lease offers, it was necessary to compile incentives directly from the vehicle manufacturers' websites. With no historic data available, analysis was restricted to current offers for August 2015, with most of the offers expiring after the Labor Day weekend holiday, midnight 9/7/2015. In order to determine if incentives were consistent within each state an investigation was conducted of multiple zip codes per state with incentives compiled for five PEV models for a 3 month period prior to the study. Incentives were found to be consistent over the selected zip codes in each state, therefore cash rebate and lease offers were captured for PEV and comparable HEV and CONV vehicles for one zip code in each state. Figure 1 and Figure 3 depict the average cash rebate and lease offers, respectively, as a percentage of the manufacturer's suggested retail price (MSRP).

4.1.1 Cash Rebate Offers

Cash rebates, a consumer discount off the vehicle purchase price, are the most popular incentive since they enable the consumer to potentially afford a more expensive vehicle and may also help to overcome the difference in price between PEVs and other less expensive vehicle technology types. This price differential has long been considered as a major barrier for market adoption of PEVs [2-4]. To better understand the magnitude of the cash rebates free from the distortion created by the range of MSRPs, the cash rebate is divided by the base MSRP creating a normalized cash rebate metric as a percentage of the vehicle MSRP.

As shown in Figure 1 average manufacturer cash rebate offers vary significantly by vehicle technology type, manufacturer, and location. These compiled offers appear to point to several discount structures with differing levels of discrimination by vehicle technology:

- No discrimination as in the case of BMW and Lincoln where the offers are almost identical for HEVs and CONVs.
- Marginal discrimination where the total variance between vehicle technology types is small but one is favored over the others.
- Clear discrimination where one vehicle technology type is clearly incentivized over the others.

The offers compiled are only a snapshot of the HEV and CONV vehicles offered by each manufacturer. Further research on offers over time would allow for a more thorough analysis of these hypothetical discount structures. Figure 1 also depicts the range of cash rebate offers across the U.S. with error bars for each manufacturer and technology type. These ranges illustrate that manufacturers may target certain regions or states with rebate offers. These localized offers could represent an effort to stimulate or maintain sales in competitive areas, resulting in higher-than-average incentives. Areas represented by lower-than-average incentives could be an indication that incentives are not necessary to maintain a desired level of sales.

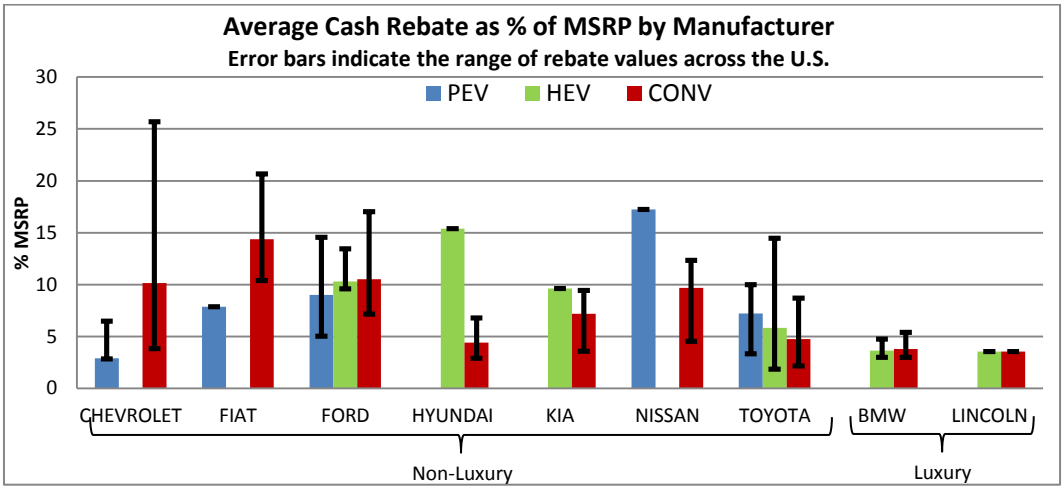

Figure 1: Average cash rebate as a percentage of MSRP by manufacturer (7)

