Research on the Impact of Financial Subsidies on Sales of China's New Energy Vehicle Industry and the Optimization of Measures

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Abstract. In the energy crisis, the development of new energy enterprises is particularly noticeable, and the subsidy policies for related enterprises are constantly being adjusted. The research topic of this paper is: to investigate the impact of financial subsidies from 2017-2019 on sales of China's new energy vehicle industry and the optimization of measures. Relevant conclusions are drawn by studying the relationship between the changes in the car sales of BYD, BAIC, and ROEWE enterprises and the changes in the relevant subsidy policies within the specified period. Second, use the qualitative study to conduct mathematical analysis on the annual sales reports of the three enterprises, and observe the impact of subsidy policies on them through data trends and changes. The results derived from the research are the reduction in subsidy did have a relatively large impact on sales, but the overall sales managed to hold firm due to the increase in the variety of models. The research also found that new energy vehicles are more accepted and sold in economically developed regions, especially in cities with limited licenses, such as Shanghai. Climate conditions were also a factor: the overall sales for Guangdong Province outnumbered Liaoning Province, which has a higher latitude. The fluctuation in sales trends in all cities is similar. The research suggested domestic NEV companies should continue to improve the technologies of motors, electronic control systems, and batteries to maximize the endurance mileage in dealing with the fiercer competition in the NEV market.

Keywords: Financial subsidies; China; New energy vehicle industry; Optimization measures.

1. Introduction

1.1 Research background

Since 2009, China has offered subsidies to boost the production and sales of new energy vehicles. But in the early years, the market for new electric vehicles was not mature enough either on a technological level or consumers' level of acceptance; thus, every year, only a small number of electric cars were being made and sold. As time passed, with more advanced techniques being used in the market, the scale of the industry in China expanded rapidly. It showed a sustained increasing trend during the five years from 2013 to 2018, and the average annual growth rate of new energy vehicle sales was maintained at more than 50%. In 2016, 507,000 new energy vehicles were sold in China, occupying 1.8% of the total car sales in that year. In 2017, 777,000 new energy vehicles were sold in China, indicating a growth of 53.3% year on year and accounting for 2.7% of the total car sales, which was 0.9 percent higher than the previous year. In 2018, 1.256 million new energy vehicles were sold, accounting for 4.5 percent of the total vehicle sales, 1.8 percentage points higher than the previous year. Although the overall sales of new energy vehicles decreased year-on-year in 2019, it still had a 4.7% of the total sales, which was higher than that in 2018 [1].

