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The Impact of Uncertainty on the Economics of Electric vs. Gas Vehicles

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ABSTRACT

Electric vehicle usage has been increasing for several years now due to the environmental attractiveness compared to conventional gasoline cars. There has been lots of research conducted to show that electric vehicles are better for the environment over their entire lifecycle. However, the big question of cost still remains. Electric vehicles typically have a higher purchase price than equivalent regular cars but other benefits, such as lower fuel cost and maintenance, that conventional cars do not. I conduct a net present value (NPV) analysis and build a cost model that considers multiple factors. To build on this base model, I perform a Monte Carlo simulation using historical gas price data to generate NPV samples for conventional cars that account for price volatility. Then, based on the resulting distribution, I find the threshold value where 95% of the gasoline car samples are more expensive. By comparing this to the NPV of electric vehicles and holding other variables constant, I determine what cost variables can impact the breakeven point between the two types of cars. To model the uncertainty of future prices, I also conduct sensitivity analyses to examine how the economics respond to changes in gas price volatility and EV upfront cost, and the resulting difference in NPVs. I find that in general, the electric vehicle is more favorable with higher gas price volatility and the gasoline car is more favorable with higher EV upfront costs.

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Chapter 1

Introduction

My research examines the cost of owning an electric vehicle compared to a conventional gasoline car and the impact of uncertainty on their economics. Electric vehicle sales are consistently growing, and with them, questions regarding their cost, efficiency, and environmental footprint. This upward trend is demonstrated by the sales data in Figure 1 (Irle).

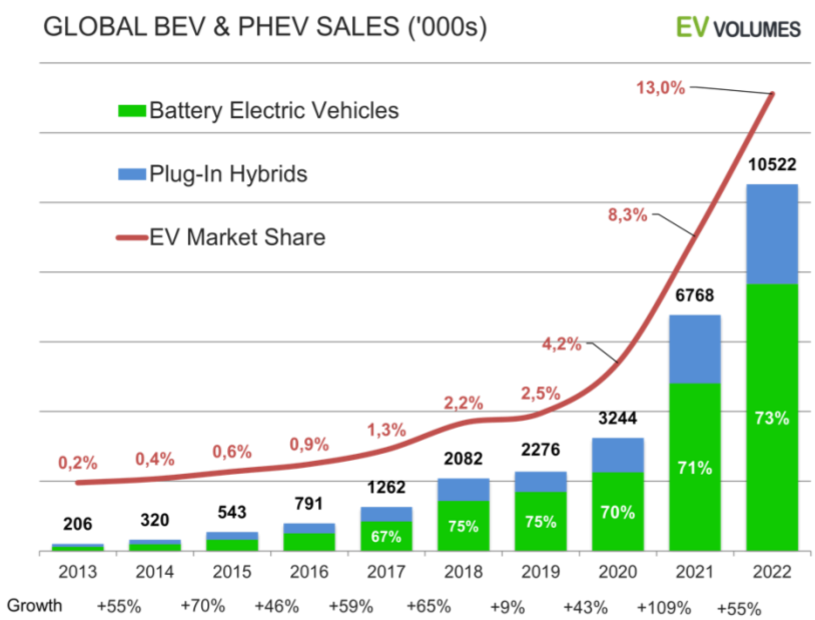

Figure 1. Increase in EV Sales

An important consideration of electric vehicles is their environmental impact and how beneficial they really are compared to conventional gasoline cars. Research has been conducted that shows that their overall carbon footprint over the life of a vehicle is less than that of gasoline cars, even with the carbon emissions that can be produced from electricity generation and battery manufacturing. (*Electric Car Pros & Cons*). This is true when considering the whole life cycle of the vehicles, however the magnitude of emission savings is dependent on the fuel mix of power plants used to generate electricity (Hawkins). With this knowledge, one of the biggest obstacles left for people considering buying an electric car is the cost considerations. This is the concern that my research addresses by performing a comparative cost analysis on the two types of vehicles. The uncertainty of costs in the future and how it impacts the economics of gas and electric vehicles motivates this analysis.

There are many factors that must be taken into account when purchasing a car. There is the obvious upfront purchase price, as well as other additional expenses incurred throughout the lifetime of owning a car, including maintenance and insurance. I construct a 10-year cost model for each car to determine their net present values that takes these factors and several assumptions into consideration. I use the Chevy Cruze gasoline car and the Chevy Bolt electric vehicle as data points for ease of comparison due to their similarity as two small sedans of the same make. My objective is to use this model to analyze the varying levels of different cost factors and their effect on the overall decision between the two cars.

A main factor in this model is the fuel cost for both cars. For the gasoline car, this is the price of gas and for the electric car, this is the price of electricity. Electricity costs vary from home charging to public charging, whereas gas prices are historically volatile and constantly changing. To account for this price volatility in the cost model, I use Monte Carlo simulation to generate a large distribution of gas price samples to input into the model based on historical gas prices and inflation data.

I use this model to make several comparisons of electric vehicles and gasoline cars that examine the uncertainty on the relative economics of gasoline vs. electric cars. I examine thresholds of different cost variables, such as the upfront cost that make one car more favorable than the other. I also conduct separate and combined sensitivity analyses on the variation of gas prices and capital cost of electric vehicles to see how the economics respond to different variables. The results from these methods show how important different cost factors are in the choice between gas and electric vehicles and what threshold level they would have to be at to make one car more expensive than the other.

Chapter 2

Literature Review

2.1 Environmental Considerations

Electric vehicle sales in the Unites States have increased by more than 40% each year since 2016 (*Electric Car Pros & Cons*). Thus, there has been an increasing interest in research about the implications of electric vehicles. One of the advantages of electric vehicles are that drivers can reduce their carbon footprint due to no tailpipe carbon emissions in comparison to conventional vehicles, which helps combat climate change. About 30% of US greenhouse gas emissions come from the transportation sector with limited public transit and the tendency for people to drive big cars that require more fuel (*Electric Car Pros & Cons*).

