SHIFT OF FUEL CHOICES TOWARDS EV: A COMPARATIVE ANALYSIS OF CONVENTIONAL AND ELECTRIC VEHICLES IN THE U.S.

IE 6200 – ENGINEERING PROBABILITY AND STATISTICS

GROUP 4 PROJECT PRESENTATION

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INTRODUCTION

- In the dynamic automotive realm, electric vehicles (EVs) disrupt traditional norms, spurred by rising gas prices and environmental concerns.
- This project explores the shift, analyzing sales trends among conventional, alternative fuels, and EVs in the US.
- It aims to present a comprehensive overview of the purchasing trends of car buyers to outline the path it is on.

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PROBLEM STATEMENT

- The idea of electric vehicles was harshly scrutinized when it was first proposed but now opinions have begun to shift.

- With the release of the first commercially available electric vehicles, steadily increasing gas prices, and environmental concerns there has been a shift in consumers beginning to purchase vehicles that utilize alternative fuel options.

- This project aims to conduct a comprehensive comparative analysis, scrutinizing the sales trends of conventional and alternative fuel type vehicles versus electric.

- One of the key objectives of the project is to analyze whether EV trends are rising enough to overcome conventional fuel usage.

DATA COLLECTION

State	Electric (EV)	Hybrid Electric (PHEV)	Hybrid Electric (HEV)	Biodiesel	Ethanol/ Flex (E85)	Natural Gas (CNG)	Gasoline	Diesel	Unknown Fuel	Electric	Alternative	Conventional
Alabama	8,700	4,400	50,800	48,100	449,800	100	4,077,100	126,100	30,300	63,900	498,000	4,203,200
Alaska	2,000	700	9,000	8,700	48,600	0	457,100	30,500	5,500	11,700	57,300	487,600
Arizona	65,800	20,400	150,800	61,200	446,000	600	5,476,100	198,700	70,100	237,000	507,800	5,674,800
Arkansas	5,100	2,500	30,600	33,300	283,900	200	2,229,500	89,700	10,600	38,200	317,400	2,319,200

DATA COLLECTION CATEGORIES FOR FURTHER ANALYSIS

Yearly Data	Electric	Alternative	Conventional	Electric+Alternative	Electric Difference	Alternative Difference	Conventional Difference
2016	4,275,900	22,859,900	232589100	27,135,800	447,300	2,800,600	3104500
2017	4,757,700	25,270,800	235531500	30,028,500	481,800	2,410,900	2942400
2018	5,276,300	26,897,600	237353900	32,173,900	518,600	1,626,800	1822400
2019	5,833,100	28,101,400	239909700	33,934,500	556,800	1,203,800	2555800
2020	6,427,000	28,518,800	240852700	34,945,800	593,900	417,400	943000
2021	7,733,000	23,479,800	247809800	31,212,800	1,306,000	-5,039,000	6957100
2022	**9,746,500**	**23,458,400**	248529800	33,204,900	2,013,500	-21,400	720000

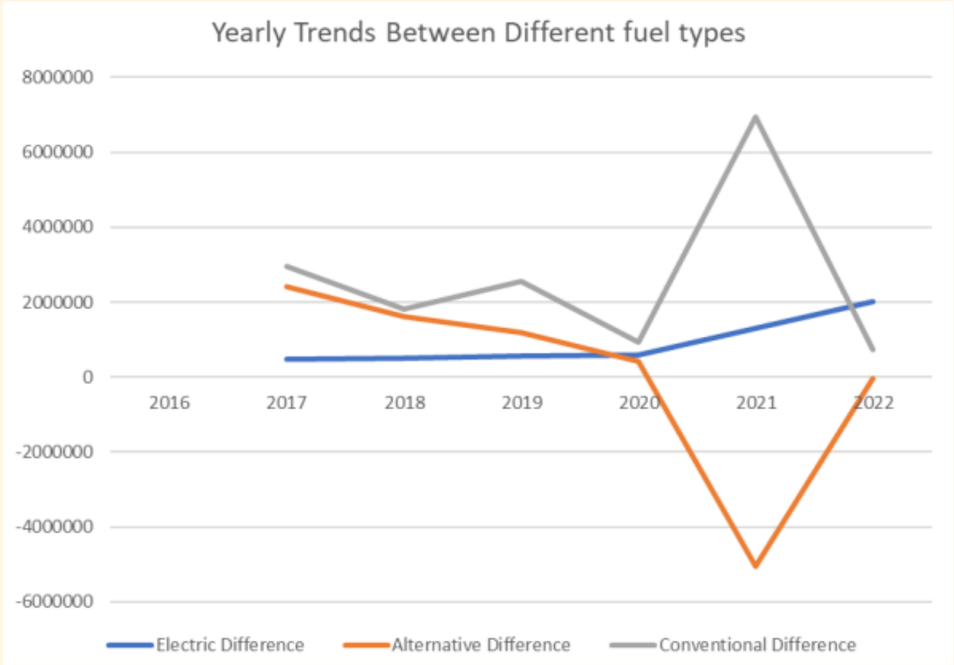
WE SELECTED SPECIFIC CATEGORIES FOR OUR FURTHER STATISTICAL ANALYSIS SUCH AS ELECTRIC, ALTERNATIVE AND CONVENTIONAL