4.1.2 Lease Offers

Manufacturer lease offers are not as straightforward as the cash rebate offers. Manufacturers create lease offers based on a specific vehicle trim level and options typically above the base model. These "lease MSRPs" were compiled along with the required down payment, monthly payment, and lease term. As there is some significant variation in the lease MSRP and lease term by technology type and manufacturer, a lease offer metric of first year lease cost is used. This metric adds the monthly payment multiplied by twelve with the down payment and then divides by the lease MSRP. To better understand the magnitude of the lease offers and how they differ by manufacturer, Figure 2 shows the first year lease cost in dollars. The non-luxury vehicles appear to have a relatively uniform first year lease cost at approximately five thousand dollars. The luxury PEV first year lease cost ranges from marginally higher than the non-luxury vehicles to three to four times the cost of a non-luxury vehicle (see Tesla and Porsche in Figure 2).

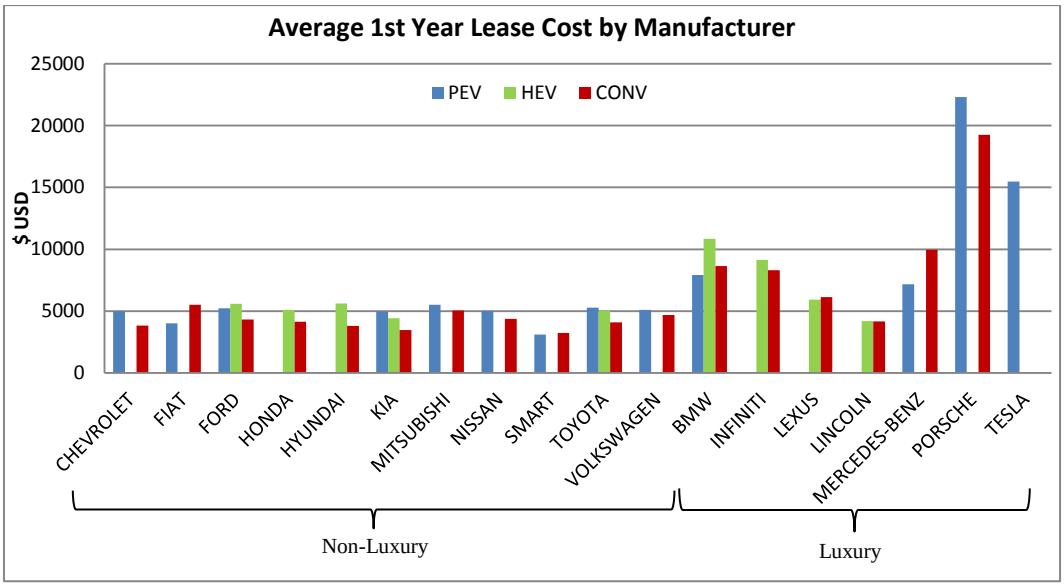

Figure 2: Average first-year lease cost by manufacturer (7)

Figure 3 shows the average first year lease cost as a percentage of MSRP by PEV model and lease term, with error bars indicating the range of first year lease cost across the U.S. The error bars show that for some models the first year lease cost can vary by up to 5% of the MSRP.