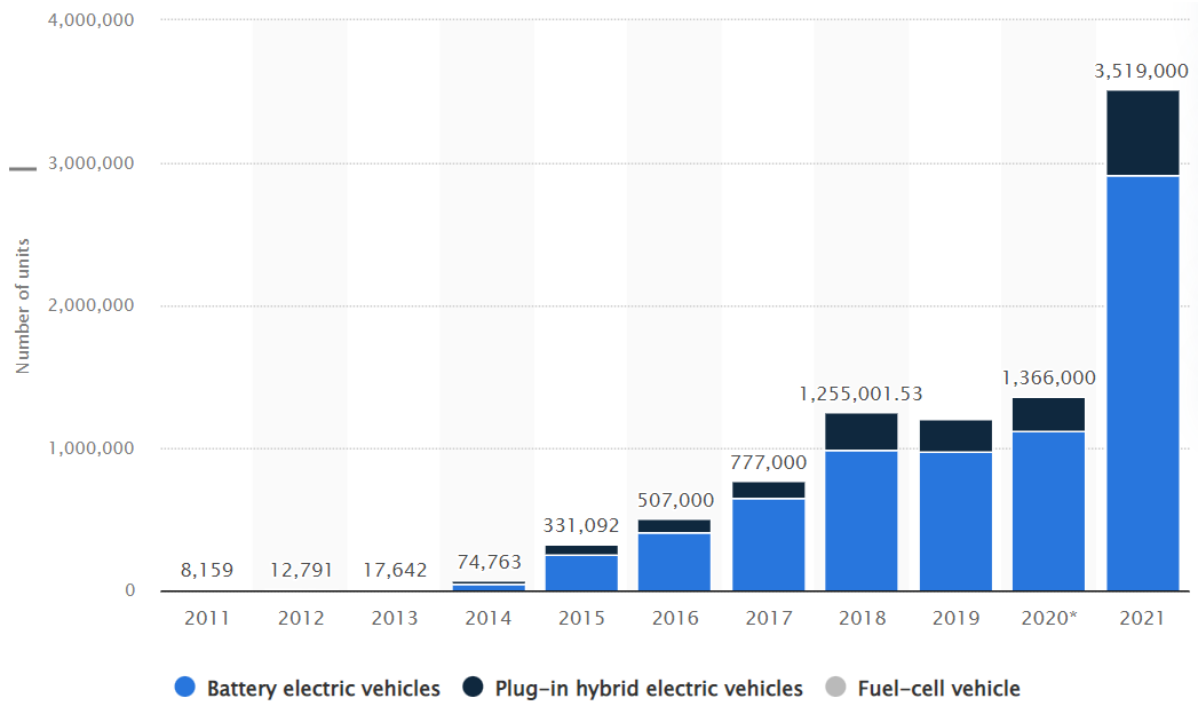

Figure 1. Number of sales of EV vehicles in China from 2011 to 2021

One of the numerous reasons for this dramatically fast growth is the subsidy offered by the government. By March 2019, the central government had issued a total of 95.84 billion yuan of special financial subsidies for new energy vehicles [1]. For 2019, 13.69 billion yuan was used for subsidy [2]. Millions of consumers have benefited directly from it, further guaranteeing the healthy development of the new energy vehicle industry. The central government's subsidies for new energy vehicles have played an irreplaceable role in industrial development.

However, since 2017 there has been a subsidy reduction since more companies are entering the market, and sales would certainly be affected.

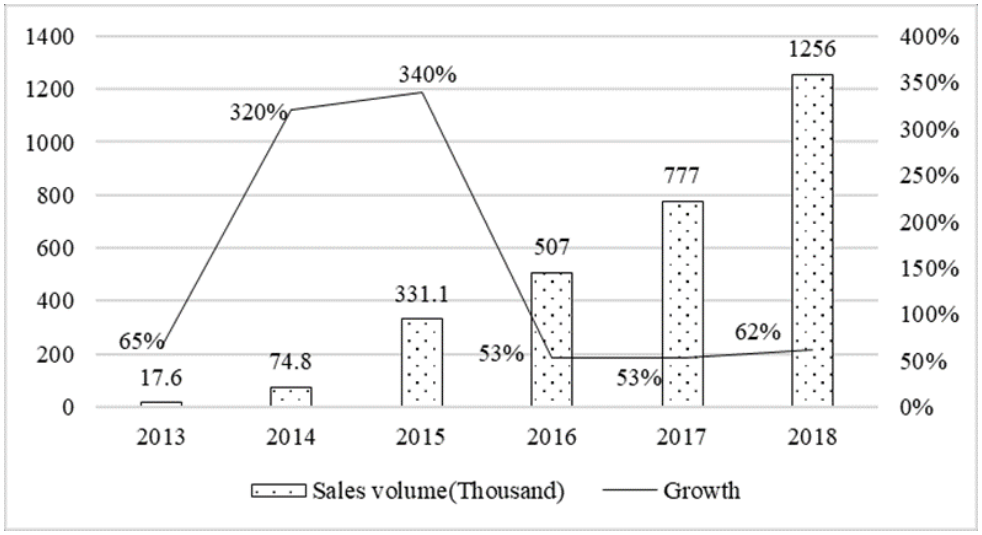

Figure 2. China EV sales growth rates

The overall sales statistics in figure 1 showed that even after the subsidy reduction in 2017, the sales growth rate in 2018 was still more than 60%. But once the new subsidy reduction was issued in March 2019, the NEV market situation plummeted. Especially when the transitional period was over in July, EV sales started to fall and continued for six consecutive months. Eventually, in 2019, the NEV sales growth rate fell to a negative number for the first time in China. But in terms of some of

the car manufacturers in the domestic market, their decline caused by the reduction in the subsidy was unknown and not easy to evaluate.

1.2 Literature Review

Zhang analyzed that under the background of implementing a pilot subsidy policy for new energy vehicles in China, the development level of new energy vehicles determines that different enterprises adopt different strategies in obtaining subsidies. The government can adjust the subsidy policy: in the early stage of new energy vehicle research and development, enterprises should be appropriately subsidized; Before new energy vehicles are listed, attention should be paid to the establishment of infrastructure for new energy vehicles; After new energy vehicles enter the market, provide the necessary support to those who buy new energy vehicles and expand the market share of new energy vehicles. The current policy of subsidizing consumers cannot solve the dilemma of sluggish production and sales with the help of the asset utilization theory, which analyzes the subsidy destination of vehicle manufacturers and the key technology suppliers within the manufacturer. The results show that the key to industrial and market development is subsidizing key technology suppliers to promote technological progress. Currently, many countries' subsidies to electric vehicle manufacturers are also set for some key technologies. The whole vehicle manufacturers, spare parts, and key technology suppliers in China's electric vehicle industry have not yet formed an integration. The government can subsidize spare parts directly to avoid interception, occupation, and blackmail. In addition, attention should be paid to avoiding disputes under the WTO framework.

