Effect of electric vehicle sales on the price of oil

Archi Arnob
School of Business and Economics
State University of New York at Plattsburgh
Aarno008@plattsburgh.edu

Submitted June 2021

Abstract

The primary goal of this study is to observe the relationship between the fluctuation of the oil price and the increasing number of sales of electric vehicles based on data from 20 developed and developing countries. As the number of electric vehicles on the market is growing, the demand in the world oil market is declining slightly and, as a result, oil prices are also declining due to several factors. Consumer theory tells us that oil prices could decline due to a rise in the number of electric vehicles sold. Electric vehicles can minimize carbon dioxide emissions and pollutants even when considering indirect emissions from power production and battery generation. Soon, the world may start banning regular gasoline vehicles as a part of the solution to climate change which has already started in Norway. The result shows us there is a slight negative relationship between the oil price and sales of electric vehicles. I can expect that the sales of electric vehicles will keep increasing and after a certain time, it will become a perfect substitute for regular gasoline vehicles.

Keywords: Electric vehicle; oil price; climate change.

1. Introduction

The idea of electric vehicles is not new. Though they have become a new trend in the last decade. The first electric vehicle was invented in 1828. However, there was not any significant development on this idea until 2006 when Tesla Motors, a Silicon Valley startup announced that they would start producing electric vehicles (Matulka, 2018). In the last 15 years, it has become very popular and most other companies have also started producing electric vehicles. The main and most common substitute for electric vehicles is regular gasoline vehicles. The oil market plays an important role in the world economy and this market is highly volatile. According to the U.S. Energy Information Administration (figure 1), in 2020, 68% of the oil was used in the transportation sector where 42% was used for light-duty vehicles. It is not easy to change the substantial market overnight, but it is worth finding the effect in recent years.

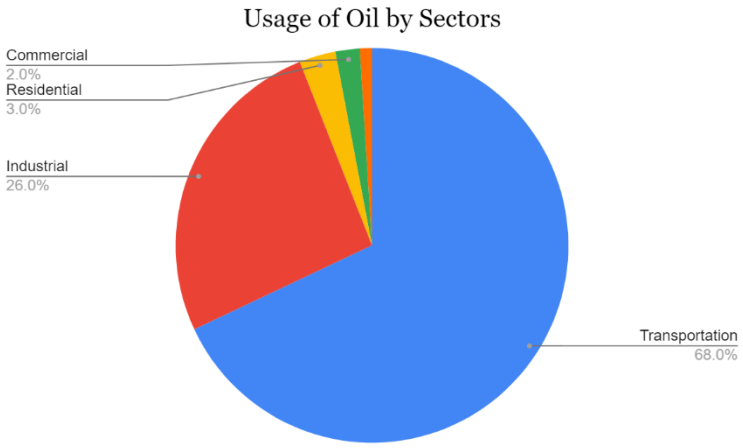

Figure 1: Usage of oil in the U.S. in 2020

In this study, I investigate the sales of electric vehicles and oil prices to find the relationship between them in 20 developed and developing countries. Beyond this, I discuss what I can expect in the sales of electric vehicles and oil prices. Moreover, I investigate the reasons

behind the growth of electric vehicles related to climate change. Electric vehicles can minimize carbon dioxide emissions and pollutants even when considering indirect emissions from power production and battery generation (Weiss et al., 2019). It is almost impossible to get rid of carbon emissions, the most I can do is minimize it as much as possible. I can expect that electric vehicles can lead us to a sustainable future.

2. Literature Review

In the consumer theory, the substitution effect tells us if there is a drop in sales for a product that can be due to buyers moving to cheaper alternatives as to the price of the product increases. In this study, I am looking at the two products which are substitutes: electric vehicles and regular gasoline vehicles. At the beginning of this new era, Tesla introduced them as a luxury product in this market. But this is not the case anymore. If I look at the market right now, there are new electric vehicles which are starting in the range of 30,000-40,000 USD. Where Tesla's first vehicle was more than 100,000 USD, right now they are launching vehicles at 35,000 USD. Fully electric and plug-in hybrid vehicles have become increasingly popular. Eventually, it is reaching to the market shares of 29% in Norway, 6% in the Netherlands, and 1.5% in China, France, and the UK (IEA, 2017).