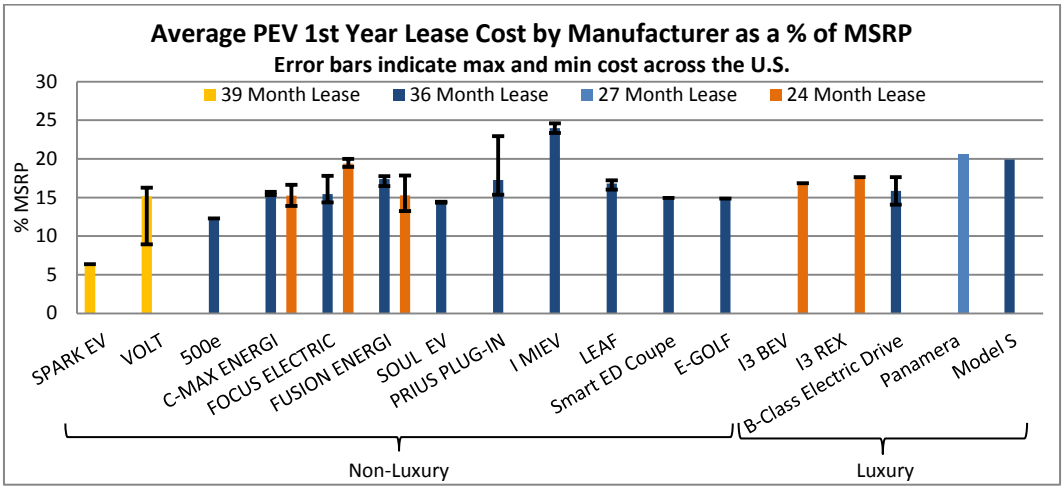

Figure 3: Average PEV first-year lease cost by model as a percentage of MSRP (7)

4.1.3 Additional Government PEV Incentives

In addition to understanding manufacturer PEV incentives and their impact on sales, it is also important to consider the manufacturer incentives in the context of state and federal government incentives, and in comparison to HEV and CONV vehicles.

State-Level Incentives. Manufacturer PEV incentives are relatively uniform across the U.S.; conversely state incentives for PEVs vary across the country and exist in several forms. As shown in Table 2, the most prevalent forms of incentives issued at the state level are tax credits and rebates, and these are typically greater than the cash rebate incentives offered by the manufacturer.

Table 2: State consumer purchase incentives for PEVs (8)

Current State Consumer Purchase Incentives for Plug-in Electric Vehicles (Dollars)						
State	Tax Credits & Rebates	Sales Tax Exemption	Reduced License and/or UseTax	Reduced Registration Fee	Title Tax Exemption	Total
AZ			$944			$944
CA	$2,500					$2,500
CO	$6,000					$6,000
CT	$3,000		$21			$3,021
DC				$36	$2,800	$2,836
IL			$83			$83
LA	$3,000					$3,000
MA	$2,500					$2,500
MD	$2,500					$2,500
NJ		$2,800				$2,800
PA	$2,000					$2,000
SC	$2,000					$2,000
TN	$2,500					$2,500
UT	$1,500					$1,500

Notes: When applicable, the vehicle was assumed to have a base price of $40,000, a weight of 3,500 pounds, and a 20 kWh battery.
Only the incentives for individuals listed in the columns above were considered. Other State incentives, such as high-occupany vehicle lane expemptions and reduced toll rates are not considered. Also, incentives on the charging equipment, electricity discounts, etc. are not considered.
Sources: Alternative Fuels Data Center accessed July 20, 2015. http://www.afdc.energy.gov

Federal-Level Incentives. The federal incentive program provides a credit for qualified PEVs, including passenger vehicles and light trucks acquired after December 31, 2009. The credit is equal to $2,500 plus $417 for a battery with 5kWh capacity and an additional $417 for each kWh of battery capacity greater than

5 kWh. The total amount of the credit allowed for a vehicle is limited to $7,500. The credit begins to phase out for a manufacturer's vehicles when at least 200,000 qualifying vehicles have been sold (9). Based on this program qualifying vehicles with a battery pack greater than or equal to 16 kWh would receive the full $7,500 credit. The Toyota Prius Plug-In with its 4.4 kWh battery pack qualifies for the minimum credit of $2,500, and the Ford Fusion and C-Max Energi with 7.6 kWh batteries qualify for just over $4,000.

4.1.4 Average Incentivized MSRP by State

The goal of all these efforts – manufacturer, state, and federal government incentives – is to make PEVs more cost competitive with HEV and CONV technologies. Figure 4 shows the average incentivized MSRP by state, broken down by powertrain type. The solid lines depict the total incentivized price including manufacturer, state, and federal government incentives. The dashed lines represent the vehicle MSRP with the manufacturer cash rebate deducted. The dotted line is the base MSRP with no incentives applied. Figure 4 shows that the incentivized price of PEVs is comparable with the incentivized price of HEVs, and that with significant state government discounts, such as in Colorado, the incentivized PEV price becomes comparable with a non-incentivized CONV MSRP. Also evident from Figure 4 is that the manufacturer incentives for HEVs and PEVs are of similar magnitude: 9.3% of MSRP for PEVs and 9.6% for HEVs. If incentives were compiled in this manner over time, further analysis could show if this 9% discount factor remains consistent. Figure 4 also shows the disparity between the magnitude of manufacturer incentive discounts (just over $2,800 on average) and the federal government incentive (just over $6,500 on average). At over twice the average manufacturer PEV cash rebate this could be an indication that the federal government has more of an investment in stimulating PEV sales than manufacturers.