1.3 Research framework

Therefore, this research aims to investigate to what extent the China EV subsidy policy from 2017-2019 affected the number of sales for NEV. Relevant research did not investigate to what extent this reduction in policy will mean to the car manufacturers but only on a more general and broader scale. As a result, this research would provide clear information on the negative influence caused by the subsidy to electric vehicle manufacturing companies.

2. Research Design and Methods

2.1 Quantitative Research

Quantitative research is the process of collecting and analyzing numerical data. It can find patterns and averages, make predictions, causal test relationships, and generalize results to wider populations. Quantitative research is the opposite of qualitative research, which involves collecting and analyzing non-numerical data (e.g., text, video, or audio) [3]. This article focuses on China's EV subsidy policy's impact on NEV sales from 2017-2019. As a result, the research will analyze the relevant quantitative data collected from NEV companies about the sales of new energy vehicles from 2017-2019. In this article, the methods mainly used are correlational research and descriptive research. The relationship between EV subsidy policy and new energy vehicle sales is expected using correlational research. Using descriptive research, the overall tendency of changes among variables and descriptive and detailed summary is expected from the analysis. Among the research, outliers found from analyzing the descriptive statistics, including finding the average and the mode, would be excluded. Using quantitative research, reliable, valid, and accurate data can be correctly collected and analyzed. Another advantage of using quantitative research is that various biases would be eliminated by objective and rational data analysis. Using quantitative research could be effective and less time-consuming among different variables of car sales.

2.2 Case Study

A case study is a detailed study of a specific subject, such as a person, group, place, event, organization, or phenomenon. Case studies are commonly used in social, educational, clinical, and

business research [4]. This research focuses on several important and representative new energy vehicle companies: BYD, BAIC, and ROEWE. BYD is committed to helping bus and coach operators transition seamlessly from traditional diesel power to 100% emissions-free, pure electric mobility; BYD, the leading European EBus manufacturer, is at the forefront of the growing trend for global transport electrification [5]. BAIC Motor is a leading passenger car manufacturer and service provider in China and a leading new energy vehicle producer in China. ROEWE has developed seven types of new energy vehicles and received great consumer comments and advice. All three bands have developed a strong base among the population. This research will use these three companies as examples to demonstrate how EV subsidy policy help or impede the research and development of new energy vehicles. The case study method is suitable when researching a specific real-world subject like the topic. Using a case study can help researchers convert observations into more rational and usable data because it can conclude the statistics with direct or indirect observations. With the data from the three companies, a reliable and valid summary and conclusion of the relationship between EV subsidy and NEV sales would be gained from comparing different periods, companies, and sales strategies.

2.3 Variables

Independent variables are the changes in the EV subsidy throughout 2017-2019. During this period, the subsidy was cut twice in both 2018 and 2019.

Table 1. 2017-2019 EV subsidy moderation based on endurance mileage and orders of magnitude

Endurance mileage (km)	2017 subsidy (RMB)	2018 subsidy (RMB)	Transitional period (2.12-6.11)	Post transitional period	2019 subsidy (RMB)	Transitional period (3.26-6.25)	Post transitional period
100-150	2000	0	Decrease by 30%	Cancelled	0	Cancelled	Cancelled
150-200	36000	15000	Decrease by 30%	Decrease by 58.3%	0	Decrease by 90%	Cancelled
200-250		24000	Decrease by 30%	Decrease by 33.3%	0	Decrease by 90%	Cancelled
250-300	44000	34000	Decrease by 30%	Decrease by 22.7%	18000	Decrease by 40%	Decrease by 47.06%
300-400		45000	Decrease by 30%	Increase by 2.3%	18000	Decrease by 40%	Decrease by 57.45%
N400		50000	Decrease by 30%	Increase by 13.6%	25000	Decrease by 40%	Decrease by 50%
Orders of magnitude (Wh/kg)	Times	Times				Times	
90-105	1	cancelled				cancelled	
105-120		0.6				cancelled	
120-140	1.1	1				0.8	
140-160		1.1				0.9	
N160		1.2				1	

Based on Table 1, it showed in 2018, during the transitional period (2.12-6.18), all-electric cars shared a 30% subsidy decrease compared to 2017. But after the transitional period, electric cars with higher endurance mileage could have a 2.3% and 13.6% increase in financial subsidy [6-9]. This moderation signals the government to boost car manufacturers to extend the maximum mileage.