Conventional vehicles with an internal combustion engine (ICE) produce direct emissions through the tailpipe, whereas electric vehicles produce zero direct emissions. Although electric vehicles produce zero carbon emissions to operate, there has been concern about the energy used to create and charge these vehicles. Critics claim that generating the energy used to charge electric vehicles may create carbon emissions and the US generates 61% of electricity by burning fossil fuels (*Electric Car Pros & Cons)*. The environmental benefit is sensitive to the power generation mix and the efficiency of the power plants and electricity transmission system (Hawkins). In areas that use more renewable sources, like wind and solar, electric vehicles have an especially high life cycle advantage over similar conventional cars (*Alternative Fuels Data Center*). The environmental benefit of electric vehicles from reduced GHG emissions varies significantly by location due to the amount of electricity generated in that region by coal and natural gas (Holland et al.). In California, where there is a lower carbon intensity electricity mix than the national average, the life cycle emissions of electric vehicles are lower, whereas in Georgia, power plant emissions reduce this benefit (Holland et al.).

Electric vehicles are found to reduce global warming potential by 20% to 24% compared to gasoline Internal Combustion Engine Vehicles (ICEVs) when powered by the European electricity mix and a lower 12% when powered by electricity from natural gas (Hawkins). Thus, there is still a benefit from using electric vehicles, but it is highly dependent on the sources that generate the electricity. It is important for the electricity grid to transition to cleaner, renewable sources across the U.S. electricity regions to increase these environmental benefits. Even in areas where EVs are charged by electricity coming from plants burning coal or oil, they are still more environmentally friendly than gasoline cars but to a limited extent (*Electric Vehicle Myths*). A study by the International Council on Clean Transportation (ICCT) found that lifetime emissions for electric vehicles are between 60-68% lower than for gasoline cars using regionally adjusted values for the carbon intensity of the electricity mix (Bieker).

Another concern is that carbon pollution comes from the manufacturing and production process of electric vehicles, especially to create the lithium batteries. There is potential for human toxicity, mineral depletion, and freshwater eco-toxicity caused by the supply chains involved in the manufacturing phase of electric vehicles (Hawkins). This effect still does not compare to carbon emissions of gasoline cars over the lifecycle of the vehicles as shown in Figure 2 (*Iea*).

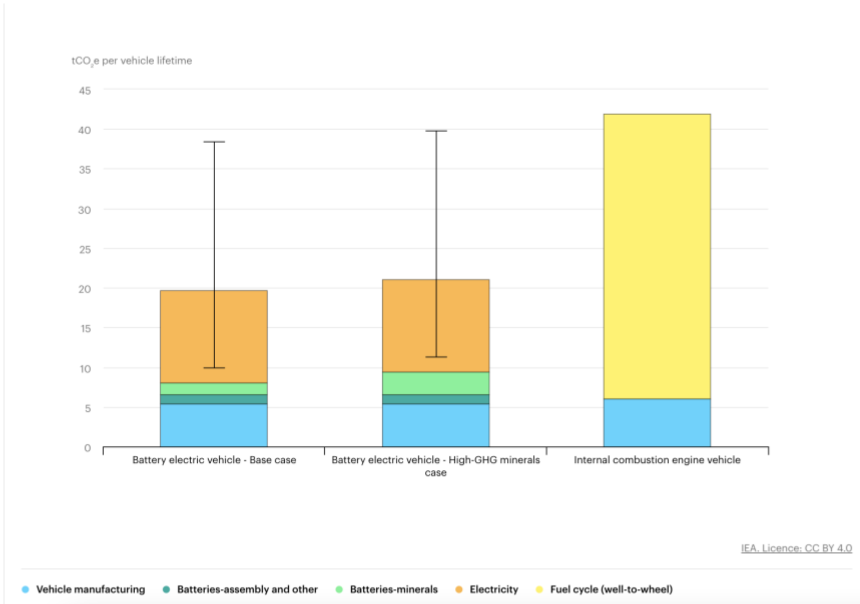

Figure 2. Lifecycle Greenhouse Gas Emissions

The bottom blue and green portions of the graph represent vehicle manufacturing, battery assembly, and battery minerals. The orange represents electricity, assuming the global average grid carbon intensity, and the yellow represents fuel usage. Taking only the first set of factors into account, electric vehicle emissions do exceed carbon emissions of the manufacturing for gasoline cars. However, the emissions over the entire lifecycle of an electric vehicle are much lower than a gas vehicle due to the significant decrease of fuel emissions. Another study that looked at lifecycle emissions showed that the high initial emission debt is paid off within approximately two years of driving an electric vehicle instead of a conventional car (*Electric Vehicle Myths*). These emissions are more likely to decline in coming years with the move towards a cleaner electricity grid. While GHG emissions for EV manufacturing alone are higher, the lifetime GHG emissions from gasoline cars are significantly greater.

Electric vehicles are also extremely energy efficient compared to traditional gas-powered cars. Internal combustion engines (ICE) vehicles convert about 12% of the energy contained in their fuel with the rest lost through internal mechanical processes like powering the engine. EVs convert 80% of the energy from their lithium batteries into movement due to fewer parts and regenerative braking, a system that recaptures energy during braking (*Electric Car Pros & Cons)*. This also depends on the efficiency of the electric grid, but the difference in fuel efficiency is clearly substantial.

With the percentage of electric vehicles being sold in the United States steadily increasing, it is important that the electric grid can account for this. There is currently enough power generation and transmission to charge all of the electric vehicles being purchased over the next few years, but if this trend continues, there will need to be some adjustments to the grid (Houston). Grid operators have started planning to increase energy capacity and transmission in the distribution infrastructure. They will need to adjust management to react to a more dynamic supply and demand. There are more resources to account for, like renewable energy, as well as more variability in customer needs and charging times.

2.2 Charging Stations Infrastructure

A point of interest for transitioning to electric vehicles is the ability to publicly charge them. Gas stations are conveniently located all across the United States, while electric car chargers are not as publicly accessible. There has been political action to change this and encourage the growth in electric vehicle sales to help the environment. President Biden passed the Bipartisan Infrastructure Law (BIL) that provides $7.5 billion to develop electric vehicle charging infrastructure. The goal is to install 500,000 public charging stations that are publicly accessible and compatible with all vehicles and technologies nationwide by 2030. This is just a small step in what the country would need if everyone were to eventually switch to electric vehicles. If half of all vehicles sold by 2030 are electric, then the U.S. would need 1.2 million public chargers in addition to private charging; almost 20 times more than it has now (Kampshoff et al.). The BIL also highlights equity and the electricity for public chargers costs significantly more than for private chargers. Public stations will need to be economical, equally distributed, appealing to use, and wired to a robust power grid. They must present good business opportunities for the companies expected to install and operate them and states are expected to contract with private companies and can use funds available through the National Electric Vehicle Infrastructure if they comply with these standards. This is a significant factor for consumers considering purchasing an electric vehicle in the future.

