

# Research on the Influence of COVID-19 on Overall Sales of Cars and Cars in Different Categories in China

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**Abstract.** COVID—19 outbreak has caused a global economic recession; automotive industry plays a key role in economy nowadays. Previous studies were focused on the short-term impact of the COVID outbreak. This study is aimed to evaluate two years after the COVID outbreak, what impact did COVID post on the Chinese automotive industry overall and across different categories, how sales of car models with different price, nationality, and car type reacts to the COVID outbreak. The result of this study shows that COVID posted a significant negative impact on Chinese car sales overall. The higher priced car models impacted less by the COVID outbreak, Chinese models impacted more by the COVID outbreak, and no significant evidence to show how SUV models impacted by the COVID outbreak. These findings can help car companies to make the most ideal production, operation and supply chain management decisions when a natural shock happens in the future.

**Keywords:** Automotive industry; COVID-19; DID; Car price.

## 1. Introduction

### 1.1 Background

The COVID-19 coronavirus pandemic (referred as COVID below) outbreak took place in January 2020 has caused a global economic recession. China, being the place where the virus was detected initially, has been suffering hard ever since the outbreak in January 2020, COVID, especially the lockdowns that come with it has caused multiple issues related to the overall economy, business, supply chain and much more. Automotive industry is closely related to people's daily life, the automotive industry is a key component when evaluating the overall economy, markets and how well the consumers. The sales of different cars directly reflect the circumstances of the automotive industry. Thus, by studying how sales of cars in different categories react to COVID, the pattern can be implied to the overall economy and the car companies can make better operation and production decisions based on the results when in the future disasters like COVID happens.

### 1.2 Literature Review

This paper is related to the stream of works related to the impact of COVID-19 and the automotive industry. The first relative topic of this research is COVID-19. The COVID-19 outbreak has caused global suffer both economically and environmentally, previous studies utilizing data across the world has proven that [1]. COVID also has affected Chinese economy both short term and long term [2] from multiple perspectives including GDP, trade, and the overall economy, heavily damaged the overall market and willingness of buying of consumers [3]. COVID also has fundamentally changed the way people live and work. People are forced to be locked down in the places where outbreaks take place, and due to the worries of being locked down, people are less willing to travel. Also, regional outbreaks have been keep happening in China throughout 2021 and 2022, thus making the recovery from the COVID even harder.

Previous studies have shown that car sales are linked to economic crisis in the European Union, the new car sales in the European Union were found positively related to the GDP of the European Union [4]. COVID has also affected the automotive industries in multiple European countries, including Slovakia, Russia, Germany and Britain, COVID has caused a decrease of both car production as well as car sales up to a more than 70% decrease when compared to previous year [5].

Studies in China also found that COVID does affected the car industry in multiple perspectives including SCM issue, production crisis and short-term sales issue [6,7].

Other studies have found that people are shifting from using public transportations to private transportations in the US due to COVID [8], this might be similar in China in short term but in long run, people will gradually go back to their routine and use public transportations more. Previous study has found that electric cars was negatively impacted by COVID in short-term [9], but in this study COVID is not considered as an individual category, due to limited data.

### 1.3 Object

Current studies are all short-term studies, and the data was mainly focused during 2020 where the COVID outbreak took place, this limits their ability to provide long-term estimations and predictions. The goal of this study is to evaluate two years after the COVID outbreak, what impact did COVID post on the automotive sales and which specific category of cars of the industry is affected the most or the least by the COVID outbreak using a linear regression model and a Difference-in-difference (DID) model. The long-term impact of COVID outbreak is a crucial mark for the automotive companies to refer to in the future where disasters like COVID happens to make their operation and production decisions.

## 2. Methodology

### 2.1 Data

The data was collected from xl.16888.com, a Chinese website that gathers news, sales and information of over 500 different models. The sales data consist of the monthly sales of the fifty bestselling car models that has enough sufficient data from August 2017 to July 2022, including total of 3000 data, January 2020 was marked as the month where COVID took place. The summary data of the sales data is shown in Table 1. Including the average and standard deviation of the overall car sales and car sales based on car category, overall, before COVID and after COVID. The descriptive data consist of their car model name, price range, average price, car type, and nationality. Car type has three variables: Sedan, SUV, and MPV. Nationality is based on the company that owns the car model, for car models that is owned by a Chinese company, the nationality is Chinese, for car models that is owned by other countries, the nationality is Foreign. Data of price range and car type was collected from xl.16888.com. Data of car models' company country is from Baidu.