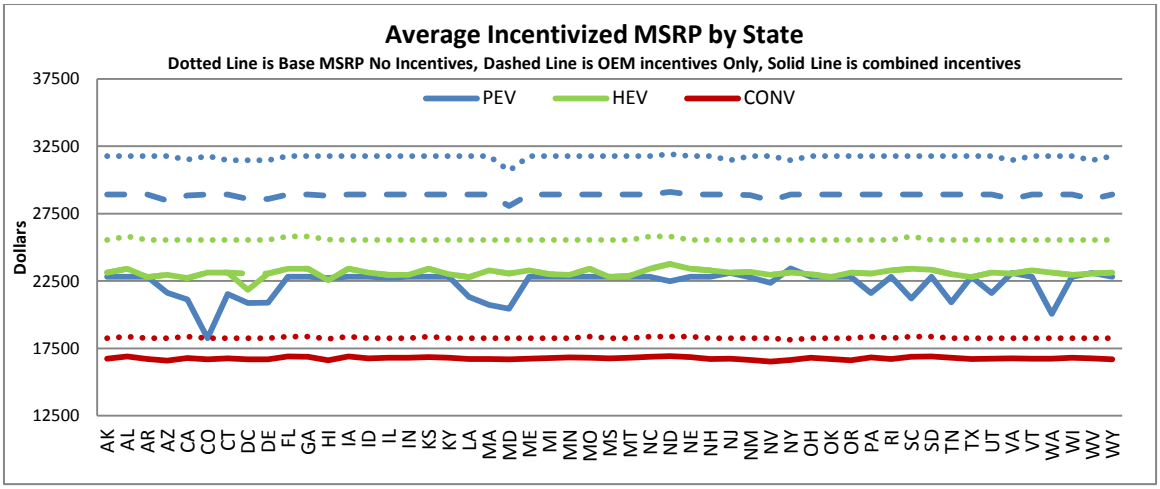

Figure 4: Average incentivized MSRP by state (7) (8)

4.1.5 What Trends are Apparent in PEV Manufacturer Cash Rebate Incentives When Comparing ZEV and Non-ZEV States?

Figure 5 shows, by state, the average PEV Base MSRP, represented by the dotted line, and Incentivized MSRP, represented by the dashed line. ZEV States are grouped on the left of the x-axis and non-ZEV states on the right. The difference between the dotted and dashed line represents the average PEV manufacturer cash rebate. On the whole there is no significant difference in PEV cash rebates between states with the range for the Base MSRP series coming in at just over $600, and the Incentivized MSRP range just over $750. The difference in the Base MSRP is due to limited availability of PEV models such as the Fiat 500e and Chevrolet Spark EV. The chart does show increased cash rebate incentive offers for California and Maryland, with the latter having the lowest cost PEV Incentivized MSRP in the country. A two sample t-test was conducted comparing incentivized MSRPs between ZEV and non-ZEV states. There was no significant difference in the values for ZEV with a mean of $28854 and non-ZEV with a mean $28864 and a t-value of 0.162. These results suggest that manufacturers are not targeting ZEV states with special cash rebate offers. It is also possible that trends in manufacturer cash rebate incentives are not apparent when averaging over all models available within each state.