Chapter 3

Methods and Data

Consumers care about the costs of electric vehicle ownership, in addition to the environmental implications. I perform a cost comparison of electric vehicles and conventional gasoline cars using a variety of techniques including energy efficiency calculations, net present value analysis, Monte Carlo simulations, and sensitivity analysis. I use the combination of these methods to answer the question of which type of vehicle is more cost effective to own over a 10-year ownership lifespan and determine how uncertainty in future prices affects the relative economics of the two vehicle types.

3.1 Cost Model

I construct a discounted cash flow model for each vehicle type using the upfront purchase cost, fuel cost, insurance, and maintenance as the main cost factors affecting buyers. This model is based on price points for the Chevy Cruze conventional car and the Chevy Bolt EV, which are two typical sedan-sized cars for a fair comparison. There are several model assumptions that allow for accurate calculations and comparisons. The first is the 10-year lifespan of a vehicle since the average length of car ownership for the top 10 models ranges from 9.7 to 11.4 years (Blackley). The Federal Highway Administration states that Americans drive 14,263 miles per year, on average (Covington). For fuel calculations, I assume they will be driven 15,000 miles a year for an approximate round number. I also assume an annual discount rate of 5%. If these assumptions were to change, the breakeven point between the two vehicle types could shift and make one car more appealing than the other.

I use online data for each Chevy Car regarding their upfront cost, insurance, and maintenance. The Chevy Cruze conventional car has an upfront cost of $18,000 (*Future Chevy Cruze Info, Specs & More*), yearly insurance cost of $1,277 (Fitzpatrick), and yearly maintenance cost of $493 (*Chevrolet Cruze Maintenance, Service & Repair Costs*). The Chevy Bolt electric vehicle has an upfront cost of $27,000, yearly insurance cost of $1,529 (Fitzpatrick), and yearly maintenance cost of $238 (*Chevrolet Bolt EV Maintenance, Service & Repair Costs*). Although these numbers can vary, I use constant values for each year in the model from the same sources for the same types of costs for the most accurate comparison.

Before creating the cash flow table, I also find the use available data to perform calculations of fuel costs for each car per year. I will later consider uncertainty in fuel costs based on historical price data. The Chevy Cruze gets 35 miles per gallon (*2019 Chevrolet Cruze*). With the assumption of driving 15,000 miles per year, dividing this by 35 miles per gallons yields 428.57 gallons per year. I assume an average gas price of $3 per gallon based on an approximate average of historical gas price data (*U.S. All Grades All Formulations Retail Gasoline Prices*). I multiply this yield by the gas price to obtain the fuel cost per year, in this case $1,285.71. I will later vary this value with additional analysis that takes more gas price data and price volatility into account.

For the Chevy Bolt, I find the data about electricity prices to determine the yearly fuel cost. I assign weights of 80% to home charging and 20% to public charging (Kampshoff). The home electricity price is $0.107 per kilowatt hour (*Charging Electric Vehicles at Home*) and the public electricity price is $0.30 per kilowatt hour (*Electric Vehicle Charging Overview*). These values are approximate as electricity prices differ in regions throughout the United States, which is why for the purpose of the model I keep them at a constant average level. This assumption could vary in the future as more electric vehicles are added to the electricity power grid and become less realistic. This price will likely increase due to an increase in demand for charging. The Chevy Bolt uses 29 kWh per 100 miles (*Find and Compare Cars*). I multiply this factor by the 15,000 miles driven per year to get 4,350 kilowatts per year. I multiply this by the home and public electricity charging costs to get $465.45 and $1,305 per kWh, respectively. Then I compute a weighted average of these two values using the initial assumption of 80% home charging and 20% public charging, yielding a yearly energy cost of $633.36. I also assume a constant 2.3% battery degradation rate per year for electric vehicles (*EV Connect*). To account for this, the energy cost is incrementally increased by 2.3% each year to reflect a lower fuel efficiency. The tables with the final cost numbers is shown below. For the conventional car, the values are based on the gas price estimate of $3 per gallon for a base case scenario. The costs are all discounted using the rate of 5% annually and summed up to get the NPV. Since there are no revenues the NPV measures the present discounted value of costs and refers to a present total cost in all future references. The table for the electric vehicle also features a cell of the NPV difference (electric NPV – gas NPV), which will be used later in further analysis. Under the base case assumptions and a constant gas price of $3, the electric vehicle is cheaper over a 10-year lifetime.

Table 1. Conventional Car NPV

Year	0	1	2	3	4	5	6	7	8	9	10
Upfront Cost	$ (18,000.00)										
Fuel Cost		$ (1,285.71)	$ (1,285.71)	$ (1,285.71)	$ (1,285.71)	$ (1,285.71)	$ (1,285.71)	$ (1,285.71)	$ (1,285.71)	$ (1,285.71)	$ (1,285.71)
Insurance		$ (1,277.00)	$ (1,277.00)	$ (1,277.00)	$ (1,277.00)	$ (1,277.00)	$ (1,277.00)	$ (1,277.00)	$ (1,277.00)	$ (1,277.00)	$ (1,277.00)
Maintenance		$ (880.00)	$ (880.00)	$ (880.00)	$ (880.00)	$ (880.00)	$ (880.00)	$ (880.00)	$ (880.00)	$ (880.00)	$ (880.00)
Total	$ (18,000.00)	$ (3,442.71)	$ (3,442.71)	$ (3,442.71)	$ (3,442.71)	$ (3,442.71)	$ (3,442.71)	$ (3,442.71)	$ (3,442.71)	$ (3,442.71)	$ (3,442.71)
DCF	$ (18,000.00)	$ (3,278.78)	$ (3,122.64)	$ (2,973.95)	$ (2,832.33)	$ (2,697.46)	$ (2,569.01)	$ (2,446.67)	$ (2,330.16)	$ (2,219.20)	$ (2,113.53)
NPV	$ (44,583.73)										