**Table 1.** Summary Statistics

| Model          | All Observations |          |              | Before COVID |          |              | After COVID |          |              |
|----------------|------------------|----------|--------------|--------------|----------|--------------|-------------|----------|--------------|
|                | Mean             | Std. Dev | Observations | Mean         | Std. Dev | Observations | Mean        | Std. Dev | Observations |
| All Models     | 15352            | 437      | 3000         | 16670        | 417      | 1500         | 14033       | 694      | 1500         |
| Chinese Models | 16965            | 730      | 480          | 20039        | 1120     | 240          | 13890       | 510      | 240          |
| Foreign Models | 15045            | 432      | 2520         | 16029        | 371      | 1260         | 14060       | 744      | 1260         |
| SUV Models     | 13649            | 397      | 1140         | 15054        | 478      | 570          | 12244       | 526      | 570          |
| Non-SUV Models | 16395            | 490      | 1860         | 17661        | 452      | 930          | 15130       | 814      | 930          |

Source: xl.16888.com

## 2.2 Hypothesis

The COVID outbreak has brought many adverse effects to the economy in China, the overall market in China has been suffered since the COVID outbreak. Because the overall economy has been negatively affected by COVID and that would also negatively affect the willingness of buying of consumers, the following hypothesis can be hypothesized:

**Hypothesis 1.** *The COVID outbreak posted a negative impact on the overall car sales.*

The COVID outbreak has affected overall economy in China, but after two years of recovering, the economy has been slowly climbing back, the models with higher price tend to have a very stable demand, because their consumers tend to be more resistant to economic crisis and part of their consumers is company or government owned business, these organizations will always have the demand of buying new cars. Thus, making the models with higher price potentially have higher resistance to the COVID outbreak. Therefore, the following hypothesis can be hypothesized:

**Hypothesis 2.** *Higher price cars are less effected by the COVID outbreak compared to lower price cars.*

Chinese models tend to have lower price and is targeted towards the lower income class. COVID posts a serious effect on the lower income class, even causing some of them lose their jobs. When compared to foreign models, even though both are produced in China, but the foreign models have a bigger variety and some higher price models to levitate the overall impact from COVID, thus the following hypothesis can be hypothesized:

**Hypothesis 3.** *The COVID outbreak impact Chinese models more than foreign models.*

The COVID outbreak has fundamentally changed the way people work and live, due to the worries of being caught in regional lockdowns and the decrease of the overall economy, the willingness of travel, especially in longer distance, is decrease after the COVID outbreak, also the cut of group travelling also contributes to this fact. SUV models are typically designed form longer distance travels and have higher price when compared to the sedan models, thus the following hypothesis can be hypothesized:

**Hypothesis 4.** *The COVID outbreak impacted SUV models more than sedan models.*

## 2.3 Method

To testify the hypothesis in section 2.2 This research first used a linear regression model to evaluate the causal impact of COVID to the overall car sales, then a Difference-in-difference (DID) model, which is commonly regarded as a great approach to evaluate the impact of a natural shock on business [10] was adapted, the details of both models will be discussed in section 3.2.

## 3. Results

### 3.1 Data Processing

The data was analyzed with the following process. The average price is calculated by taking the average of the upper and lower end of the price range. Then the car models were distributed into four groups based on their average price (10,000CNY), the four groups are: <10,10-20,20-30, and >30. These data are later used for evaluating the impact of COVID on cars of different price.

### 3.2 Experimental Design

This research first used a linear regression model to evaluate the causal impact of COVID to the overall car sales using the following equation (1):

$$Sales_t = c + \beta Treatment_t + \varepsilon_t \quad (1)$$

Where  $t$  denotes the week,  $Sales_t$  denotes the average monthly sales of the fifty models during week  $t$ , and  $\varepsilon_t$  is the error term. The dummy variable  $Treatment$  equals to 1 if the week  $t$  is after COVID, and 0 otherwise. The coefficient  $\beta$  estimates the effect of COVID on the overall car sales.