FEATURES AND DATASET

- The data set contained a subset of 4 attributes.
- Date: Year(month and day) that the vehicle was bought.
- State: What state the the where the vehicle was bought.
- Electric Vehicle Total: The number of electric vehicles purchased.
- Non-Electric Vehicle Total: The number of non-electric vehicles purchased.
- Vehicle sales data came from one source, while fuel economy data was obtained from another, both linked to the US Department of Energy (Alternative Fuels Data Center and Fuel Economy US website).

DATA VISUALIZATION

Fig 1 : Trend of all type of vehicles in USA
From 2017 to 2022



- The sales trend for conventional vehicles in the USA has exhibited consistent stability over the past decade, showcasing a steady and enduring trajectory in consumer demand.

- The sales trend for alternative fuel vehicles mirrors a decline in consumer demand.

EV'S VS CONVENTIONAL SALES

Fig 2 : From 2017 to 2022

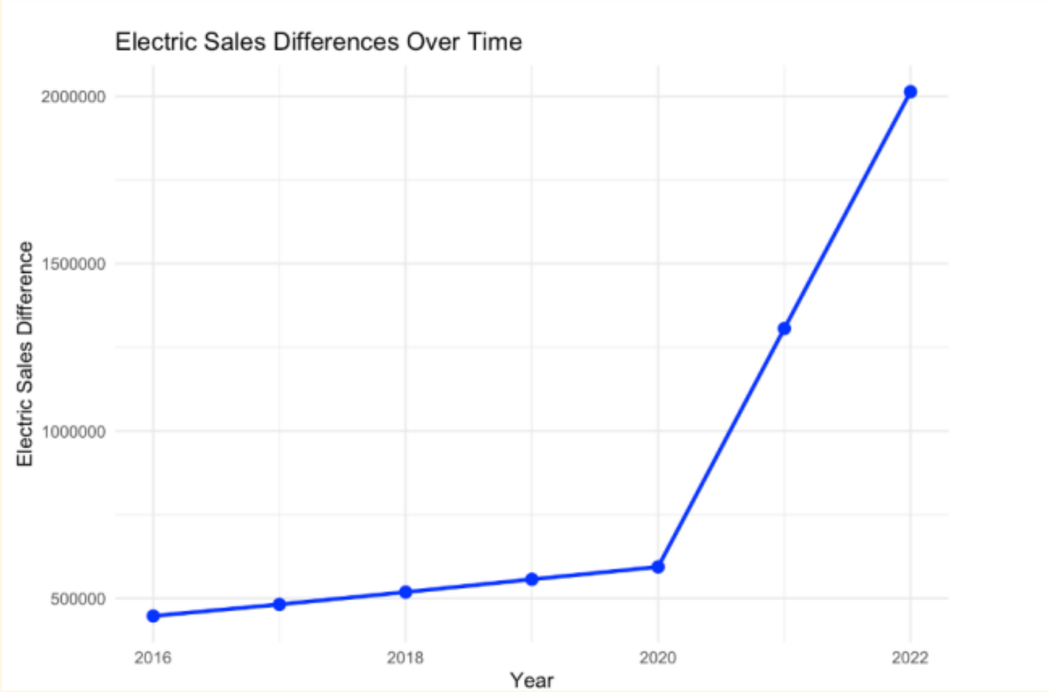
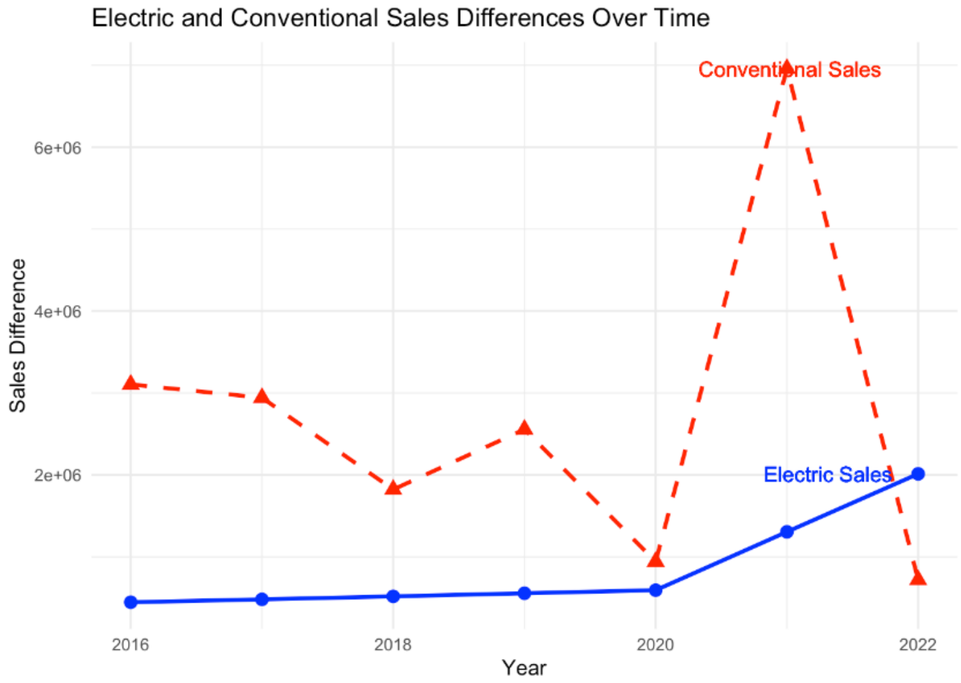