Table 2. Electric Vehicle NPV

Year	0	1	2	3	4	5	6	7	8	9	10
Upfront Cost	$ (27,000.00)										
Fuel Cost		$ (633.36)	$ (647.93)	$ (662.83)	$ (678.07)	$ (693.67)	$ (709.62)	$ (725.95)	$ (742.64)	$ (759.72)	$ (777.20)
Insurance		$ (1,529.00)	$ (1,529.00)	$ (1,529.00)	$ (1,529.00)	$ (1,529.00)	$ (1,529.00)	$ (1,529.00)	$ (1,529.00)	$ (1,529.00)	$ (1,529.00)
Maintenance		$ (238.00)	$ (238.00)	$ (238.00)	$ (238.00)	$ (238.00)	$ (238.00)	$ (238.00)	$ (238.00)	$ (238.00)	$ (238.00)
Total	$ (27,000.00)	$ (2,400.36)	$ (2,414.93)	$ (2,429.83)	$ (2,445.07)	$ (2,460.67)	$ (2,476.62)	$ (2,492.95)	$ (2,509.64)	$ (2,526.72)	$ (2,544.20)
DCF	$ (27,000.00)	$ (2,286.06)	$ (2,190.41)	$ (2,098.98)	$ (2,011.57)	$ (1,928.00)	$ (1,848.10)	$ (1,771.69)	$ (1,698.63)	$ (1,628.75)	$ (1,561.92)
NPV	$ (46,024.09)										
NPV Difference	$ 1,440.36										

3.2 Monte Carlo Analysis

There is significant variability in gas prices in a 10-year time period due to fluctuations in supply and demand and other external factors. Thus, I obtain historical gasoline price data from the last 30 years to incorporate into the model for conventional cars from the U.S. Energy Information Administration (*U.S. All Grades All Formulations Retail Gasoline Prices*). The goal is to find the effect of gas price variability on the net present value of gasoline cars. A time series of this data demonstrates the annual variability in gas prices before adjusting for inflation (Figure 3).

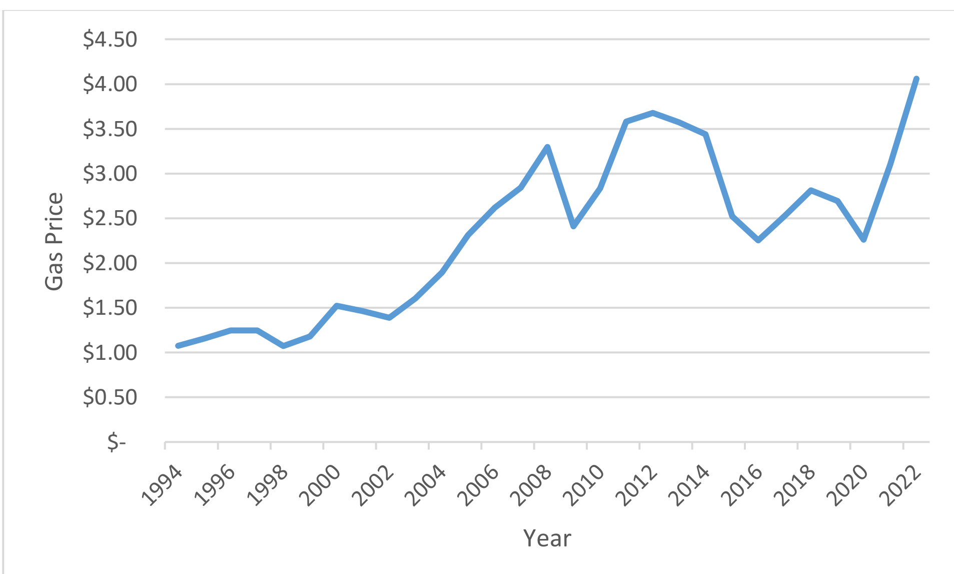

Figure 3. Gas Price Historical Variation

In addition to the gasoline prices each year from 1993-2022, I use CPI data from the U.S. Bureau of Labor Statistics to adjust for inflation by getting the CPI for the same years (*CPI For All Urban Consumers*). I make 2000 my base year by dividing each year's CPI by the 2000 CPI of 172.2. To reflect the inflation in gas prices, I then divide the gas price in each year by the adjusted CPI in that year. I plot this data on a histogram shown below in Figure 4.

