



# An Econometric Analysis of the Automotive Industry in Germany – Drivers of Sales of Electric Vehicles



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Econometrics 2020-2021

**Group Mambo No.6**

(16461)

# Content



Challenges in  
automotive



Conclusion

Market analysis



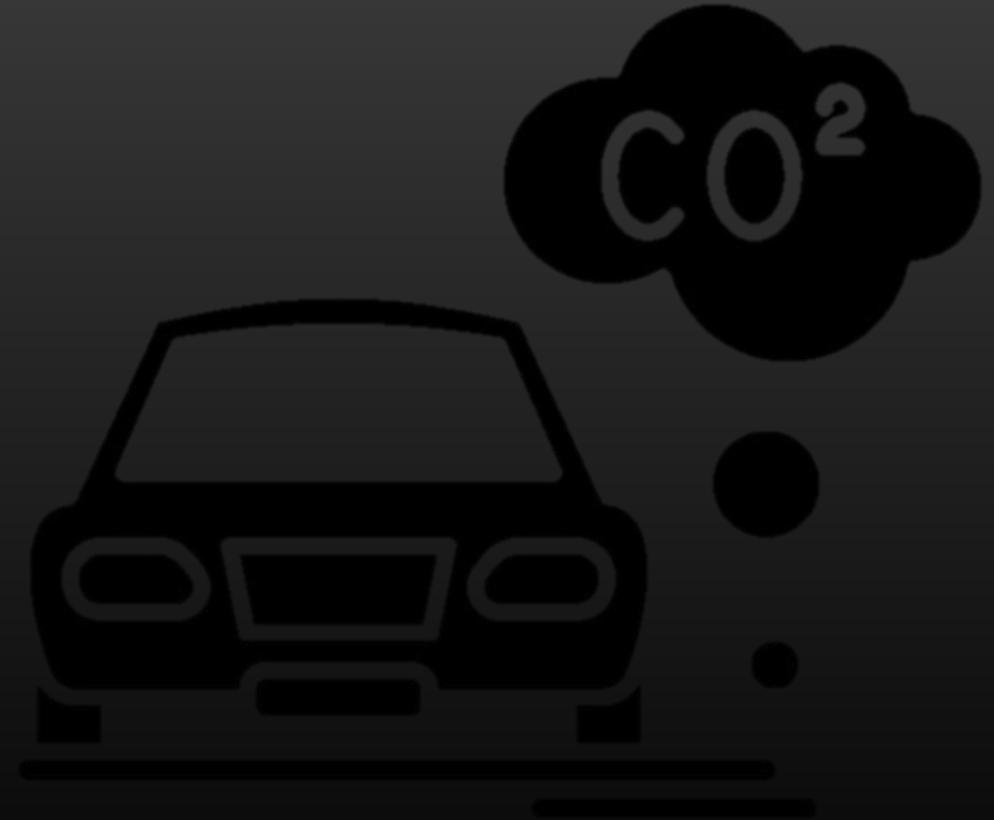
Data evaluation



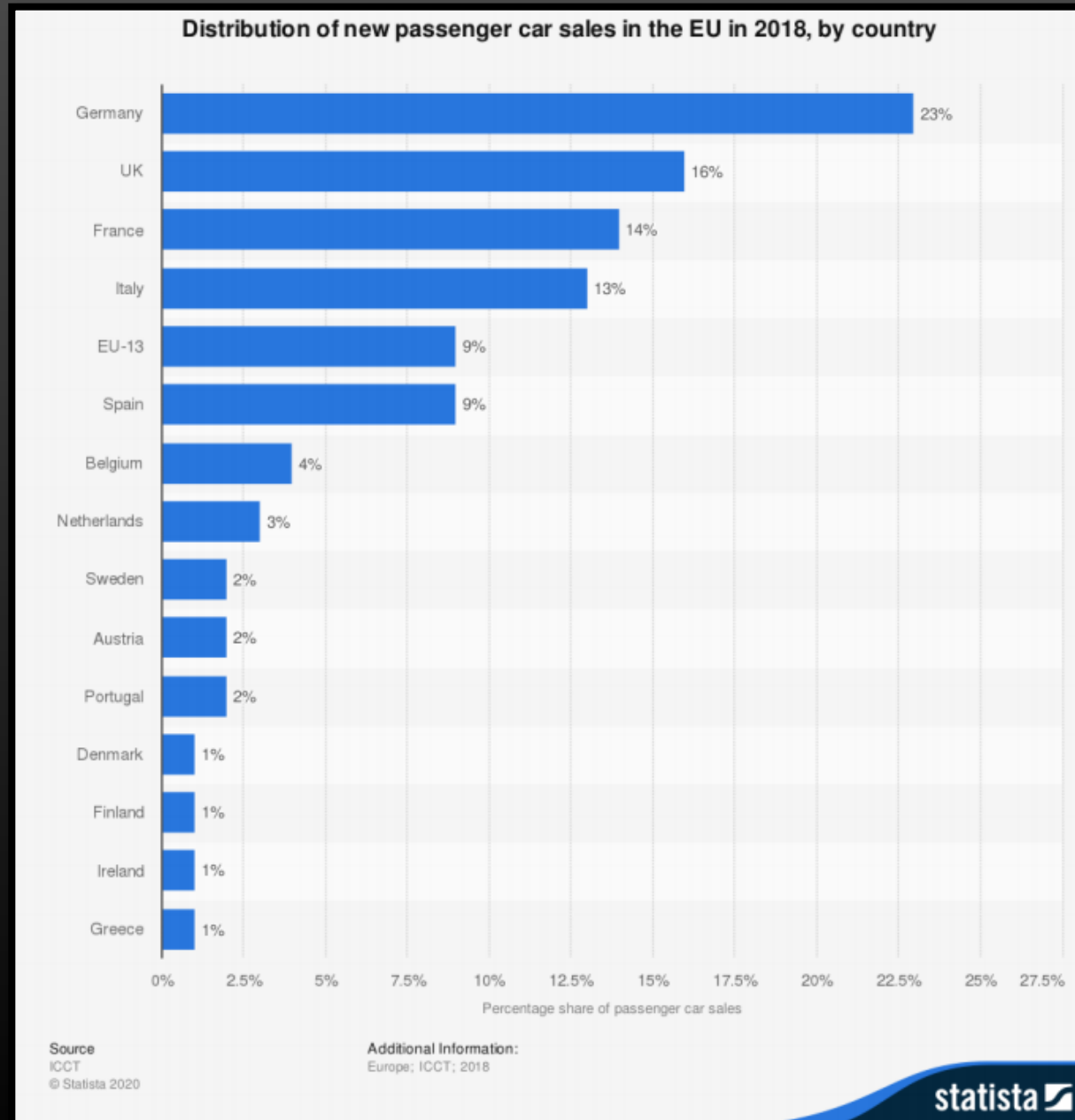


# Challenges in Automotive

- Environmental pressure & fuel dependency
- Rise of car sharing
- Electric vehicles
- Connected Vehicles