In 2019, subsidy reduction rose to a larger scale. There was no subsidy for cars with an endurance mileage under 250km after the transitional period. Besides, for cars with endurance mileage above 250km, there was also an averaging 50% reduction, which is huge compared to 2018.

The dependent variables are the sales of electric cars from 2017-2019. This research included three domestic brands with many sales during these three years. (BAIC Motors, BYD and Roewe)

Table 2. 2017-2019 BAIC Motors, BYD, and Roewe's cars sales

Brand	Car type	City	Time	Sales
BYD	Yuan EV	Guangzhou	Jan, 2019	88
BYD	Yuan EV	Shenzhen	Jan, 2019	670
BYD	Yuan EV	Foshan	Jan, 2019	51
BYD	Yuan EV	Shenyang	Jan, 2019	25
BYD	Yuan EV	Dalian	Jan, 2019	47
BYD	Yuan EV	Shanghai	Jan, 2019	230
BAIC Motors	EU5	Shenzhen	Nov, 2018	331
BAIC Motors	EU5	Guangzhou	Nov, 2018	246
BAIC Motors	EU5	Shanghai	Nov, 2018	160
Roewe	eRX5 PHEV	Shenzhen	Dec, 2017	624
Roewe	eRX5 PHEV	Guangzhou	Dec, 2017	33
Roewe	eRX5 PHEV	Shanghai	Dec, 2017	2878

2.4 Data

For the data, the researchers used the China Passenger Car Association (CAAM) and the China Association of Automobile Manufacturers (CPCA) as the sources, two official websites that recorded the total sales of cars over the past years. Data was also gathered from some statistical websites where specific city sales were available [10]. Therefore, in this research, seven cities were included to make the comparison in terms of economic power and geographical location. The seven cities include Shanghai, Guangzhou, Shenzhen, and Foshan from the Guangdong province and Shenyang, Dalian, and Anshan from the Liaoning Province. Guangzhou province is located in southern China, where the average temperature is around 20 degrees Celsius. Liaoning is in the northern part, where the average temperature is around negative 15 degrees Celsius during winter. Shanghai is in the middle. Economically speaking, Shanghai is the most developed city in China; Guangzhou and Shenzhen are also two cities with high levels of development. Shenyang and Dalian are two of the best cities in the northern part of China. Relatively smaller cities are also included as a comparison, which is Foshan and Anshan.

In terms of the car type, as the above part has mentioned, this research includes BAIC Motors, BYD, and Roewe, three of the domestic car manufacturing companies. Within the three brands, each has a relatively thorough and complete product line which entails cars with different price levels and endurance mileage.

The research would do a quantitative analysis showing how much percentage of the reduction of sales for these car types was experienced during the three years and analyze why it happened. Eventually, the research would provide the corresponding suggestions to car manufacturers dealing with reducing the subsidy policy.