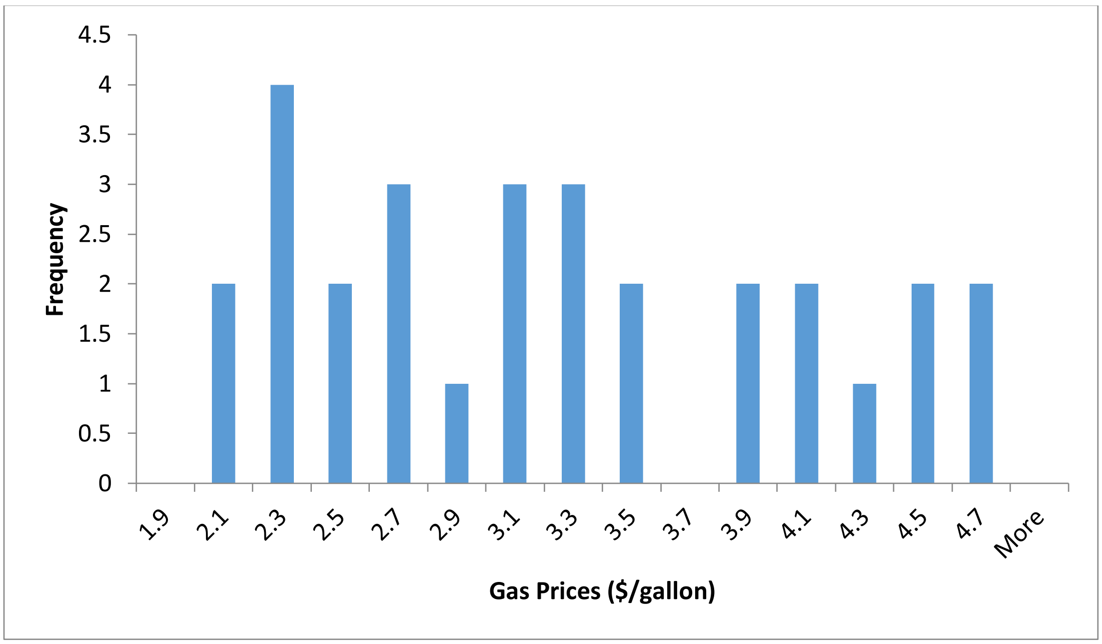

Figure 4. Histogram of Inflation Adjusted Gas Prices

I choose to fit a lognormal distribution to the data because of the right-skewed tail and the observance of no negative gas prices. I use the data to create a Monte Carlo distribution in excel, consisting of 1000 random samples. A lognormal distribution is a distribution of a variable whose logarithm is normally distributed. Therefore, to model the lognormal distribution of gas prices, I take the natural logarithm of the inflation adjusted gas prices. I obtain the parameters for the analysis from this data, which represents the natural log of gas prices. This yields a mean of 1.12 and standard deviation of 0.27. I use these to generate 1000 random samples and convert these samples back to gas prices by taking the exponential of each of the samples, resulting in

1000 random gas price samples that account for historical variation and inflation. The resulting histogram in Figure 5 shows this gas price distribution.

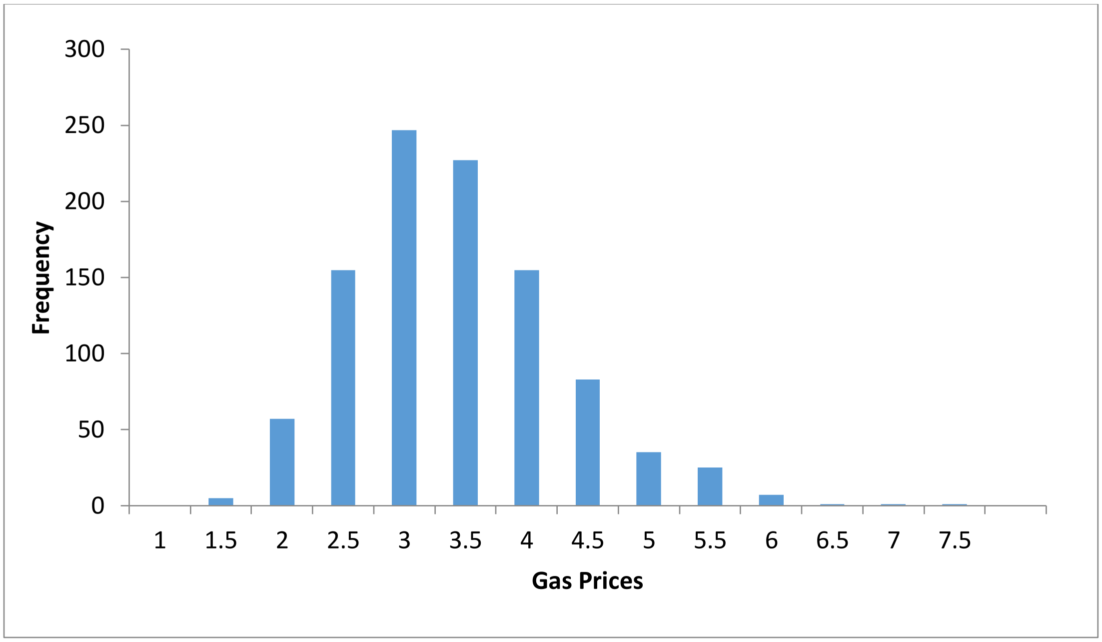

Figure 5. Distribution of Simulated Gas Prices

However, it is not appropriate to assume a constant as price over ten years due to the inter-annual price volatility. For each of the ten years, I generate 1,000 independent and identically distributed (IID) gas prices from the same lognormal distribution. This follows the assumption that the volatility of gas prices is the same in each year because they are based on the same distribution. I input these samples into the base case model to obtain NPV samples for conventional cars that account for gas price volatility.

For each gas price sample, I multiply it by the 428.57 gallons per year that I previously calculated. I calculate the 10-year NPV of the gas prices for each sample and I include the constant insurance and maintenance costs in this calculation by adding their 10-year NPV as well as the one-time upfront cost, all from the data in the previous discounted cash flow table. I use the 1000 NPV samples to generate histograms and perform threshold and sensitivity analyses.

Chapter 4

Results

From the cost model and Monte Carlo analysis, I generate resulting histograms that represent the net present value of conventional gasoline cars. I chose to analyze the gas price variable because of its historical variation and future potential to spike or decline based on supply and demand. This histogram, shown in Figure 6, reflects the gas price volatility accounted for in the lognormal distribution generation of conventional car NPV.