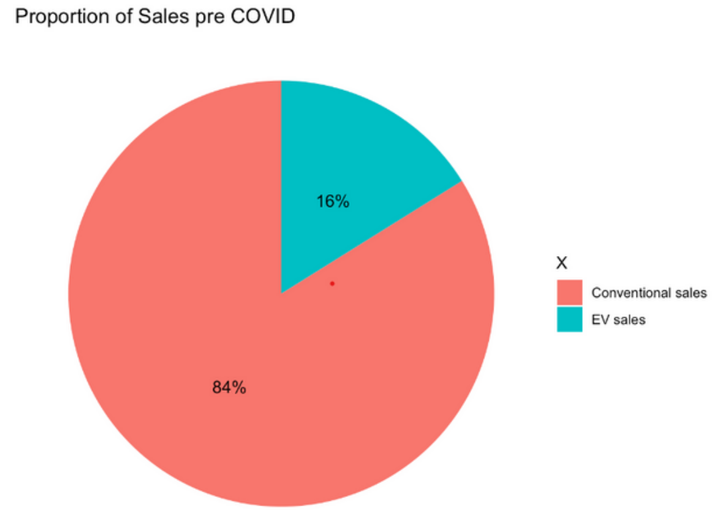
Fig 3 : From 2017 to 2022

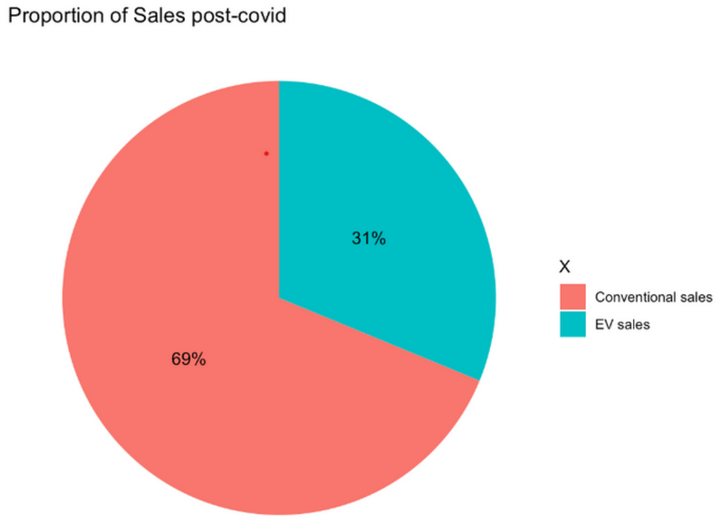


- Over the past six years, the demand for electric vehicles (EVs) among consumers in the USA has shown a consistent upward trajectory, indicating a sustained growth of about 27.82% in sales between 2020 to 2022

DATA PROCESSING

- After combining the data for all three segments we can see the surge in the post covid sales of EV vehicles.
- The vast majority, accounting for 84%, preferred conventional vehicles pre covid, while electric vehicles (EVs) make up only 16% of the market share.
- on the contrary we can see that post covid, there is a decrease in Conventional vehicle sales and increase in EV vehicle sales by 15%.





DATA PROCESSING

- Our analysis encompasses five key states in USA: Massachusetts (MA), New York (NY), Florida (FL), New Jersey (NJ), and Georgia (GE).

- The resulting line graph we achieved vividly illustrates a consistent and impressive uptick in electric vehicle (EV) adoption across these regions.

- This graphical representation serves as compelling evidence of a substantial and simultaneous surge in EV integration within the transportation landscape of these states.

- It highlights a pronounced shift towards sustainable travel choices, showcasing the growing interest and widespread acceptance of EVs across the USA area.

SALE TRENDS

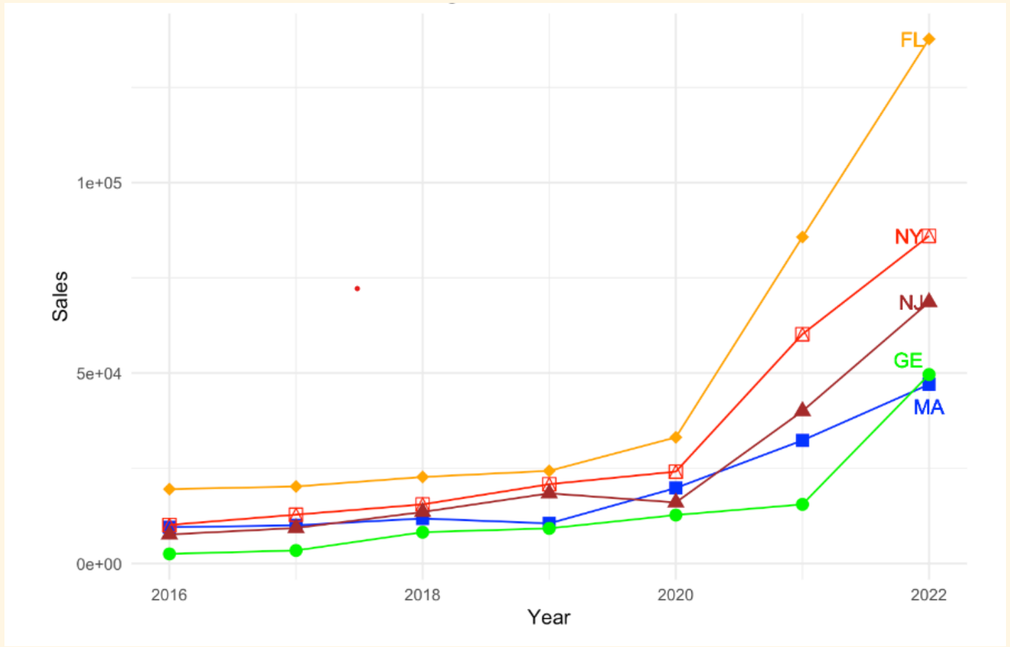


Fig 4 : The trend of electric vehicle (EV) utilization in the five states in USA.