3. Results

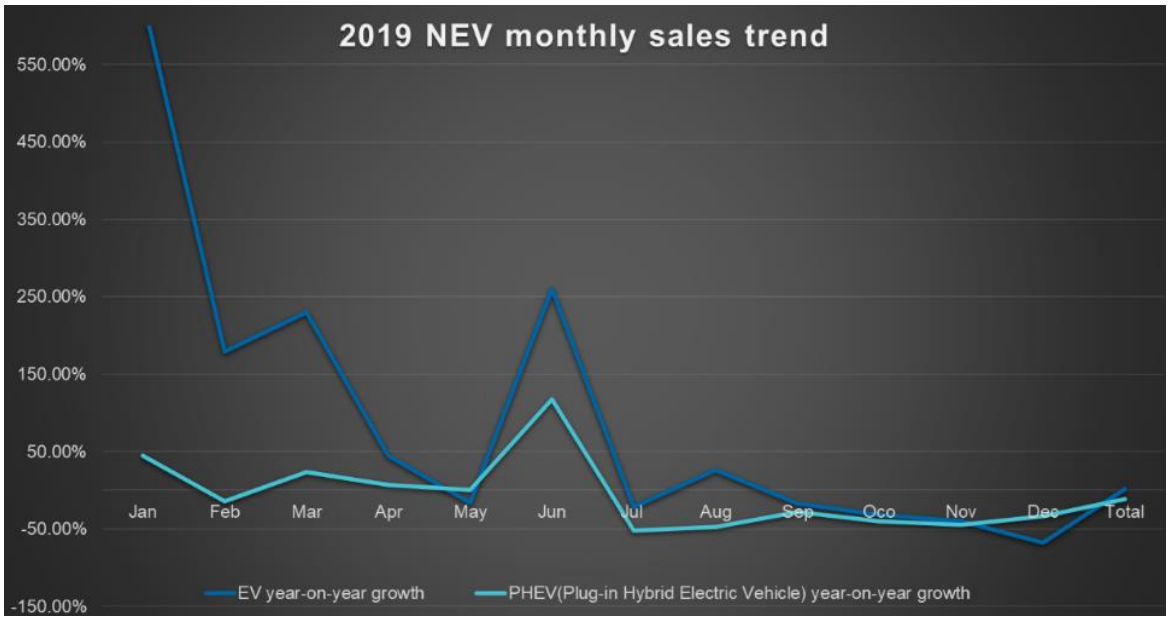

Figure 3. 2019 NEV monthly sales year-on-year growth trend

Figure 3 illustrates the 2019 new electric vehicles' monthly sales growth trend. In January, there was a huge increase in sales compared to the same time in 2018. But entering the transitional period between February 2019 and June 2019, sales started to decrease. Later, at the end of the transitional period, cars with low endure mileage would have any form of financial subsidy provided by the government in the future. Thus, the sales bounced back. The graph indicated whether it is a hybrid or pure electric version, sales in the last six months of 2019 did not have good figures and showed a reduction. In conclusion, the fifty percent reduction in the amount of subsidy will affect new electric vehicle sales largely.

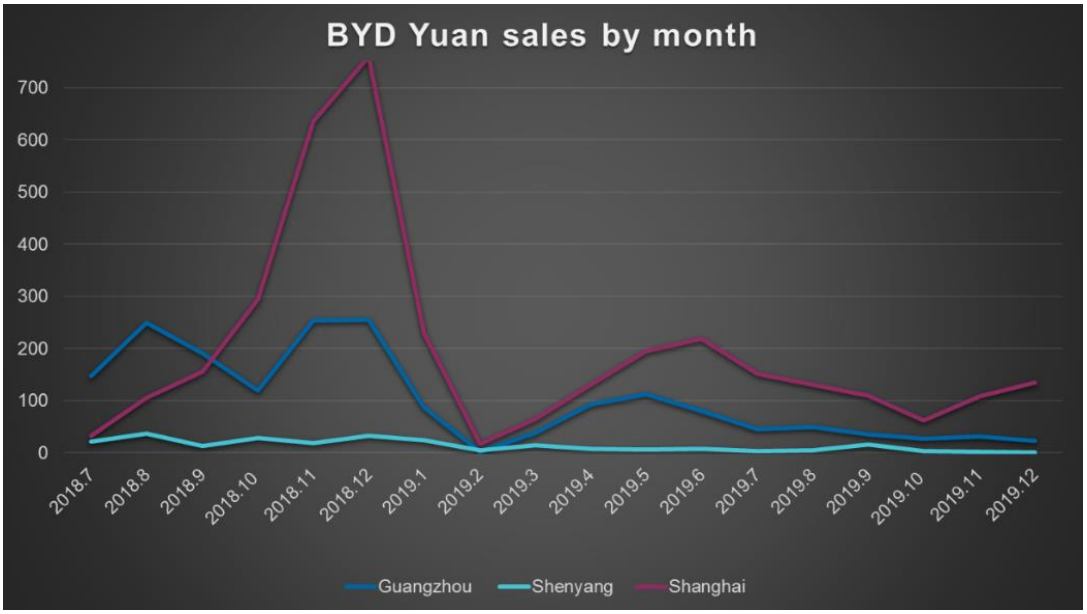

Figure 4. 2018.8-2019.12 BYD Yuan sales

The changes in sales have also shown on the specific car. Taken by BYD Yuan as an example, the figures showed that from July 2018 to December 2019, there was a huge reduction in sales, and this is largely due to the reduction after the transitional period. The research selected three cities: Guangzhou, Shenyang, and Shanghai. All of them are economically strong. The trend for the above

three cities is similar if the magnitude of the sales is ignored. Particularly, a peak has been shown at the end of 2018 when sales and discounts are promoted. In Shanghai, the total number of sales has surpassed 700, which is three times more than the next month. Similar differences also applied to Guangzhou and Shenyang. Entering 2019, the sales plummeted. In the transitional period, between February 2019 and June 2019, the sales gradually increased since the amount of subsidy would significantly decrease when this period was over. Therefore, the statistics have proven that the reduction in the amount of subsidy affects sales and brings negative impacts to the consumers and the car manufacturing companies.