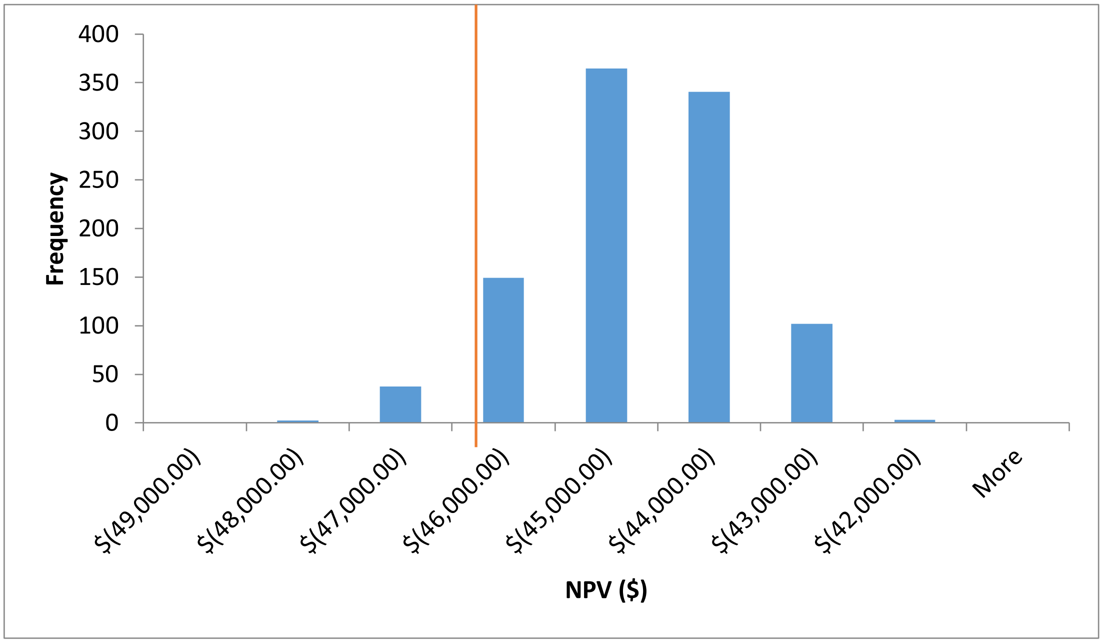

Figure 6. Conventional Car NPV

4.1 Threshold Analysis on EV Upfront Cost

Using these results, I perform a threshold analysis to compare this distribution to the previously calculated discounted electric vehicle cost of -$46,024.09 shown by the orange line in Figure 6. 66.3% of the simulations are more expensive than the base case NPV for the electric vehicle. This means that the EV will only be economical if inflation-adjusted gas prices remain in the upper one-third of their historical distribution, on average, over the life of the car.

I evaluate how cheap the electric vehicle will need to get for it to be more economical 95% of time. To do this, I determine the 95th percentile of the above gasoline car NPV distribution, or the value that 950 of the 1000 samples are more expensive than. This value comes out to be $43,628, meaning that 95% of gasoline car simulations are more expensive than this value. This is the threshold value that the electric vehicle NPV must be so that in 95% of the Monte Carlo simulations, it is less expensive than the gas vehicle. This is not far off from the base case electric vehicle NPV of $46,024.09.

One of the biggest elements of the electric vehicle cost that can deter consumers from buying them is the upfront purchase price. This is why I evaluate what this price would have to be so that 95% of the time the EV is cheaper compared to the gasoline car on a NPV basis. Using the goal seek function I set the electric vehicle NPV equal to the 95th percentile gasoline car NPV of $43,628 by varying the upfront cost. The upfront cost that satisfies this condition is $24,603.91, which is reduced from the original data point of $27,000. This result makes sense because in order to make the electric vehicle more attractive to consumers in comparison to gasoline cars, the upfront cost would have to be reduced.

4.2 Sensitivity Analysis on Gasoline Prices

I examine the effect of fuel price volatility on the gas NPV 95% threshold by performing a sensitivity analysis on the standard deviation of the gas price distribution. The original standard deviation was 0.27 so I create two scenarios by varying this to 0.1 and 0.4, everything else remaining constant. The two resulting present discounted cost (NPV) distribution histograms are shown below.

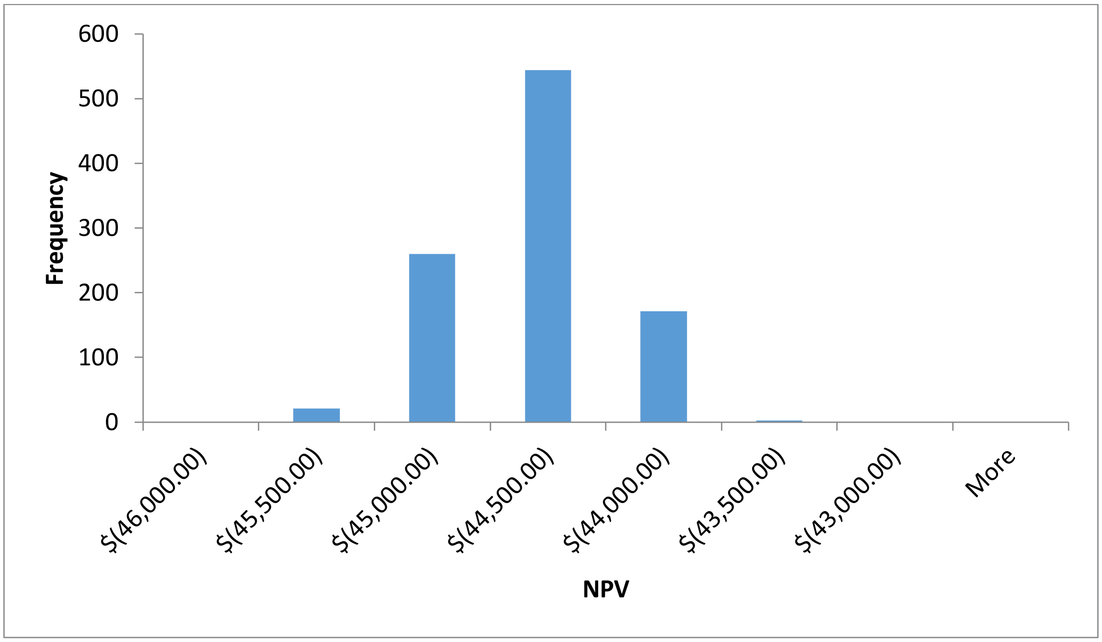

Figure 7. PDC Distribution (σ = 0.1)

