# An Investigation into the Rising Sales of Electric Cars

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**Abstract.** Recent awareness of climate change, coupled with the desire to drive better, cleaner, more efficient vehicles, is driving demand for electric cars (EVs). While current costs for some alternative methods of transportation are high, and travelers worry about that which they do not yet fully understand, recent incentives and technological improvements are working to bring about a change in the way that we think about transportation. The purpose of this study is to re-examine the potential causes leading to increasing sales of EVs. Potential causes were fuel prices, interest rates, and various government subsidies combined with a cost benefit analysis. My findings suggest multiple causalities and may benefit those seeking to bring about a change in how we view transportation.

## 1. Introduction

Rising sales of electric cars has increased dramatically over the last ten years. The incentive behind this work comes from reading the work of one Mitchell Ng, of Princeton University, who claimed that the choice of an electric or hybrid vehicle was a poor one given current conditions. While there are many perks associated with the ownership of an EV, this paper looks into the quantifiable causes behind the recent increase in sales [5]. Looking into the cities with the largest sales of EVs, specifically, San Francisco, Los Angeles, New York, Seattle, as well as the overall United States [1], I look at a cost benefit analysis of EV ownership much as Ng did in his paper. Next I examine how the change of fuel prices, interest rates, and government subsidies, affect the change on the sales of various EVs and hybrids across those cities.

## 2. Experiment, Results, Discussion, and Significance

Mitchell Ng's paper titled Short and Long-Term Cost Efficiency Analysis of Fossil Fuel versus Alternative Energy Vehicles [4], published in the Journal of Business Studies Quarterly in 2011, uses a breakeven analysis to determine the length of time an individual must own an alternatively fueled vehicle to break even on the investment. While the math behind the argument is sound, I found the methodology lacking. Ng uses just three vehicles for his representations of the fossil fuel and alternative fuel industries, the Honda Civic, Toyota Prius and Chevrolet Volt. His selection of vehicles is not a bad representation in and of itself, however when using these particular three vehicles for a breakeven analysis, one should quickly notice that the Honda Civic is one of the lowest priced gasoline powered cars available while the GM Volt represents the upper end of the price spectrum when it comes to EVs, leading to a biased review and representation. For my research I expanded the selection to sixteen cars total, with eight gasoline powered vehicles and eight alternatively fueled vehicles. Some selections were based on popularity of the models while other consideration was given to price points, and body style. Three of the gasoline powered vehicles selected, were chosen to compete head-to-head with their EV counterparts of the same make and name. After taking into account the quantifiable subsidies available, the breakeven point is much different than the image painted by Ng. For instance, when comparing the Nissan Leaf with the Mazda3 5 door hatchback, the breakeven point is only two months [6]. Furthermore, after reaching the breakeven point, the cost saved in gas acts as a payment to the owner, resulting in a positive present value, as shown by the Tesla Model S versus the Audi 8, and also when looking at the Toyota Prius versus the Hyundai Sonata. The breakeven ratio is shown below where P represents the initial price difference in cost, and i, represents the interest rate funding the price difference, we then solve for T to find the number of periods to break even.

$$P = \text{Fuel Cost Savings per month} * [ (1 - \{ 1 / ( 1+ i )T \} ) / i ]$$

To test the different elasticities, or how the change in one variable affects the change in another, I took the natural log of the sales numbers of the different vehicles, along with the natural logs of the explanatory variables, gas prices and the federal funds rate. While the Federal Funds Rate is not a great interpretation of auto loan rates since auto loans vary in length and amounts, the decreasing Federal Funds Rate since the recession of 2008/2009, has led to a lower cost of money in the open market, which in turn has led to a lower borrowing rate for auto loans [2]. Using the following equation, where the variable (S) is used to describe the national sales of a particular electric car in a given month, the dependent variable (F) is used to describe the federal funds rate average in that given month, and the

variable (G) is used to describe the gasoline price of either a particular city or the national average on a monthly basis, we estimate the effects of fuel prices and interests rates on sales of EVs.

$$\log(S) = A + \alpha\log(F) + \beta\log(G) + C$$

The results of the individual regressions showed that out of all of the alternatively fueled vehicles chosen, only two, the Nissan Leaf and the Chevrolet Volt, showed significant changes in their sales in all five regions, brought about by changes in the explanatory variables. This is not that surprising as both of these vehicles are the best selling vehicles in the market. The Honda Accord hybrid was found significant in four of the areas tested, while only two other models were found to have significance. The Federal Funds Rate was found to be significant on sales of the Ford Fusion Hybrid, while fuel prices in New York were found significant on sales of the Toyota Prius Hybrid.

## 3. Conclusions

While the independent variables tested proved to be decent in explaining the variation of the dependent sales variable for some of the models, there are many other benefits of owning an electric car that cannot be quantified. For example, how do you put a price on being able to use the HOV lane in a city packed with bumper to bumper traffic? As sales for many of these models continue in the coming months, expect to see more analysis of the effectiveness of the subsidies and tax benefits. We will see in the coming months which element proves stronger for sales, the decrease in cost because of government subsidies, or the decrease in cost due to the learning curve effect currently being experienced by auto manufacturers. The EV is clearly showing signs of tremendous growth potential in the U.S. and around the world, with sales increasing at nearly 100% every year [3]. The firms with the ingenuity and capability to take advantage of the coming technology increases will be the new leaders in the next era of vehicles.

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## 5. References

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