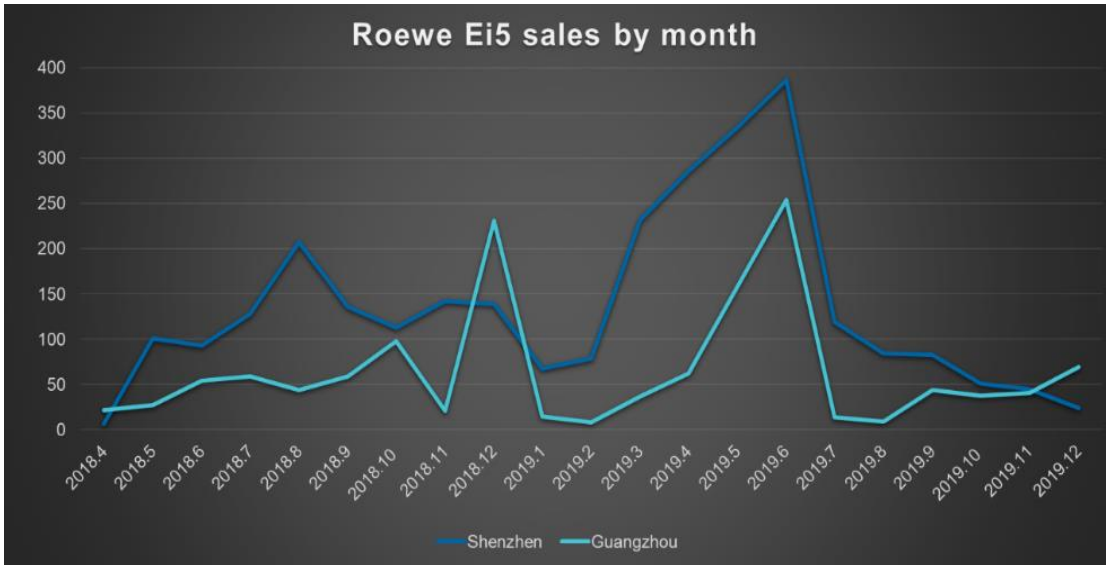

Figure 5. 2018.4-2019.12 Roewe Ei5 sales in Guangzhou and Shenzhen

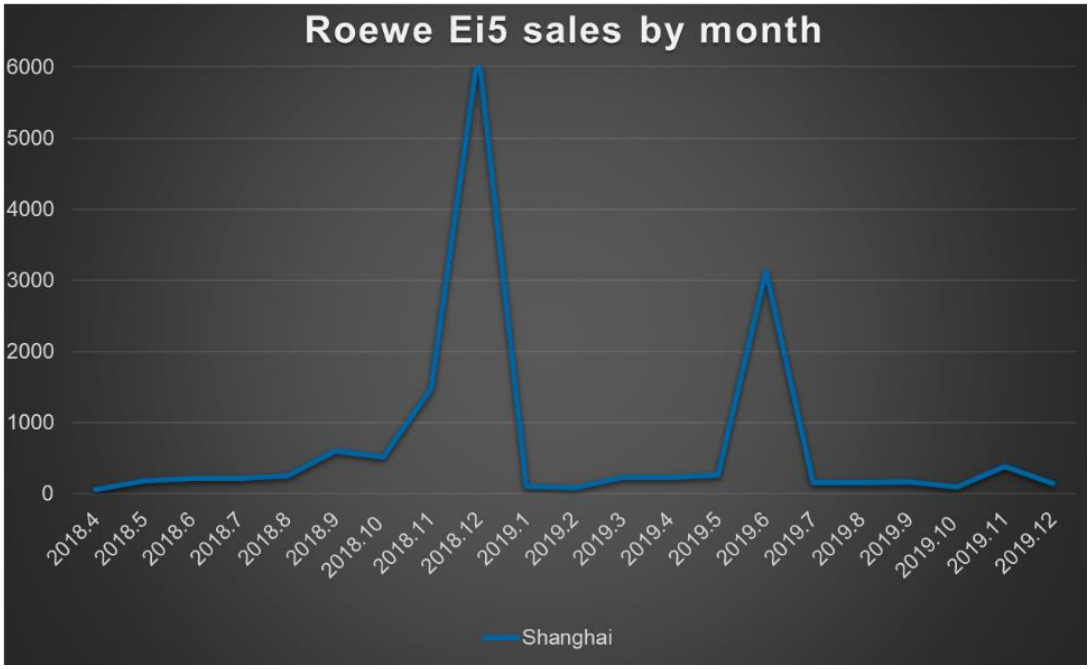

Figure 6. 2018.4-2019.12 Roewe Ei5 sales in Shanghai

Roewe Ei5 was another example. Three of the largest cities in China, Guangzhou, Shenzhen, and Shanghai, are included. Graphically speaking, three cities all experienced two peaks in the number of sales in December 2018 and June 2019. But either during or after the transitional period in 2019, the sales number did not perform well largely due to the differences in actual prices and consumers' anticipated prices in 2018. Roewe Ei5 sales also decreased by large numbers as BYD Yuan did.