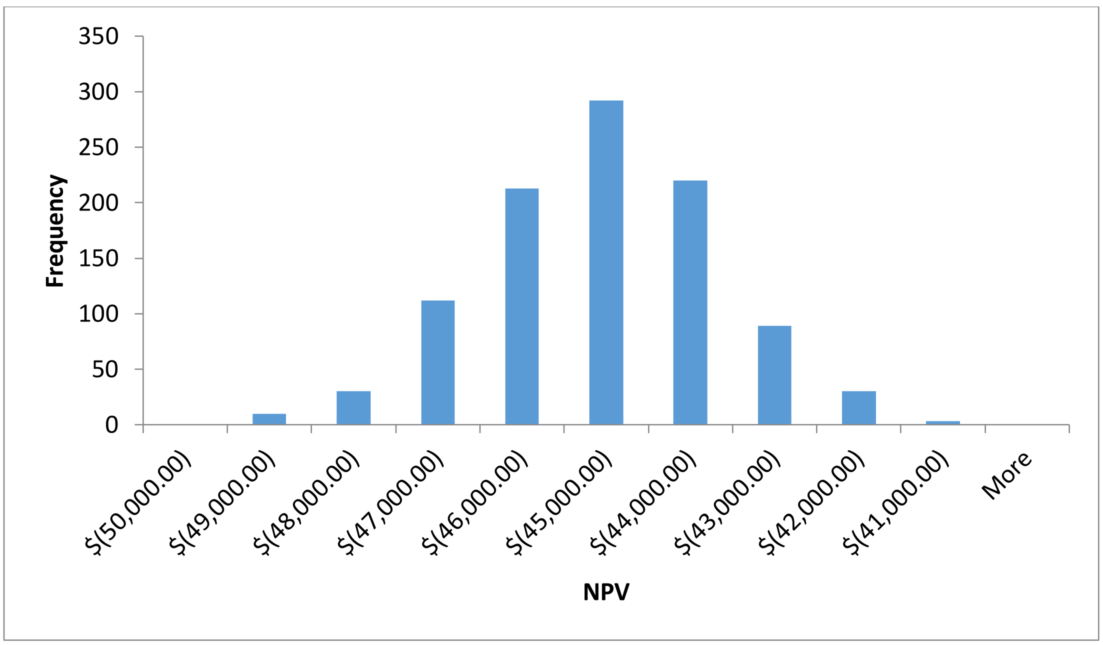

Figure 8. PDC Distribution (σ = 0.4)

It is apparent by the shape and x-axis range values that this change influences the spread of the distribution. For the smaller standard deviation, the data is much closer together, and for the larger standard deviation, it is more spread out. The means of the original, smaller deviation, and larger deviation scenarios are -$45,169.83, -$44,814.39, and -$45,547.53, respectively. These are all very close with only slight variation due to new random sample generation of gas prices. I perform the same threshold calculation for these two scenarios as I did with the original to determine the cost of electric vehicles so that that 95% of gasoline car samples are more expensive. The value where 95% of samples are more expensive for the case with the smaller distribution is $44,290 and the value is $43,327 for the larger standard deviation distribution. These numbers make sense because they are above and below the original cost value of $43,628. I then perform the same threshold analysis for the electric vehicle upfront cost on each of these cases to find the level that the upfront cost would have to be to make electric vehicles cheaper 95% of the time. This yields results of $25,265.91 and $24,302.91 for the smaller and larger standard deviation cases, respectively. Comparatively, the base case standard deviation upfront cost was $24,603.91. Figure 9 shows graphically how this threshold changes on an upward trajectory with the standard deviation of gas prices.

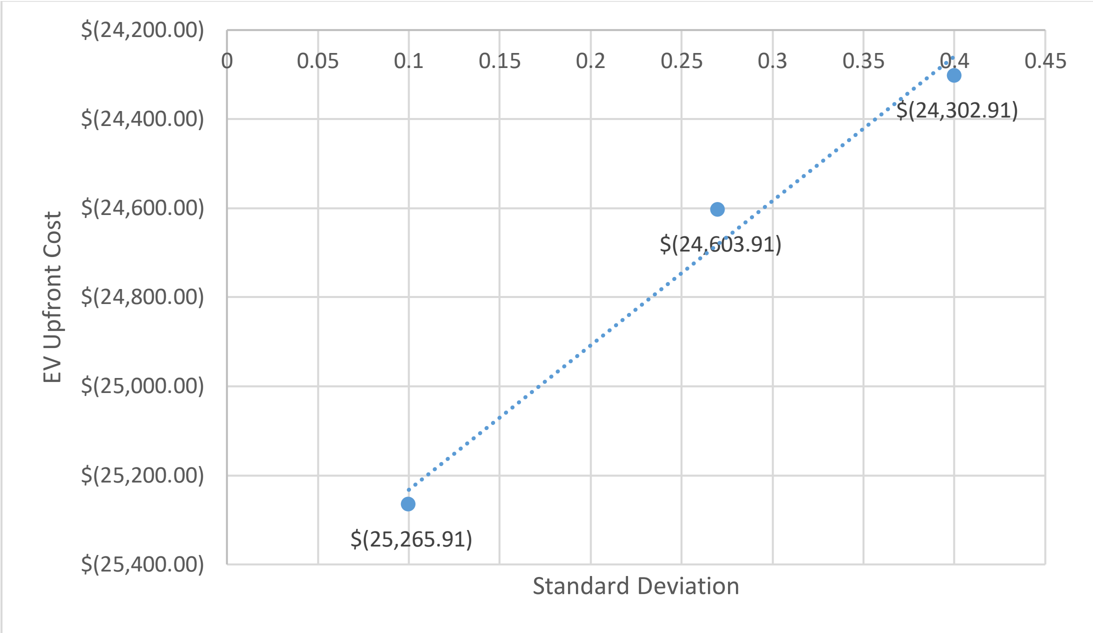

Figure 9. Gas Price Variability Effect on Upfront Cost Threshold

The points on the graph are the levels that the upfront cost of electric vehicles would have to be at so that 95% of the gasoline car samples are more expensive. The positive correlation of all three threshold values with the standard deviation of the NPV distribution indicates that higher gas price volatility requires less reduction in the upfront cost of electric vehicles from $27,000 to become the economically favorable choice.

4.3 Sensitivity Analysis on Gasoline Prices and EV Upfront Cost

I perform a second sensitivity analysis that looks at two variables at once. I vary gasoline prices and the upfront cost of electric vehicles at the same time to determine their combined effect on the difference in NPV for the two car types. These two variables have a significant impact on the breakeven point of the two cars. I create a heat map in excel that represents the difference in cost (electric NPV – gas NPV) using the data table function. The result is shown in

Figure 10. The blue (negative) areas are where the gasoline car is more favorable, and the red (positive) areas are where the electric vehicle is more favorable as shown in the legend.