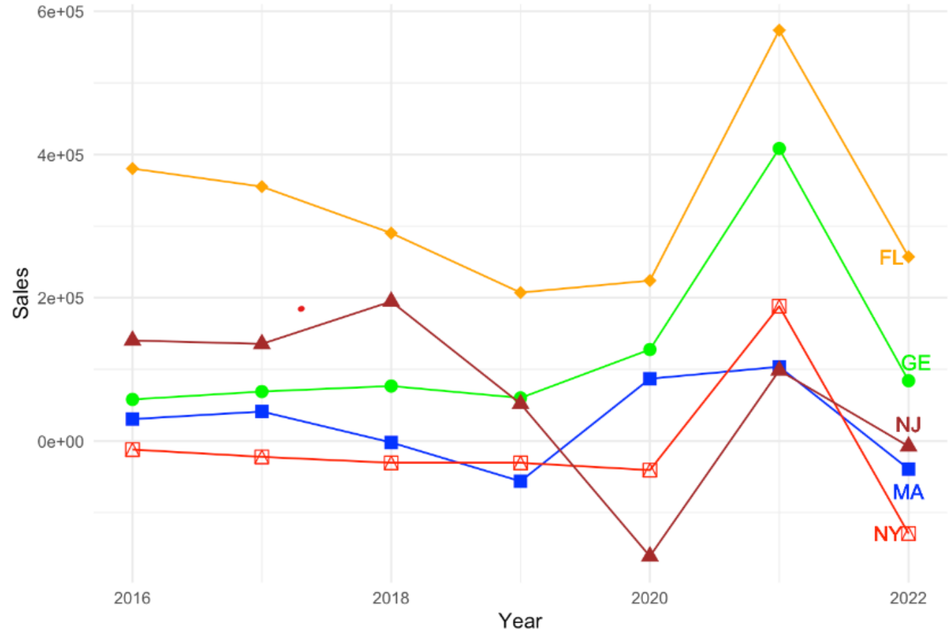


Fig 5 : The trend of traditional fuel-based vehicles in the five states in USA.