The researchers believed that the solution to deal with the increasing competition and, more importantly, the cut for EV subsidy for domestic car manufacturers is to improve R&D and product quality to raise competitiveness effectively. Under the lack of industrial support and protection from the government for domestic companies, the products produced now are not competitive compared to foreign brands. Earlier built advantages began to shrink. Thus, it is significant for enterprises to improve R&D capabilities and product quality further. China leads the world in both output and technological levels of power batteries in terms of power batteries. Energy density should be continuously improved, being adopted to more efficient and low-cost new materials, and maintaining the current technology's advantage.

In conclusion, based on the result, the research showed that the market was complex and unpredictable after the cut of new energy vehicle subsidies. It surely affects the sales of NEV vehicles, especially after the transitional period in June 2019. But since, the competition among enterprises is increasingly fierce as more and more traditional car manufacturing companies enter the market. For instance, a larger variety of electric vehicles were provided at Volkswagen and Mercedes-Benz, enabling the total number of sales to hold firm compared to 2018, even with the huge reduction. Therefore, a new round of industrial reshuffles is expected. Domestic electric vehicle companies should devote more effort to innovation, expanding cars' endurance mileage rather than getting financial assistance with those low endurance mileage cars. Otherwise, these enterprises successful at the present would not win in the future.

4. Discussion

4.1 NEV manufacturers should invest more money in dealing with the competitive market

The research results indicated adjusting strategies for domestic NEV manufacturers because of the rapid development of the NEV market in China and the huge reduction in subsidies. Therefore, the first optimization the research suggested is to invest more money in upgrading the electric motors, electronic control systems, and battery technology, ultimately increasing the endurance mileage in dealing with the competitive market.

When the NEV market was not mature enough, the financial subsidy alleviated the funds shortage caused by enterprises' investment in new energy vehicle product research and development in the early times. BYD, BAIC Motors, Roewe, and other large new energy vehicle enterprises benefited from it and have prospered since then. But meanwhile, many small and medium-sized enterprises with imperfect management systems were overly dependent on the subsidy; once the subsidy was reduced, they could no longer develop, eventually leading to stagnation. Therefore, R&D on the core technology is pivotal in the long run.

Take BYD Qing as an example. As a result of the consistent breakthrough and improvements in electric motors and batteries, four of its generations' endurance mileage from the 2017 version, 2018 version, 2019 version, and 2021 version continued to increase each time. It helps the car stay competitive within the market, averaging 260 Qing being sold in Shanghai every month from 2017-2019, which was one of the best among other competitors. Therefore, improving the motor, electronic control, and the battery is one of the keys to improving the competitiveness of new energy vehicle manufacturers.

4.2 Government should ramp up the installation of charging poles and provide more support

On the government side, they should install more charging poles and formulate the standards to establish a mature industry chain from upstream to downstream. Although China currently has the world's most extensive NEV charging network, China's car charging network is also heavily subsidized and concentrated in major cities. However, in less developed regions, the lack of charging equipment limits the development of NEV. These cities could be the potential forces in consuming a great number of NEV with low endurance mileage and a lower price. New energy vehicles cannot be replenished through gas stations, and private car piles still cannot be fully realized for consumers, so

it is necessary to build piles as basic charging facilities. In 2018, the total number of pure electric vehicles in China was up to 21 thousand, accounting for 9% of the total number of domestic vehicles. The number of charging piles increased continuously from 107,000 units in 2015 to 1.02,000 units at the end of June 2019. But the use of car charging stations in China has so far been limited [11].

To meet the aim of a low-carbon economic development path, government support for new energy vehicle manufacturers is indispensable both on technological and financial levels. The support is reflected in helping manufacturers and using policies to encourage consumers' consumption enthusiasm and confidence. For instance, Shanghai's previous policy of free license plates for electric vehicles is one of the important policies of the state to encourage consumers to consume new energy vehicles. The research reckons that local governments should learn from Shanghai's implementation and unveil their policies as an effective way of boosting the development of the NEV market. In this way, manufacturers would also benefit from it.

4.3 Better market positioning and market division

Through reasonable market positioning, enterprises can select and enter the most favorable target market for their enterprise development according to their marketing concepts. The problem for domestic NEV manufacturing companies is that the proportion of export volume over total sales is low; the export volume of new energy vehicles in the first half of 2019 only accounted for less than 1% of the total sales. Moreover, the proportion of commercial vehicles in the total export was too high, reaching 36.3%. Although the unit price of commercial vehicles is high and the profit is considerable, the overall growth is weak due to the small market size. Eventually, the products are generally uncompetitive: Only BYD and Geely Auto's new energy passenger vehicle products have gained a firm foothold in overseas markets. The research suggested domestic companies should first export cars to less developed regions where NEV is not popular to expand the foreign market. Meanwhile, it gradually improved its competitiveness to achieve better sales numbers.