There are a few reasons behind the downward trend in the price. Most importantly, the price of the battery which is the major component of electric vehicles is decreasing. Battery costs dropped 35% in 2016 and are on track to make unsubsidized electric vehicles affordable (Randall, 2016). Also, there are more competitors in the market now; even the luxury sports vehicle companies like Lamborghini, Ferrari, etc. are making electric vehicles. Therefore, there is a higher supply in the market. When a luxury product turns into a normal good for the consumers, the demand for that product will increase, which also happened to electric vehicles.

The oil market is volatile, and its price depends on a lot of other factors. I have seen that most of the oil in the U.S. is used in the transportation sector, but oil consumption per capita is continuously decreasing for the last 14 years and reached the point where were at in 1965 (The World Bank, 2015). In recent years, I have found several different substitutes for oil such as solar power, biofuel, and higher usage of electricity. Since most oil is used on light-duty vehicles, a cheaper substitute, electric vehicles can replace the regular vehicle in the market. Electric vehicles are also cheaper to recharge. According to the U.S. Department of Energy, electricity costs only 4 cents per mile whereas regular gasoline cost 10 cents per miles. For two substitute products, consumers will choose the cheaper alternative.

The rise of electric vehicles is more than just a substitute for regular gasoline vehicles. Climate change is an important factor to concern about nowadays. In the production of oil, in every stage, there is a high carbon emission. In the U.S., the transportation sector is the second-largest emitter of greenhouse gases (GHGs) and is responsible for more than a quarter of GHG emissions. Moreover, nearly two-thirds of the transportation GHG emissions are associated with light-duty vehicles. As compared to traditional hybrid vehicles, the battery results in higher total performance and a reduction in carbon dioxide emissions of 25% in the short term and 50% in the long term (Lane et al. 2017). Increasing sales of electric vehicles is also an investment for a sustainable future. There is an exponential growth of electric vehicles in the last 5 years. From the International Monetary Fund's study, it was projected that in the next 10–25 years electric vehicles will replace regular gasoline vehicles just as regular gasoline vehicles displaced horses a century ago, and so oil will lose its role as the main fuel for transportation (Cherif et al. 2017). Recently, the pandemic showed us the effect in the oil market what would happen if people stopped using regular gasoline vehicles. It may seem quite impossible to understand the situation at this moment, but I can

certainly expect that there will be an oil crash in the recent future which will lead to permanent lower demand in the future.

3. Methodology

This study is based on the data collected from 20 countries from 2010 to 2019. The countries are: Belgium, Brazil, Canada, China, Finland, France Germany, Greece, India, Italy, Japan, New Zealand, Netherlands, Norway, Poland, South Korea, Spain, Sweden, United Kingdom, and the United States. Here, the dependent variable is the retail gasoline price which is adjusted for inflation. The main independent variable is the sales of electric vehicles. Also, I have used some other independent variables which are interest in electric vehicles through google search, research and development expenditure, and Gross Domestic Product (GDP) growth rate. Adjusted retail gasoline prices are in USD per gallon and to get this I have converted from different currencies through the average conversion rate on a particular year. The sales of electric vehicles have set by per million of population, otherwise, the raw data of sales can be misled. Interest in electric vehicles through google search means how frequently people search electric vehicles in google which has collected from google insights. Research and development expenditure has used in a sense to higher innovation will lead to use newer technology such as electric vehicles. GDP growth rate also has used in a similar hypothesis where a better lifestyle will lead to the use of better commodities. For the regression analysis, I have used a double log or log-log model. My empirical model is below-

$$\ln GasPrice = \beta 0 + \beta 1 * \ln ECar + \beta 2 * \ln Google + \beta 3 * \ln RD + \beta 4 * \ln GDP + \boldsymbol{\varepsilon}$$

I used the double log form because electric vehicle sales have shown exponential growth over the years. Then, I used the Hausman test to determine whether a fixed effect or a random effect model

is more suitable. Also, I conducted tests for heteroscedasticity, serial correlation, and multicollinearity.

In figure 2, I have the descriptive statistics of the dataset. Most of the variables have a similar standard deviation except sales of electric vehicles and google search. Sales of electric vehicles per million of the population are high in a few European countries where the population is low, and those countries are more concerned about climate change. Google searches also work in a similar way, for example, nowadays before buying anything, people want to do research about that product in google.