STATISTICAL ANALYSIS

PRE - COVID

BOX PLOT

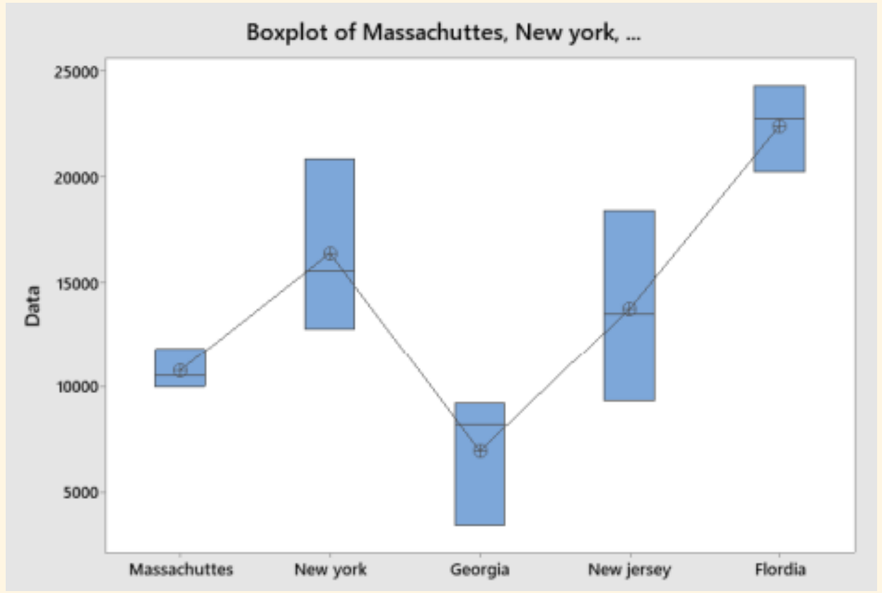


Fig 6 : Mean EV sales in 5 states

CONFIDENCE INTERVALS PLOT

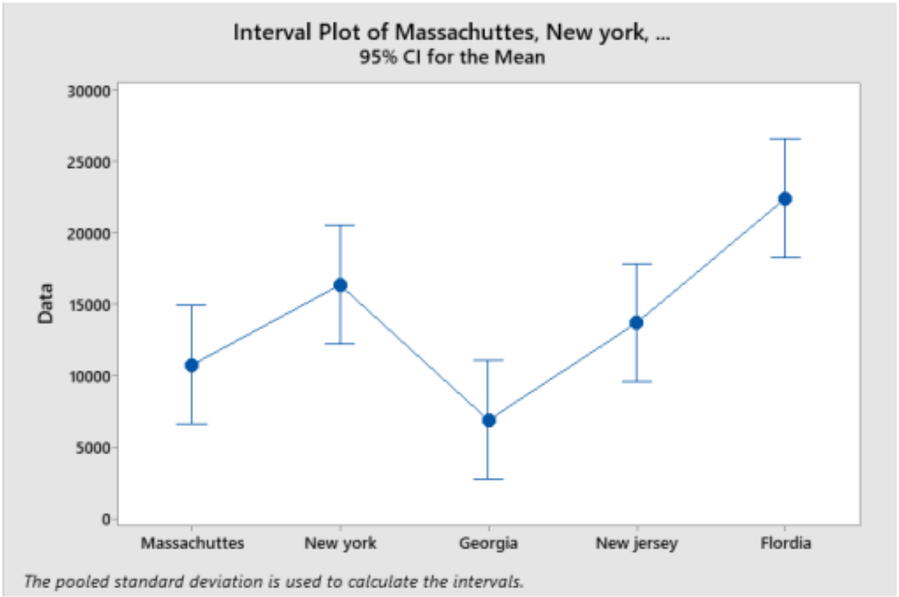


Fig 7 : Mean EV sales in 5 states

STATISTICAL ANALYSIS

POST - COVID

BOX PLOT

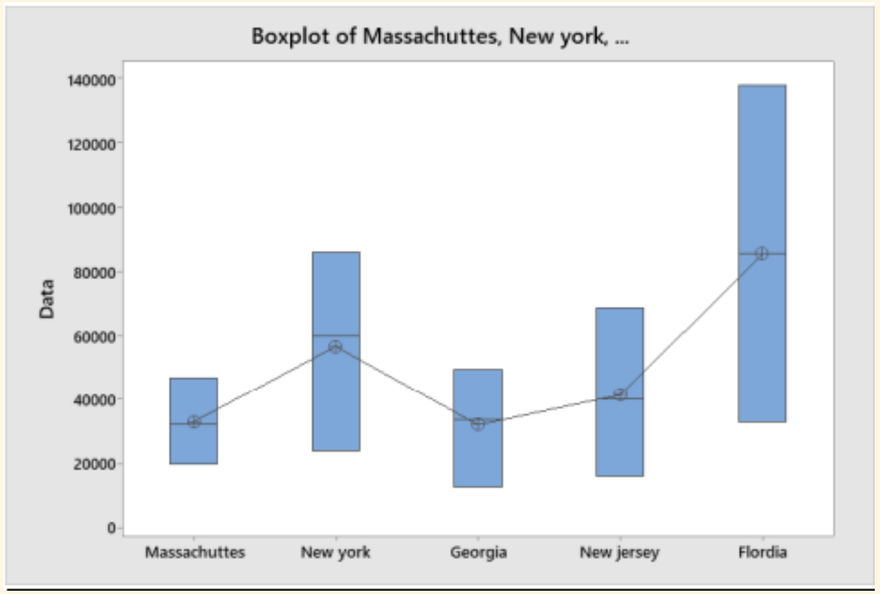


Fig 8 : Mean EV sales in 5 states

CONFIDENCE INTERVALS PLOT

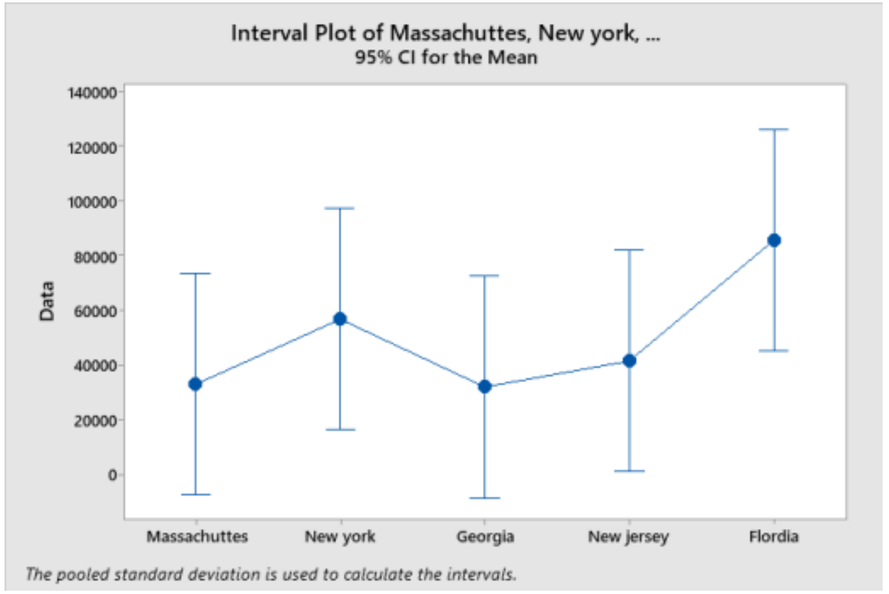


Fig 9 : Mean EV sales in 5 states

STATISTICAL ANALYSIS

HYPOTHESIS TESTING

Test 1(All Years)

Testing for Significance Difference in EV Sales Mean vs. Conventional Sales Mean

- H0 : The mean of EV sales is equal to the mean of conventional vehicle sales.
- H1 : The mean of EV sales is not equal to the mean of conventional vehicle sales.
- **p-value of 0.0001608, rejected the Null hypothesis.**
- There is a difference .

Test 2 (2016-2019)

Testing for Significance Difference in EV Sales Mean vs. Conventional Sales Mean

- H0 : The mean of EV sales is equal to the mean of conventional sales.
- H1 : The mean of EV sales difference is not equal to the mean of conventional sales .