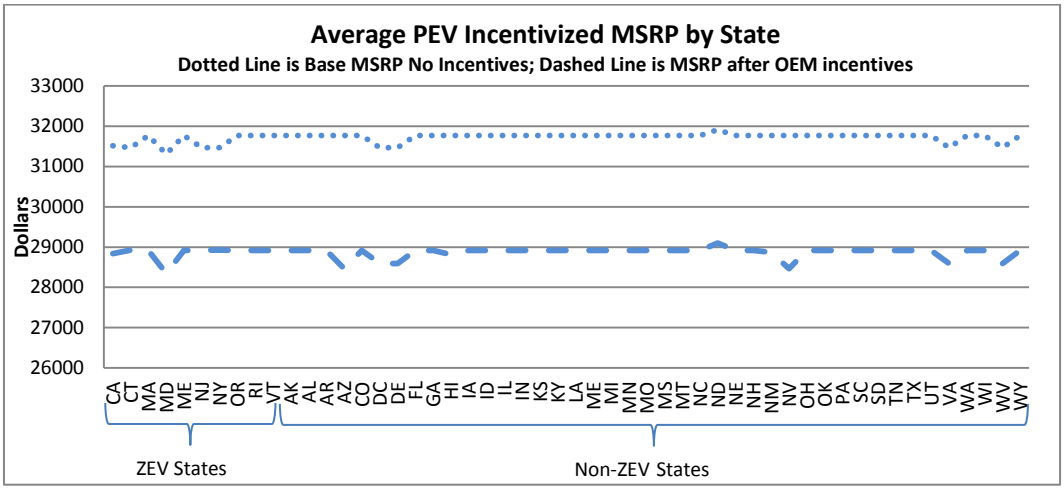

Figure 5: Average PEV incentivized MSRP by state (7) (8)

To address the last possibility Figure 6 depicts PEV Manufacturer cash rebates offers for ZEV states at the model level. Similar to Figure 5 Maryland has the highest overall discounts as shown as a percentage of MSRP, followed closely by California. The difference between the two is mainly due to the Prius Plug-in having double the incentive in Maryland than that of California. The only other model level difference is the Fusion Energi incentive for California is 1.5% greater than the rest of the ZEV states. The remaining PEV models have consistent incentives across the ZEV states.

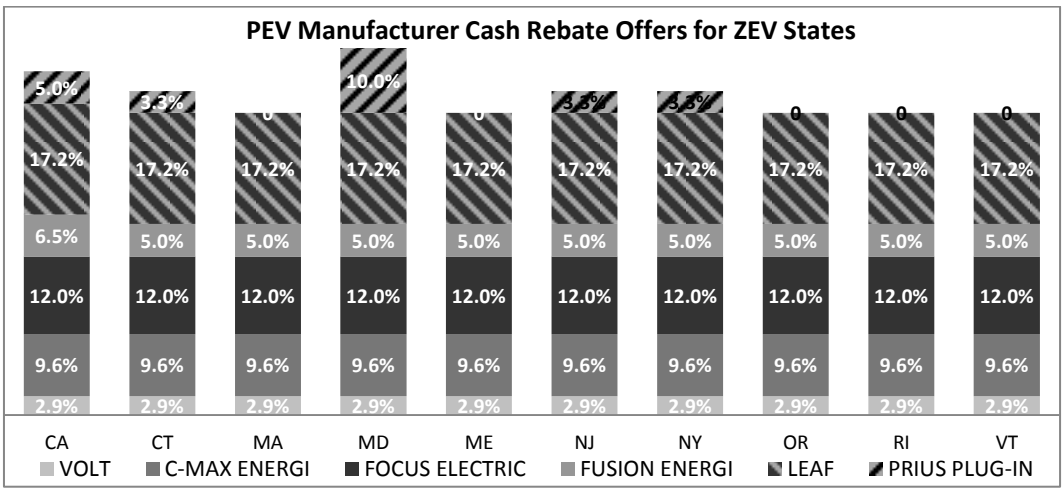

Figure 6: August 2015 PEV manufacturer cash rebate offers for ZEV states

4.2 Cash Rebate Incentives over Time

To better understand how manufacturers time their offers, the cash rebate offers were broken down by model year and manufacturer over time. These incentives were compiled on a monthly basis for a period of one year beginning in August 2014 using Automotive News monthly consumer incentives summaries, which contain a national average of cash rebate offers on vehicles (10). Like in section 4.1.1, the cash rebate is divided by the MSRP creating a normalized cash rebate metric as a percentage of the vehicle MSRP.

Figure 7 shows that the majority of the cash rebate offers tend to hover around 5% of MSRP for most of the year. The increase seen in the summer months, May through August, could be attributed to summer sales promotions, as well as model year close out and introduction. In most months, Chevrolet and Nissan have the lowest cash rebate in terms of MSRP percentage, which coincides with the fact that their products – Volt and LEAF, respectively – are the two top best-sellers among the PEV mass market.