Besides exploring global markets, domestic enterprises should emphasize individual personalized needs, derive low, medium, and high positioning products, and focus on differentiated performance to meet different consumer groups. The so-called refined market is not only the accuracy of market segmentation but also the rationality of commodity pricing, delivery accuracy, the matching of after-sales services, and the precise layout of the entire industrial chain [12].

In addition, as the new members of the automobile industry, the companies' marketing concept of new energy vehicles must not only adhere to the original traditional automobile marketing principles but also integrate the characteristics of the enterprise to formulate new strategies. It needs to make accurate positioning for the target customer groups according to the needs of all ages. In the automobile industry, due to the different configurations of a series of products, there are corresponding divisions for the target customer groups based on general convergence.

New energy vehicles need to determine the target customer group first, then put forward specific methods and measures according to the product characteristics, determine the product price, and face a variety of consumer groups at a reasonable price. For instance, BYD pays attention to the needs of various potential consumer groups, innovates business models, and realizes multi-party cooperation to help market new energy vehicles. For individual consumers, BYD, through in-depth cooperation with financial institutions, introduced payment methods in the form of loans and installment payments to meet different needs. These measures could successfully solve consumers' cash flow problems and realize the convenience of low-interest loans for a car purchase [1].

BYD's strategies enabled them to achieve good sales during these three years; with the statistics provided below, BYD's cars occupied three of the five top-selling EVs in China up to Mar 2019, perfectly stressing the importance of implementing an appropriate marketing strategy [12].

Table 3. China EV sales rankings (up to Mar 2019)

Ranking	Manufacturers	Car type	Sales	Ranking
1	BYD	Yuan	24446	1
2	BAIC Motors	EU series	19343	2
3	BYD	Tang	14887	3
4	BYD	E5	14527	4
5	Geely Auto	Dihao EV	10677	5

For group purchase consumers, such as cars, taxis, and other special customers with large orders to purchase new energy vehicles, the quantity advantage will inevitably bring the price advantage. The two sides innovate and carry out deeper cooperation, including equity, asset mortgage, and other ways. At the same time, it is also necessary to actively strive for policy support from local governments, effectively and reasonably use the preferential policies provided by local governments, and constantly promote the development of new domestic energy vehicles.

5. Conclusion

5.1 Key findings

In summary, based on the sales numbers from BYD, BAIC Motors, and Roewe in Shanghai, Guangdong province, and Liaoning province, the data showed the reduction in subsidy did have a relatively large impact on sales. Still, the overall sales managed to hold firm due to the increase in the variety of models. Geographically speaking, the research concluded that NEV were more accepted and sold more in economically developed regions, especially in cities with limited licenses, such as Shanghai. Climate conditions were also a factor: the overall sales for three cities in Guangdong Province outnumbered three other cities in Liaoning Province, with higher latitudes. However, in policy recession, the fluctuation in sales trends in all cities are similar. In terms of the benefits, the reduction in subsidy would effectively promote the continuous growth of the automobile manufacturing industry, improve the competitiveness of new energy vehicle products, and promote the faster development of the industry.

5.2 Research significance

To conclude, the research analyzed the extent to which the moderation in subsidy from 2017-2019 affects the number of sales of BYD, BAIC Motors, and Roewe in different regions. It offered specific suggestions on the implementation of the manufacturing and government sides in the upcoming post-subsidy era. It provided a thorough review of these three years and forecasted the potential risks faced by the companies. The government recently announced that there would be no more subsidies in 2023, so the auto industry needs to take a closer look at its product strategy to avoid competing with costly technologies. There are too many unknown factors in the upcoming year.

5.3 Limitations

The research's limitations are that the data range might not be large enough convincing since it only selects seven cities in China, which might not account for some exceptions. There also should be better models analyzing the data quantitatively rather than using simple comparisons in the total number of sales within different periods to explain the effect on sales. Moreover, the research did not collect primary data in investigating the consumers' perceptions and opinions towards the moderation of the subsidy. The data collected from this angle would be another analytical point in explaining the reduction in sales, especially for those EVs with low endurance mileage and low prices. Because the target consumer group of these products is relatively more sensitive to the price, thus the price change will affect their purchase decision. Future studies could entail this form of survey and extend the

research time range to a longer period till the end of 2022. This could make the analysis more thorough, including the different subsidy reduction levels from 2017-2022.

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