In figure 3, I have the covariance matrix. Here, gasoline prices and sales of electric vehicles are positively correlated but this is not significant. I am supposed to have a clear negative correlation between them according to the theory. There are a few reasons I can estimate for this unexpected result. First, the idea of electric vehicles is relatively new compared to regular gasoline vehicles. Still, a huge population in this world is not aware of electric vehicles. Also, I have collected data from different countries where there are a different number of sales of electric vehicles.

Variable		Mean	Std.Dev.	Min	Max	Observations
GasPrice	overall	1.542	0.454	0.587	2.513	N = 174
	between		0.404	0.776	2.132	n = 20
	within		0.221	1.130	1.924	T = 8.699
EVehicle	overall	776.770	2269.894	0.148	16599	N = 168
	between		1566.301	0.808	7170.963	n = 20
	within		1557.080	-6245.578	10204.810	T-bar = 8.4
Google	overall	34.190	16.227	3.833	84.500	N = 200
	between		10.088	18.133	60.167	n = 20
	within		12.890	7.540	80.298	T = 10
RnD	overall	2.013	0.911	0.598	4.810	N = 174
	between		0.916	0.708	4.165	n = 20
	within		0.141	1.315	2.659	T = 8.699
GDP	overall	2.203	2.573	-9.133	10.636	N = 200
	between		2.066	-1.973	7.694	n = 20
	within		1.595	-4.956	8.343	T = 10

Figure 2: Descriptive statistics

Pairwise correlations

Variables	(1)	(2)	(3)	(4)	(5)
(1) GasPrice	1.000				
(2) EVehicle	0.114	1.000			
(3) Google	-0.117	0.337***	1.000		
(4) RnD	0.043	0.053	0.139*	1.000	
(5) GDP	-0.386***	-0.099	-0.166**	0.040	1.000

**** p<0.01, ** p<0.05, * p<0.1*

Figure 3: Covariance matrix

In figure 4, I get a better understanding of the lower positive correlation between gasoline price and sales of electric vehicles. Here, I have the graphs for gasoline price and sales of electric vehicles over time for each country. Only the Netherlands, New Zealand, Norway, and Sweden have noticeable sales compare to other countries.