- **p-value of 0.0004527, rejected the Null hypothesis**.
- There is a difference.

STATISTICAL ANALYSIS

HYPOTHESIS TESTING

Test 3(2020-2022)

Testing for Significance Difference in EV Sales Mean vs. Conventional Sales Mean

- H0 : The mean of EV sales between 2020 and 2022 is equal to the mean of conventional sales
- H1: The mean of EV sales between 2020 and 2022 is not equal to the mean of conventional sales
- **p-value of 0.1571, Failed to reject the Null hypothesis**
- No significant difference

RESULT

Tests	P - Value	Null - Hypothesis
All years	**0.0004527**	Rejected
2016 - 2019	**0.0001608**	Rejected
2020 - 2022	**0.1571**	Failed Rejection

- **Between 2020 and 2022, insufficient evidence to reject the null hypothesis.**
- **Therefore, buyer preference for EVs > Conventional vehicle preferences.**
- **Especially after the impact of COVID-19.**

STATISTICAL ANALYSIS

ANOVA TESTING

PRE - COVID

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	4	409849333	102462333	9.84	0.002
Error	10	104106667	10410667		
Total	14	513956000			

Fig 10

- Indicates we must reject the null hypothesis
- There is a statistically significant difference between the means.

POST - COVID

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Factor	4	5960857333	1490214333	1.51	0.271
Error	10	9847606667	984760667		
Total	14	15808464000			

Fig 11

- Indicates we must accept the null hypothesis.
- There is no statistically significant difference between the means of the samples.

CONCLUSION

- All testing and analysis completed throughout the course of this project indicated an upwards trend in the purchasing of electric vehicles across the entire united states.
- The beginning of the increase was seen after the pandemic which began in 2020 and the purchase of EVs rather than conventional vehicles has only continued to rise. Outside of another global pandemic or national crisis.
- The project acknowledges a limitation in delving into the intricate details of charging infrastructure challenges for electric vehicles.
- Further research is needed to implore long term implication and Identify additional factors.

THANK YOU