The disaggregation of the incentive data by model year in Figure 8 shows some interesting potential trends. For instance the decline of Ford 2014 model year discounts starting in September 2014 and ending in July 2015, and conversely the increase in 2015 model year discounts starting in September 2014 and peaking in June 2015 indicate that this timing could be explained by the introduction of new model year 2015 Ford vehicles in July or August 2014, causing a slow reduction in Ford model year 2014 incentives as inventory is depleted and replaced by Ford model year 2015 vehicles. Further compilation of manufacturer incentives over time would more clearly illustrate manufacturers' incentive strategies through model year change over and the annual sales cycle.

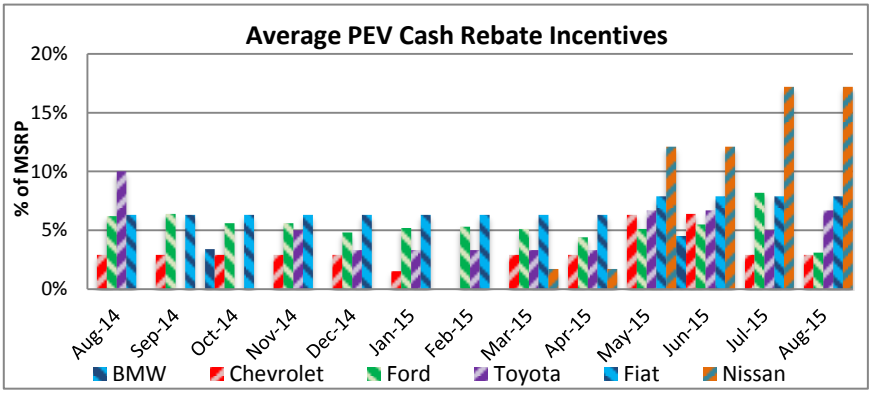

Figure 7: Average PEV cash rebate incentives by manufacturer and model year [24]

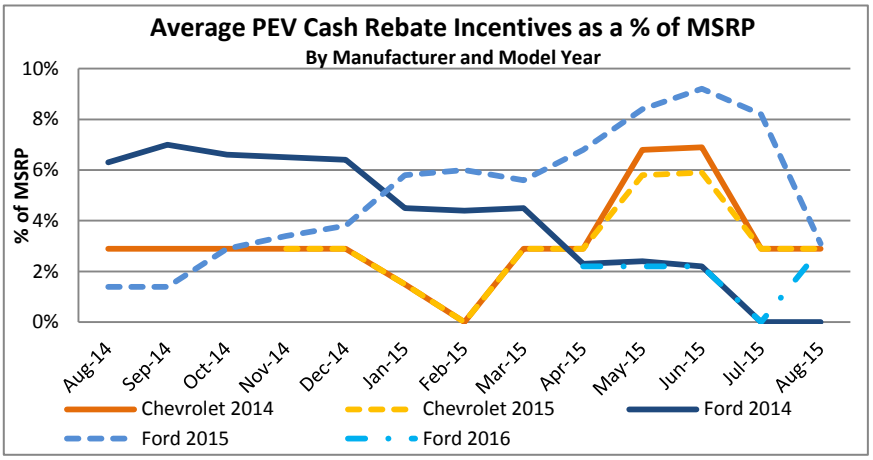

Figure 8: Average manufacturer PEV cash rebate incentives (10)

4.2.1 Have Manufacturer PEV Cash Rebate Incentives Been Implemented in Such a Way to Stimulate, Maintain, and/or Maximize Sales?

Generally an increase in sales as a response to an increase in cash rebate offers would be expected. This is not the case when considering the relationship of average PEV cash rebate offers and average PEV sales as shown in Figure 9. On average there is a significant increase in the value of PEV cash rebate incentives from April to May 2015 with no corresponding increase in sales. Similarly HEVs and CONVs average cash rebates show increases and decreases without corresponding movements in sales. This lack of relationship, on average, could lead to the conclusion that manufacturer cash rebate offers are not a primary factor in