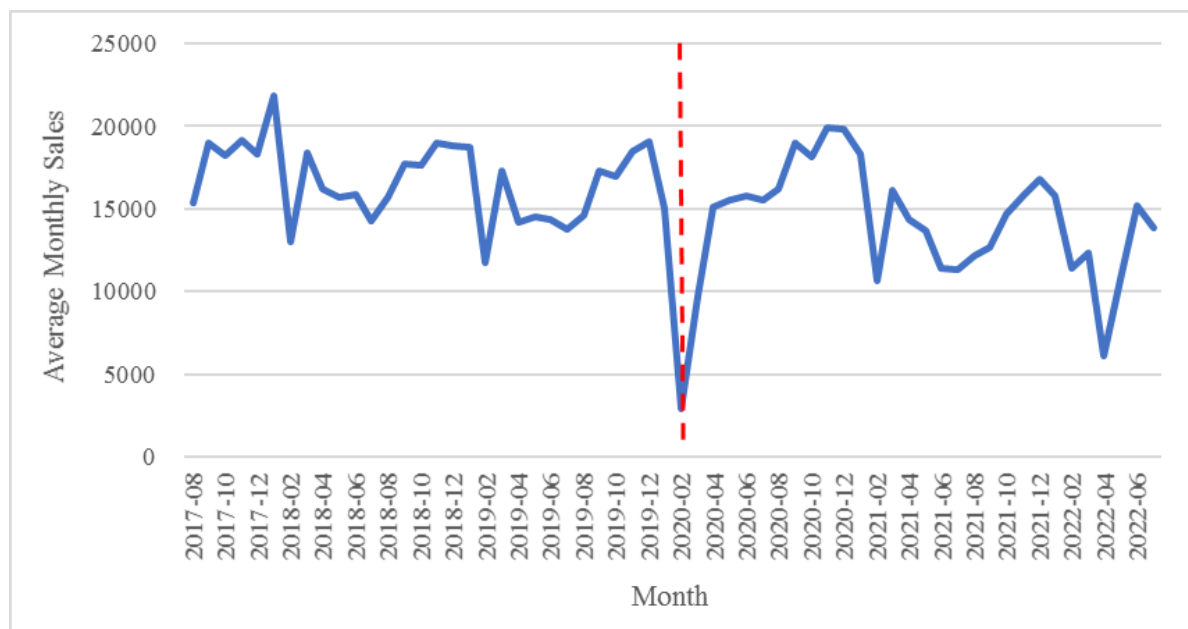
The second method that was adopted in this research is using a DID (Difference-in-Difference) model, which is a common approach to evaluate the impact of a natural shock on business [10] to evaluate the impact of COVID on different categories of cars. The COVID outbreak lockdown was taken as a natural shock and evaluated the difference of car sales of a specific car type before and after the shock using the following equation (2):

$$Sales_{it} = c + \beta Treatment_{it} \times Category + \varepsilon_{it} \quad (2)$$

Where  $i$  denotes the car model,  $t$  denotes the week,  $Sales_{it}$  denotes the average monthly sales of a specific model  $i$  at week  $t$ . The dummy variable  $Treatment_{it}$  equals 1 if the time is after COVID, equals to 0 otherwise, the dummy variable  $Category$  equals to 1 if the car model  $i$  falls under the category, equals to 0 otherwise, coefficient  $\beta$  denotes the impact of the treatment, type denotes the contribution of the type of the specific car model belongs to, and  $\varepsilon$  denotes an error term. This DID model was used to evaluate how car sales of a specific model reacts to the COVID lockdown natural shock after two years.

### 3.3 Result Analysis

Fig. 1 shows the plot of the average monthly sales of all models from August 2017 to July 2022, the vertical line represents where the COVID outbreak took place, it is obvious that the COVID outbreak impacted the Chinese automotive industry in a negative way, where in the figure there is a clear immediate decline after the COVID outbreak, and the average sales continues to slump after the COVID due to regional outbreaks throughout 2021 and 2022, also the overall economy was hit hard by the COVID.



Source: xl.16888.com

**Fig. 1** Time trendline of overall average monthly car sales

The impact of COVID on the overall car sales estimated using equation (1) in section 3.2 is shown in Table 2, in column (2) the coefficient of the impact which is the difference is -2637, which represents a -15.82% decrease of average monthly car sales after COVID when compared to before COVID, signifies COVID posted a negative impact on the overall car sales. This result confirms the

hypothesis (1) proposed in section 2.2. Table 2 also includes the results of the impact of COVID on cars of different prices, from column (3) to column (6), a clear pattern can be determined as the price goes up, the absolute value of the difference decrease, also the P-value increases, represents that the higher the price, the smaller the difference before and after COVID, also the less significant the result is, which signifies that the higher the price of the car model, COVID posts less effect on its sales, which confirms the previous hypothesis (2).