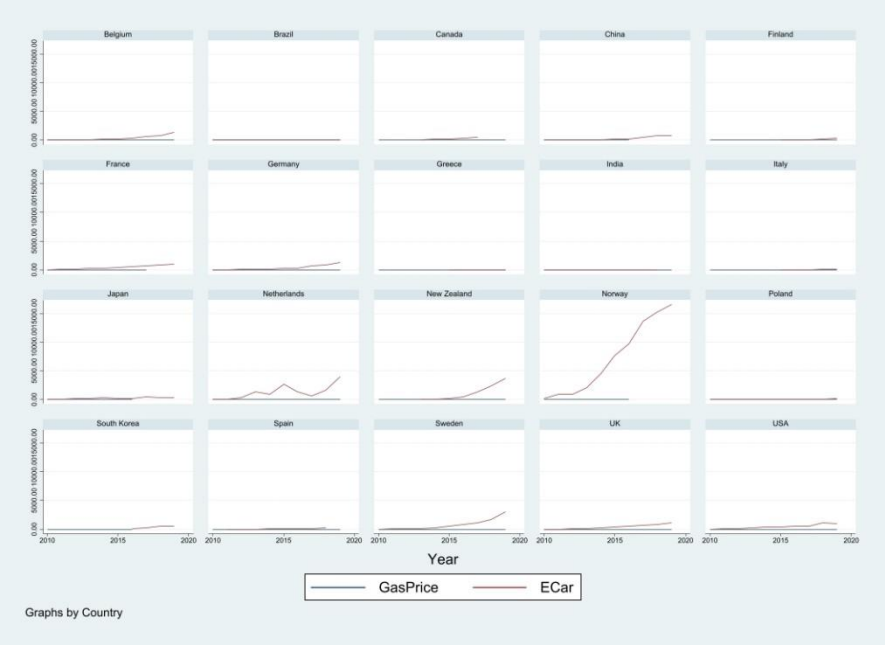

Figure 4: Movement overtime on sales of electric vehicles in each country

In figure 5, I have the results from the regression analysis. First, I calculated both the fixed effect and the random effect model. Then, I ran the Hausman test which gave us the freedom to use any of the models. So, I chose the fixed effect model. Later, I test for heteroscedasticity and found out that heteroscedasticity is present. In my result, sales of electric vehicles have a negative coefficient, what I was supposed to get, and the value is significant. This result implies that if the retail gasoline price goes down 100%, then the sales of electric vehicles will go up 4%. To solve this issue, I did the robust estimator of variance which is my third model on the figure. I also conducted tests for serial correlation and multicollinearity. Although multicollinearity is not

presented in the data, the serial correlation exists. Since I worked on a panel data set, and my dataset is low, I are not worried about this here.

	(FE Model) lnGas	(RE Model) lnGas	(FE Robust) lnGas
lnEVehicle	-.036***	-.036***	-.036***
	(.014)	(.013)	(.009)
lnGoogle	-.036	-.031	-.036
	(.051)	(.05)	(.03)
lnRD	-.167	.04	-.167
	(.261)	(.134)	(.18)
lnGDP	-.028	-.038	-.028
	(.026)	(.026)	(.034)
_cons	.745***	.618***	.745***
	(.185)	(.166)	(.109)
Observations	119	119	119
R-squared	.225	.z	.225

Robust standard errors are in parentheses
**** p<.01, ** p<.05, * p<.1*

Figure 5: Regression analysis

4. Discussion

Empirical results provide a negative relationship between the retail gasoline price and sales of electric vehicles. Earlier I mentioned the impact on the environment from regular gasoline vehicles. Also, from the figure 6, Norway has higher sales of electric vehicles than any other country in the world. Since the relationship is very low, and the oil is limited, what can I expect in the future?

Norway has shown tremendous growth in its economy in the last 60 years. Norway's GDP per capita has increased 4 times in constant price and 51 times in current price from 1960 to 2019 (The World Bank, 2019). One of the key reasons for this success is a natural resource: oil. In 1963, Norway claimed a sovereign right on a certain area of the North Sea, and in 1969, the government started to extract oil through the state-owned company Statoil. They found 313,000 BARRELS/PD/PMP, which was highest in 1970 and still now the 4th highest in the world

(Kryukov et al. 2020). The most unique idea they used was not to commercially extract the oil and charging fewer taxes than before. They spent in a totally different way, which is the key to its sustainable development. They invested in the sovereign wealth fund, which is the world's largest worth 1 trillion USD (Richardson, 2011). Norway is keeping its old moves in recent years in climate change. They are working on every possible way to reduce carbon emissions. In Norway, electric vehicles can use most toll roads and several ferry connections free of charge, and battery charging is free at a rapidly growing number of publicly funded charging stations. Norwegian pay 50% lower company vehicle tax on electric vehicles (Holtsmark, 2014). It attracts the consumer to spend on it rather than a regular gasoline vehicle since tax is already very high. To be sustainably developed in this world, consumers should choose electric vehicles instead of regular gasoline vehicles and if the government helps on this project through subsidy, it will eventually be helpful for the world. In the U.S., most electric vehicles are registered in California. From a study, it is expected that the subsidy bill required for California to reach its goal of 1.5 million electric vehicles by 2025 would be likely to exceed $12-18 billion (Muehlegger, 2018). In this process, the higher demand for electricity will also have a negative impact on the environment, but it will be much less than using oil.

5. Conclusion

Exponential growth in the sales of electric vehicles is one of the key components to lead us to the sustainable growth of the economy. The result has shown us the effect is already visible, and I can expect that it will continue. I can also expect that the competition between companies and technological growth will, in time, reduce the cost of production of electric vehicles. Once I had to worry about the scarcity of oil, but I have finally found the substitute that will help us to get rid of oil dependency. It is high time: I need to think about climate change and understanding the

negative impacts of gasoline consumption will motivate us to move to clean energy. Electricity also has negative impacts on the environment, but it is much lower than gasoline. Technological advancement may also take us to a better solution in the future than electric vehicle, but until then, electric vehicles is the better solution.

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