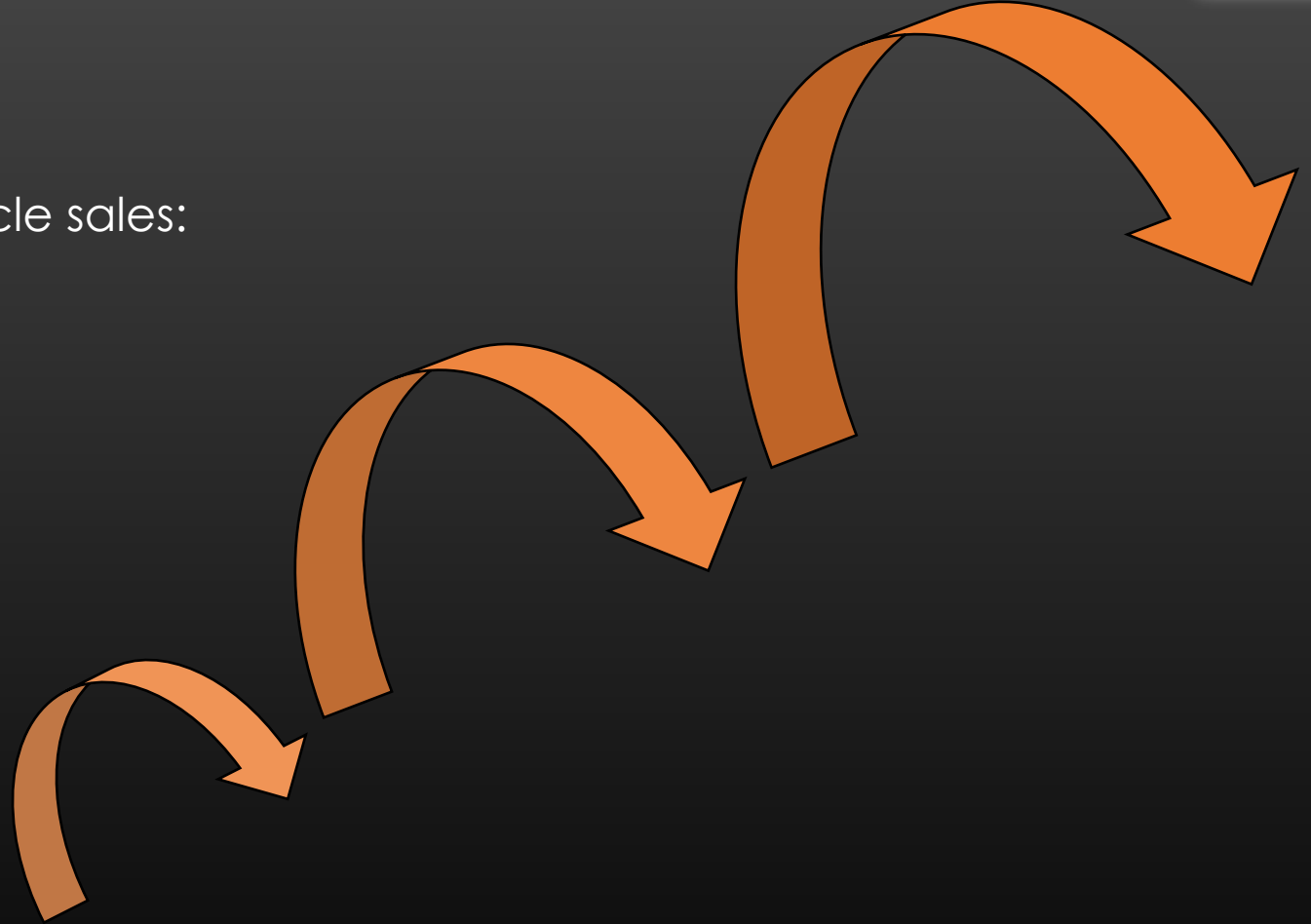
# Importance of the automotive industry in Germany





# Market analysis

- Reasons for the growth of electric vehicle sales:
  - Environmental pressure
  - Price decrease
  - Charging network
  - Incentives
  - More alternatives
  - Potentially the better technical solution