**Table 2.** Impact of COVID on car sales overall and based on price

|                          | Overall | Price (10,000CNY) |         |        |       |
|--------------------------|---------|-------------------|---------|--------|-------|
|                          |         | <10               | 10-20   | 20-30  | >30   |
| Difference               | -2637   | -6004             | -3313   | -1519  | 346   |
| Difference in percentage | -15.82% | -37.84%           | -17.35% | -8.54% | 3.67% |
| P-value                  | 0.0019  | 5.8E-07           | 7.6E-04 | 0.13   | 0.55  |
| Observations             | 3000    | 480               | 1260    | 660    | 600   |

Source: xl.16888.com

The impact of COVID on car sales based on car category using equation (2) previously mentioned in section 3.2 is shown in Table 3 below. The impact of COVID on Chinese models vs. foreign models is shown in column (2) and the impact of COVID on SUV models vs. non-SUV models is shown in column (3). There is a negative relationship between the sales and the nationality of the car which signifies that Chinese models are more impacted by the COVID compared to the foreign models. Thus, validating the hypothesis (3) in section 2.2. However, for the impact of COVID on SUV models vs. non-SUV models, the P-value is 0.81 which is greater than 0.1 confirms the null hypothesis represents that the result is not statistically significant. So, there is no evidence to prove hypothesis (4), rejecting hypothesis (4).

**Table 3.** Impact of COVID and on car sales based on car category

| Variables                       | Dependent variable: Average monthly sales |                     |
|---------------------------------|-------------------------------------------|---------------------|
|                                 | Treatment: Nationality                    | Treatment: Car Type |
| <i>Treatment</i>                | 4011                                      | -2607               |
| P-value                         | 0.000216                                  | 0.002087            |
| <i>Treatment</i> × <i>After</i> | -4181                                     | -279                |
| P-value                         | 0.000216                                  | 0.812294            |
| Observations                    | 3000                                      | 3000                |

Source: xl.16888.com

#### 4. Discussion

The results and the analysis above proved that COVID posted a significant impact on the automotive industry. The overall car sale is decrease 15.82% on average, there are multiple reasons behind it. Due to the COVID outbreak, the Chinese economy is negatively impacted by the COVID, a lot of people experienced a decrease in their income some of them even lost their jobs. The middle to lower class was significantly hit by the pandemic. The automotive industry overall is facing the general market of consumers where the middle- and lower-income class accounts for most of the market. Thus, COVID posted a serious effect on car sales overall.

When the price of the car models was taken into considerations. There is a clear pattern that the higher priced car models are less effected by COVID, the potential reason behind that is that higher priced models have a more stable demand, and the consumers of these models tend to be in high-income class, and they own more properties so that they are more resistant to natural shock like COVID or other disasters. Similarly, the Chinese models are impacted more by COVID when

compared to foreign models, because Chinese models are generally targeted towards the middle to lower-income class, where foreign models are targeted more towards middle to higher-income class.

One interesting discovery of this research is that there was no significant evidence to prove that the SUV models were impacted more by COVID when compared to the non-SUV models, the potential reason behind that could be that even though people changed their way of traveling and living in short-term, but for the long run, especially two years after COVID, most of people returned to their living style thus COVID did not post a significant impact on SUV models when compared to non-SUV models.

Several key suggestions to the car companies can be drawn from the previous findings: (1) Due to the fact that higher priced cars are not impacted by COVID, the car companies should always make sure there is good stream of constant supply of these models, as their demand is very stable. (2) Chinese car companies should be more concerned about natural shocks such as natural disasters or pandemic like COVID, because their targeted customers are more prone to be impacted by these shocks. (3) Car companies should try to expand their car models to face different consumers to have better resistance to natural shocks.

In long run, people will adjust to the shock and come back to their lifestyle, so the balance and timing of lowering supply immediately after the shock and rising supply when people are settled with the situation is an important decision for the car companies to consider and to be discussed in future research.

## 5. Conclusion

Overall, the COVID outbreak posted a significant negative impact on Chinese car sales and across majority of car categories. This study found that COVID posted less effects on higher priced car models, impacted Chinese models more compared to foreign models. No significant evidence was found to prove that COVID impacted SUV models more than non-SUV models. The study utilized linear regression model and DID model which is a common model used to evaluate the impact of natural shock. The reasoning behind the findings could be that COVID posted a negative impact on the automotive industry especially on Chinese models and higher price models is that COVID posted a negative impact on the overall economy of China, the middle to lower class is less resistant to economic recession and Chinese models and lower priced models are targeted towards these consumers. From these findings and the potential reasoning behind them discussed in previous sections, car companies should be aware of what is the most ideal production, supply chain and marketing decisions to make when natural shocks happen. Also, how to raise their resistance to natural shocks such as expanding their production line.

This research does have some limitations, first is that the data source is not officially from government or the car companies, therefore potential errors could occur within the data. Secondly, the study could not take in some independent variables that shows economic indicators since these numbers are often reported quarterly or annually, future studies can consider finding monthly reported economic indicators and add that into the models. This study provides a basic insight into the two-year impact of COVID on Chinese automotive industry collectively and categorically, future studies can delve deeper into other specific details of car models such as gas consumption or consider take other independent variables into the models to evaluate the long-term impact of COVID on automotive industry.

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