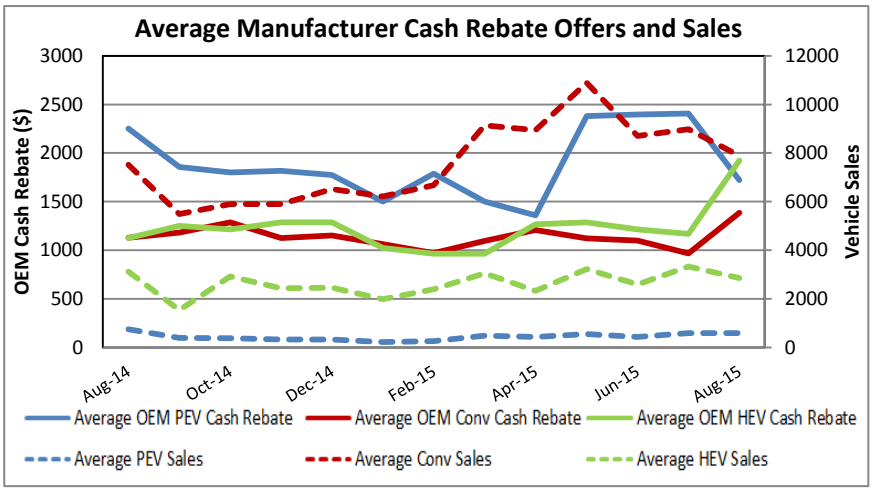

Figure 9: Average manufacturer cash rebate offers and vehicle sales [24-25]

influencing vehicle sales, or that cash rebates never reached a significant enough value to effectively stimulate sales.

At the model level 5 out of the 7 PEVs analyzed here exhibit at least a weak positive correlation between cash rebate offers and sales. Of these 5 only 2, the Prius Plug-In and 500E, have a strong positive correlation.

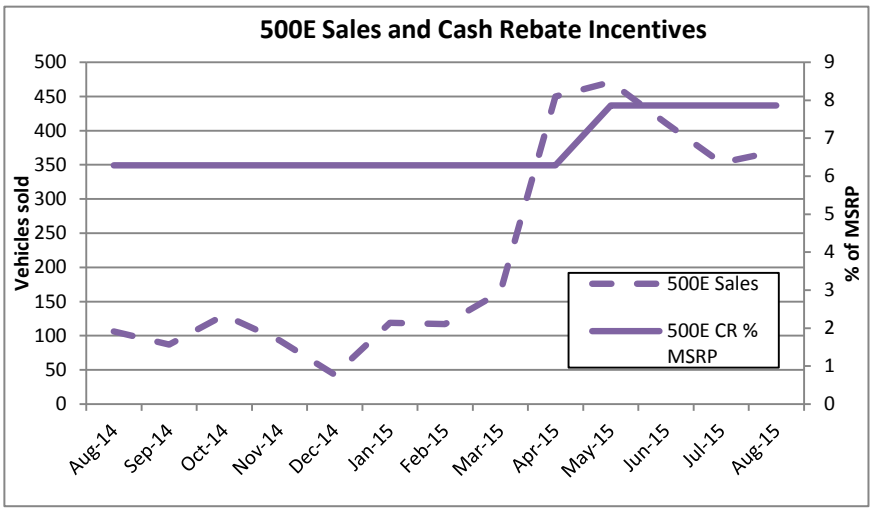

Figure 10: 500E sales and cash rebates over time

500E sales increase month over month from February 2015 through May 2015, as shown in Figure 10. As sales were increasing Fiat increased the cash rebate in May 2015 from just over 6% to almost 8% of MSRP. This increase in cash rebate value while sales were increasing could be interpreted as a strategy to maintain or maximize 500E sales. Alternatively this increase in sales pre-dating the increase in cash rebate is evidence that the rebates are not the cause. The increase in sales could be due to 500E inventory availability, or other factors. Additional research would be necessary to better understand these and other factors affecting 500E sales.

As shown in Figure 11, fluctuations in Prius Plug-In sales are matched very closely by cash rebate offers, a high number of sales generally relates to a high cash rebate value. It is interesting to note that the highest rebates, and sales, are evident around the same time that the model year change over occurs. This timing coincidence of increased rebates and model year change over may be a result of Toyota's strategy to reduce the previous year's inventory to make way for next year's model.