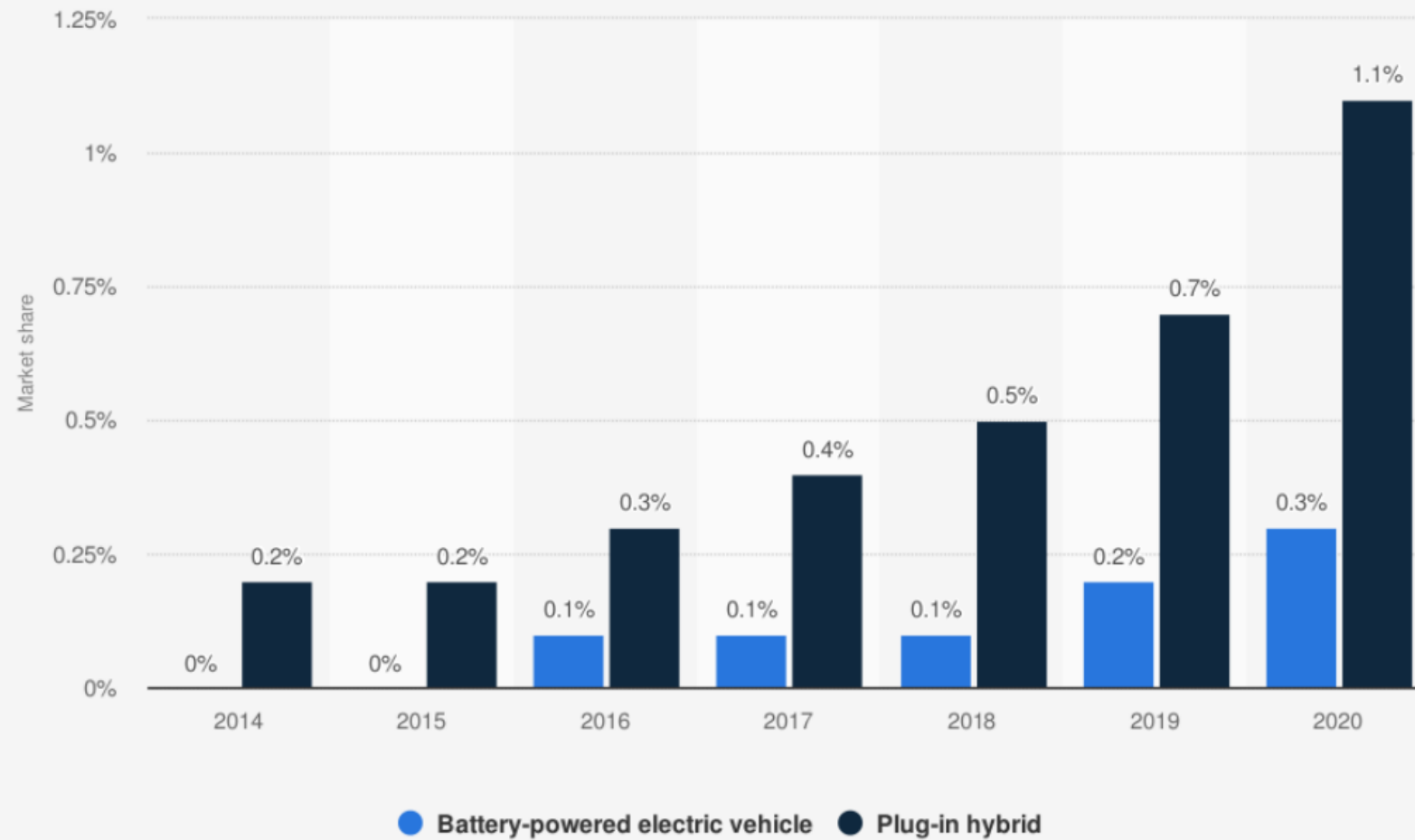
# Market analysis

- Challenges for the electric vehicle:
  - Charging infrastructure
  - Range
  - High price
  - Quality issues






## Market share of electric vehicles in Germany from 2014 to 2020



Source  
KBA  
© Statista 2020

Additional Information:  
Germany; 2014 to 2020



What are the  
drivers of sales  
of electric  
vehicles?