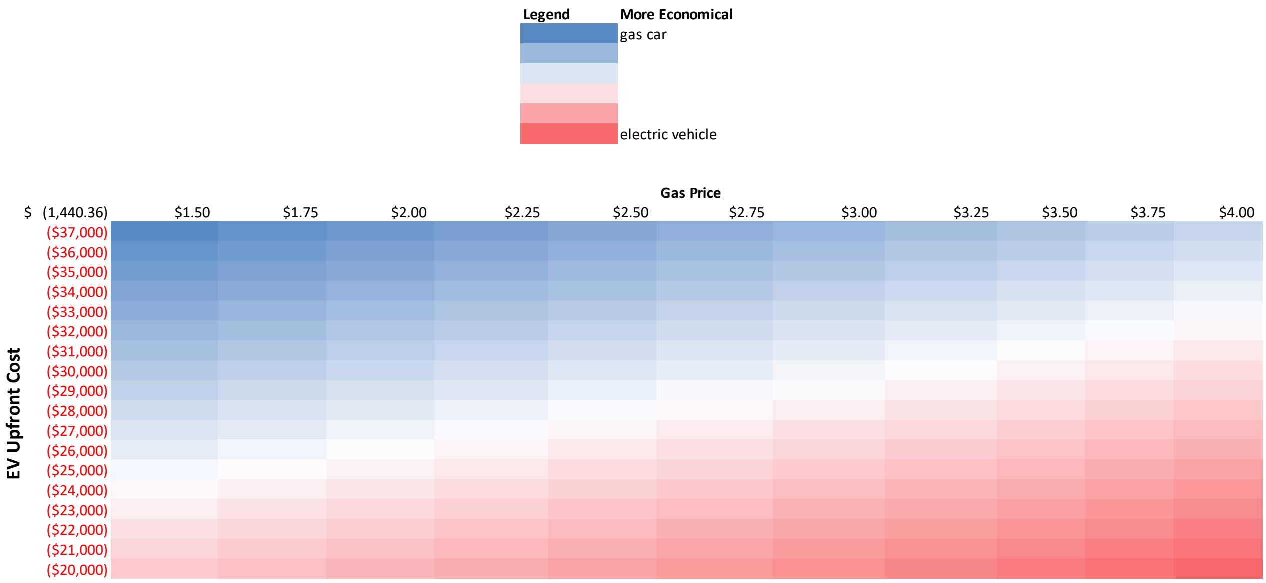

Figure 10. Upfront Cost vs. Gas Price Heat Map

The results of this table are that as gas prices increase, the difference becomes more positive, which is where electric vehicles are more favorable. As the upfront cost of EVs increases, the difference becomes more negative, which is where gasoline cars are more favorable. Overall, the electric vehicle is the better choice at higher gas prices and lower upfront costs and the gasoline car is the better choice at lower gas prices and higher upfront costs. This makes sense because each car will be less expensive in the cases where the costs associated with the other car increase. The uncertainty of the future of these prices is why the economic appeal of the cars varies at different cost levels.

Chapter 5

Conclusion

The economics of owning an electric vehicle compared to a conventional gas vehicle are an important consideration for consumers. While a large motivator to purchase an electric vehicle comes from the environmental benefits, there is more to consider when it comes to the life cycle costs of a vehicle. The cost variables that I examine include maintenance, insurance, energy, and purchase price. By creating a cost model that includes these variables over the life of a vehicle, I examine the net present value of both types of cars in a base case scenario. There is lots of uncertainty around what these prices will do in the future, and in particular, the volatility of gas prices. I generate a Monte Carlo distribution of gas prices for each year based on historical gas prices, inflation, and annual variability. I subsequently obtain a distribution for the net present value of gasoline cars that I perform threshold and sensitivity analysis on to further explore the uncertainty of cost variables. I compare the electric vehicle NPV to the threshold NPV of the gasoline cars that 95% are more expensive than. This gives me a useful value for comparison for the electric vehicle NPV. With this information, I adjust cost variables in the model, one at a time, to evaluate how they affect the decision between cars. The upfront cost can be reduced in order to make the electric vehicle cheaper than 95% of the gasoline car samples, and thus, more appealing. I also perform sensitivity analyses on the gas price volatility and the EV upfront cost. In essence, the results indicate that more volatile gas prices make the electric vehicle the economical choice, whereas higher ranges of upfront costs for EVs make conventional gasoline cars more appealing.

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ACADEMIC VITA

NAYA PANDEY

EDUCATION

The Pennsylvania State University | Schreyer Honors College — **University Park, PA**
College of Earth and Mineral Sciences
Bachelor of Science in Energy Business and Finance — *Class of May 2023*

RELEVANT EXPERIENCE

Deloitte & Touche LLP — **Arlington, VA**
Risk and Financial Advisory Intern — *Jun 2022 – July 2022*

- Collaborated with my project team to develop Enterprise Risk Management (ERM) materials to present risk appetite and tolerance, risk profile, and risk response templates for our client
- Researched industry best practices and regulations regarding identifying and responding to top risks to guide our client in maturing their ERM program
- Networked and frequently communicated with clients and company personnel
- Supported the Tech Enablement firm initiative by categorizing Deloitte digital assets under each of the ERM process steps

Penn State Smeal College of Business — **University Park, PA**
Finance 301 Teaching Assistant — *Jan 2022 – Aug 2022*

- Evaluated student assignments and provided appropriate feedback on work
- Reviewed and revised lesson materials to include updated finance definitions and examples Assisted students in office hours with questions on content and course logistics

Penn State College of Earth and Mineral Sciences — **University Park, PA**
Energy Mineral Engineering Intern — *May 2021 – Aug 2021*

- Collaborated with a team to explore methane sources and their atmospheric warming effect
- Performed cost-benefit analyses of potential methane reductions and offsets for Penn State to get closer to carbon neutral

Penn State Campus Recreation — **University Park, PA**
Building Supervisor — *Oct 2019 – Present*

- Oversee all operations and activity to ensure member satisfaction and safety
- Supervise facility attendant staff performance and tasks
- Authorize club group room uses and address any questions or concerns

LEADERSHIP AND INVOLVEMENT

Kappa Alpha Theta — **University Park, PA**
Dancer Relations THON Committee — *Jan 2020 – Present*

- Assisted with the organization of fundraisers and service events such as the blood drive and local restaurant fundraisers, as well as our philanthropy, Court Appointed Special Advocates
- Planned for THON weekend for our dancers and scheduled snack baskets and moral boosts to be delivered to them throughout the weekend

HONORS, SKILLS, AND INTERESTS

Honors: Dean’s List, National Merit Commendation, AP Scholar with Distinction, National Honor Society
Skills: Proficient Knowledge of Microsoft Office, SolidWorks, Python, Java, R; Excellent Communication; Organization