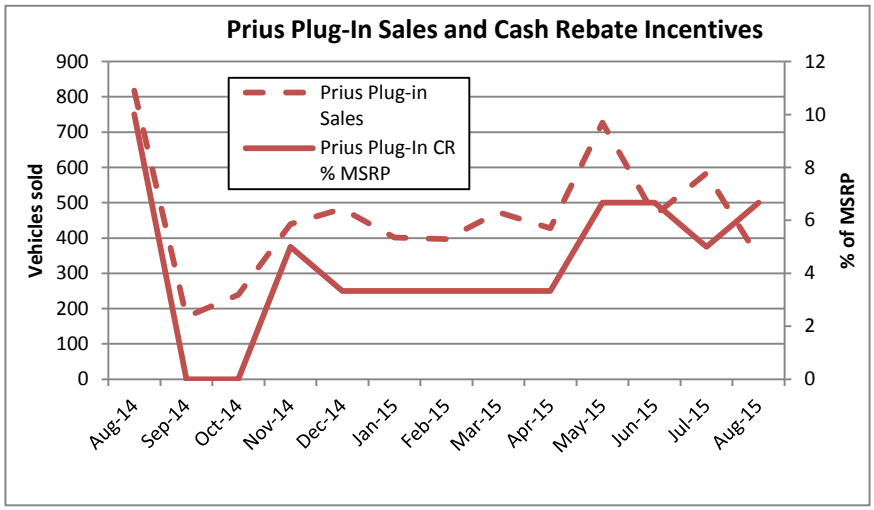

Figure 11: Prius Plug-in sales and cash rebates over time

There is little evidence to support cash rebate offers as a sole means to improve vehicle sales. This could be due to the cash rebate values not being significant enough to stimulate sales, or that as cash rebates increased vehicle inventory was quickly consumed. It may be possible that in order to be effective cash rebate offers need to be combined with some other factor that would contribute to increased sales. Further research into the factors that drive PEV sales would be helpful to characterize these relationships.

5 Concluding Remarks

In addition to providing a general understanding of the magnitude and distribution of manufacturer PEV incentives, there are several key questions this paper attempts to answer. First, how does the incentivized PEV price, manufacturer, state and federal government incentives combined, compare by state, by

manufacturer, and by technology? As discussed in section 4.1.4 and illustrated by Figure 4, the incentivized price of PEVs are comparable with the incentivized price of HEVs. When OEM incentives are supplemented by significant state government discounts, such as in Colorado, the incentivized PEV price can be comparable with a non-incentivized conventional vehicle MSRP.

On average across the country, Figure 4 shows that the manufacturer incentives for HEVs and PEVs are of similar magnitude at roughly 9% of MSRP. Additional data collection over time would be useful to further characterize this percentage of MSRP discount as a standard for HEVs and PEVs. Figure 4 also shows the disparity between the magnitude of manufacturer incentive discounts and the federal government tax credit. With a value over twice the average manufacturer PEV cash rebate this could be an indication that the Federal government has more of a vested interest in subsidizing PEV sales than manufacturers.

Second, what role have manufacturer incentives played in either stimulating or maintaining PEV sales? Of the seven PEVs included in this analysis, two – the Prius Plug-In and 500E – have a strong positive correlation between sales and cash rebates. These strong positive correlations could indicate that increasing the value of PEV cash rebates causes PEV sales to increase. It is also possible that the increases in rebate offers were coordinated with vehicle availability, to sell down outgoing model year inventory or to entice customers to new model year vehicles, and therefore cash rebate offers were merely one of many factors potentially influencing PEV sales.

Third, how does the manufacturer incentivized price compare between ZEV and non-ZEV states? The ZEV state average manufacturer PEV incentives depicted in Figure 6 are not significantly greater than the rest of the country therefore it is possible that manufacturer's cash rebate incentive strategies do not favor ZEV states. At the model level a similar conclusion can be drawn with only two models, the Toyota Prius Plug-In and the Fusion Energi, offering a unique incentive in a ZEV state.

Manufacturer incentives have the potential to significantly improve PEV sales by helping to overcome the barrier of upfront purchase cost. The manufacturer PEV incentives characterized in this analysis, in conjunction with State and Federal incentives were not significant enough to make PEVs cost competitive with conventional vehicles, and therefore did not have a significant influence on PEV sales.

Acknowledgments

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