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# Data evaluation

## Linear Regression Model

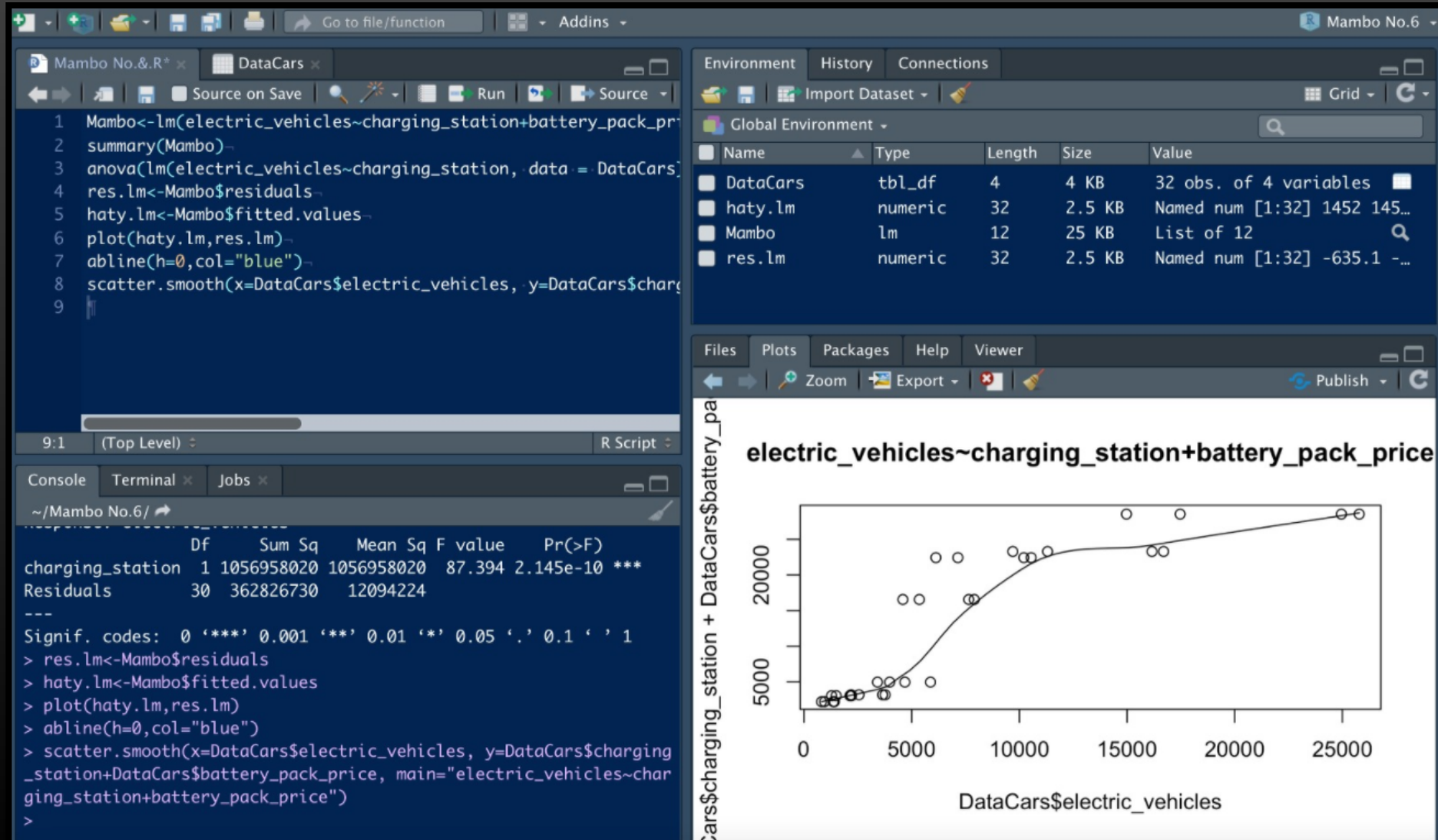
$$Y = \beta_1 + \beta_2 X + \varepsilon$$

Quarters	charging_station	battery_pack_price	electric_vehicles
2012 Q1	1.500	721	817
2012 Q2	1.500	721	954
2012 Q3	1.500	721	1362
2012 Q4	1.500	721	1408
2013 Q1	2.400	663	1282
2013 Q2	2.400	663	1494
2013 Q3	2.400	663	2134
2013 Q4	2.400	663	2205
2014 Q1	2.606	588	2188
2014 Q2	2.606	588	2553
2014 Q3	2.606	588	3647
2014 Q4	2.606	588	3768
2015 Q1	4.587	381	3412
2015 Q2	4.587	381	3979
2015 Q3	4.587	381	4684
2015 Q4	4.587	381	5874
2016 Q1	16.266	293	4590
2016 Q2	16.266	293	5355
2016 Q3	16.266	293	7651
2016 Q4	16.266	293	7906
2017 Q1	22.213	219	6124
2017 Q2	22.213	219	7145
2017 Q3	22.213	219	10207
2017 Q4	22.213	219	10547
2018 Q1	23.112	180	9695
2018 Q2	23.112	180	11311
2018 Q3	23.112	180	16158
2018 Q4	23.112	180	16697
2019 Q1	28.382	156	14972
2019 Q2	28.382	156	17467
2019 Q3	28.382	156	24953
2019 Q4	28.382	156	25784





# Data evaluation





# Data evaluation

The screenshot displays the Mambo No.6 R IDE interface. The main editor window shows the following R code:

```
1 Mambo<-lm(electric_vehicles~charging_station+battery_pack_price, data = DataCars)~
2 summary(Mambo)
```

The console output shows the results of the linear model fit:

```
Call:
lm(formula = electric_vehicles ~ charging_station + battery_pack_price,
    data = DataCars)

Residuals:
    Min       1Q   Median       3Q      Max
-6645.1 -1791.5  -67.1  1413.8  9496.3

Coefficients:
              Estimate Std. Error t value Pr(>|t|)
(Intercept)   -663.9045   5096.2159  -0.130 0.897249
charging_station    0.5879    0.1602   3.671 0.000971 ***
battery_pack_price  1.7118    7.8123   0.219 0.828097
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
```

The summary output is partially obscured by a yellow box highlighting the t-value and p-value for the `charging_station` variable. A yellow arrow points from this box to a larger yellow box on the right, which contains the following text:

```
t value Pr(>|t|)
-0.130 0.897249
3.671 0.000971 ***
0.219 0.828097
```

The right sidebar shows the Environment pane with the following variables:

Name	Type	Len...	Size	Value
DataCars	tbl_df	4	4 KB	32 obs. of 4 v...
Mambo	lm	12	25 KB	List of 12



# Data evaluation

The screenshot displays the Mambo No.6 RStudio interface. The script editor on the left contains the following R code:

```
1 Mambo<-lm(electric_vehicles~charging_station+battery_pack_price, data = DataCars)~
2 summary(Mambo)~
3 anova(lm(electric_vehicles~charging_station, data = DataCars))~
4 |
```

The console on the bottom left shows the output of the R commands:

```
~/Mambo No.6/
Coefficients:
(Intercept)      -663.9045   5096.2159   -0.130  0.897249
charging_station    0.5879    0.1602    3.671  0.000971 ***
battery_pack_price  1.7118    7.8123    0.219  0.828097
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1

Residual standard error: 3534 on 29 degrees of freedom
Multiple R-squared:  0.7449,    Adjusted R-squared:  0.7273 
F-statistic: 42.33 on 2 and 29 DF,  p-value: 2.5e-09

> anova(lm(electric_vehicles~charging_station, data = DataCars))
Analysis of Variance Table

Response: electric_vehicles
          Df      Sum Sq   Mean Sq F value    Pr(>F)    
charging_station  1 1056958020 1056958020  87.394 2.145e-10 ***
Residuals       30  362826730   12094224             
---
Signif. codes:  0 '***' 0.001 '**' 0.01 '*' 0.05 '.' 0.1 ' ' 1
> |
```

The environment pane on the right shows the Global Environment with the following variables:

Name	Type	Len...	Size	Value
DataCars	tbl_df	4	4 KB	32 obs. of 4 v...
Mambo	lm	12	25 KB	List of 12

The Files pane at the bottom shows the current directory structure.

A yellow box highlights the **Pr(>F)** value of **2.145e-10** in the ANOVA table, with an arrow pointing to a larger yellow box containing the text:

**Pr(>F)**  
**2.145e-10** \*\*\*





# Data evaluation

Mambo No.6

```
1 Mambo<-lm(electric_vehicles~charging_station+battery_pack_price, data = DataCars)
2 summary(Mambo)
3 anova(lm(electric_vehicles~charging_station, data = DataCars))
4 res.lm<-Mambo$residuals
5 haty.lm<-Mambo$fitted.values
6 plot(haty.lm,res.lm)
7 abline(h=0,col="blue")
```

Environment History Connections

Global Environment

Name	Type	Length	Size	Value
DataCars	tbl_df	4	4 KB	32 obs. of 4 variables
haty.lm	numeric	32	2.5 KB	Named num [1:32] 1452 1...
Mambo	lm	12	25 KB	List of 12
res.lm	numeric	32	2.5 KB	Named num [1:32] -635.1...

Files Plots Packages Help Viewer

7:23 (Top Level) R Script

Console Terminal Jobs

~/Mambo No.6/

Analysis of Variance Table

Response: electric\_vehicles

	Df	Sum Sq	Mean Sq	F value	Pr(>F)
charging_station	1	1056958020	1056958020	87.394	2.145e-10 ***
Residuals	30	362826730	12094224		

---  
Signif. codes: 0 '\*\*\*' 0.001 '\*\*' 0.01 '\*' 0.05 '.' 0.1 ' ' 1

```
> res.lm<-Mambo$residuals
> haty.lm<-Mambo$fitted.values
> plot(haty.lm,res.lm)
> abline(h=0,col="blue")
>
```



# Conclusion

- E-Mobility is on the rise
- Charging station-network is a significant factor in E-mobility
- Yet, internal combustion still reigns supreme in personal transportation



# Sources

- <https://www.statista.com/>
- [https://www.bing.com/images/search?view=detailV2&ccid=5IS3ITxF&id=9D2672128F9CF6C1CF57C6A91E00E536B927720B&thid=OIP.5IS3ITxF0CW4\\_KVhrhNA7gHaEK&mediurl=http%3a%2f%2fimages.car.bausercontent.com%2fpagefiles%2f78015%2ftesla\\_roadster\\_05.jpg&exph=956&expw=1700&q=tesla+roadster&simid=608007875870721664&ck=1B3F3537D27736F4AEA6FD9F75335C93&selectedIndex=16&FORM=IRPRST&ajaxhist=0](https://www.bing.com/images/search?view=detailV2&ccid=5IS3ITxF&id=9D2672128F9CF6C1CF57C6A91E00E536B927720B&thid=OIP.5IS3ITxF0CW4_KVhrhNA7gHaEK&mediurl=http%3a%2f%2fimages.car.bausercontent.com%2fpagefiles%2f78015%2ftesla_roadster_05.jpg&exph=956&expw=1700&q=tesla+roadster&simid=608007875870721664&ck=1B3F3537D27736F4AEA6FD9F75335C93&selectedIndex=16&FORM=IRPRST&ajaxhist=0)
- <https://www.flaticon.com/free-icons/presentation>
- [https://www.bing.com/images/search?view=detailV2&ccid=vMm3vRT6&id=EB245C918064A277F4719025D0A7DED7F28EDD84&thid=OIP.vMm3vRT6-TMN8ymGeWRKgAHaH\\_&mediurl=https%3a%2f%2fcdn5.vectorstock.com%2fi%2f1000x1000%2f45%2f04%2fmotor-vehicle-pollution-black-icon-sign-on-vector-23014504.jpg&exph=1080&expw=1000&q=environment+pollution+car+icon&simid=607993062578458621&ck=8267102D7767C5434DED725DE4628E4D&selectedIndex=54&FORM=IRPRST&ajaxhist=0](https://www.bing.com/images/search?view=detailV2&ccid=vMm3vRT6&id=EB245C918064A277F4719025D0A7DED7F28EDD84&thid=OIP.vMm3vRT6-TMN8ymGeWRKgAHaH_&mediurl=https%3a%2f%2fcdn5.vectorstock.com%2fi%2f1000x1000%2f45%2f04%2fmotor-vehicle-pollution-black-icon-sign-on-vector-23014504.jpg&exph=1080&expw=1000&q=environment+pollution+car+icon&simid=607993062578458621&ck=8267102D7767C5434DED725DE4628E4D&selectedIndex=54&FORM=IRPRST&ajaxhist=0)
- [https://www.bing.com/images/search?view=detailV2&ccid=fEPn%2bzIG&id=A2D008CA203F43BAAC3954A1191268AF1B415E10&thid=OIP.fEPn-zlGmXKWpPtDh5fn4wHaHa&mediurl=https%3a%2f%2fwww.nauticawebshop.com%2fimage%2fcache%2fdata%2fosculati%2findicatore\\_cromato\\_osculati-500x500.jpg&exph=500&expw=500&q=indicatore+stato+benzina+nero&simid=608003546547947809&ck=1D00B5210098130D9948B50703954D61&selectedIndex=85&FORM=IRPRST&ajaxhist=0](https://www.bing.com/images/search?view=detailV2&ccid=fEPn%2bzIG&id=A2D008CA203F43BAAC3954A1191268AF1B415E10&thid=OIP.fEPn-zlGmXKWpPtDh5fn4wHaHa&mediurl=https%3a%2f%2fwww.nauticawebshop.com%2fimage%2fcache%2fdata%2fosculati%2findicatore_cromato_osculati-500x500.jpg&exph=500&expw=500&q=indicatore+stato+benzina+nero&simid=608003546547947809&ck=1D00B5210098130D9948B50703954D61&selectedIndex=85&FORM=IRPRST&ajaxhist=0)

Thank you for listening