1) **Find the car manufacturer, which contains most quantity of car models e.g. BMW 3 series and BMW 5 series are different models.**

Pandas Result:

Mfr Name	Num_of_Models
BMW	86
General Motors	59
Volkswagen Group of	55
Porsche	31
Chrysler Group LLC	29

SQL Result:

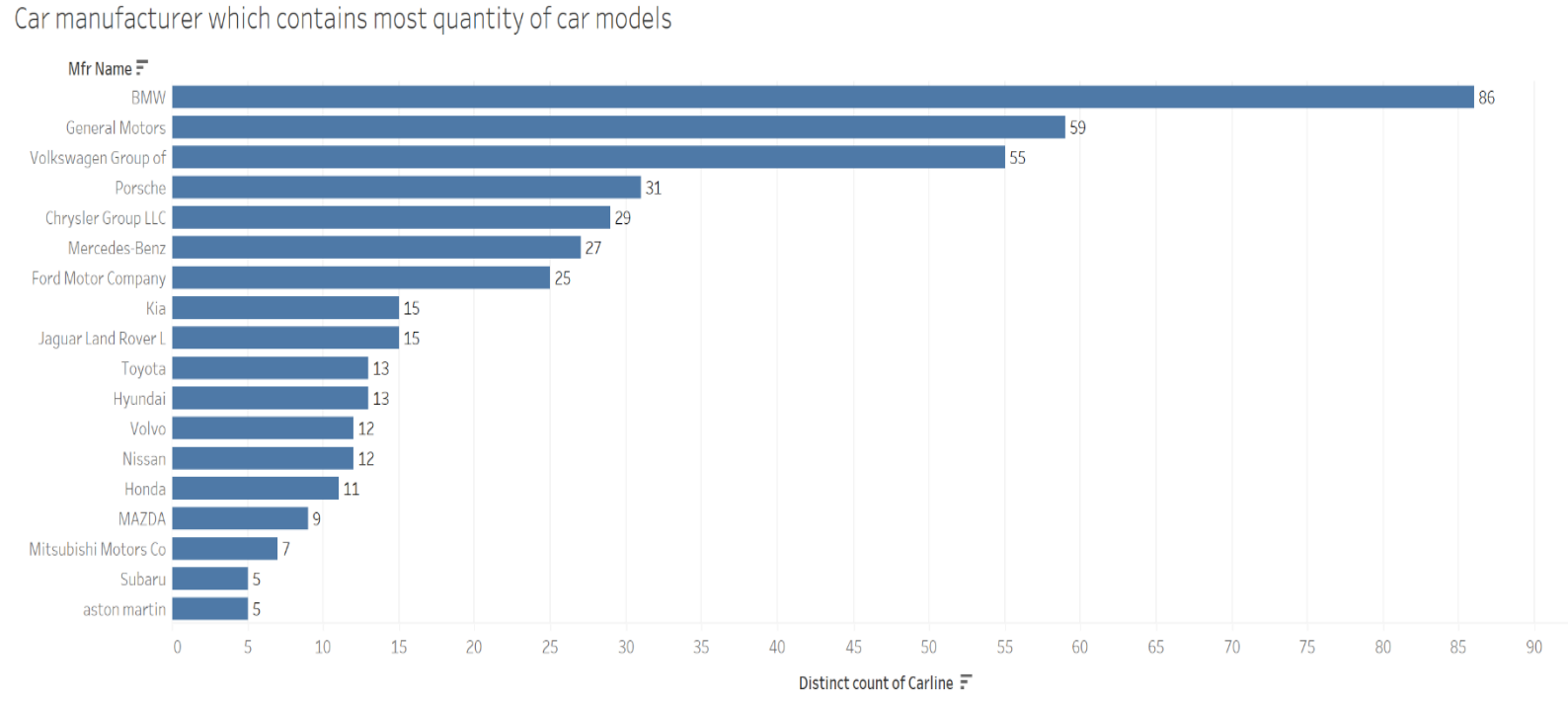
```
SELECT `Mfr Name`, COUNT(DISTINCT(`Carline`)) AS Models FROM data15 GROUP BY `Mfr Name` ORDER BY Models DESC LIMIT 3;
```

Profiling [Edit inline] [Edit] [Explain SQL] [Create PHP code] [Refresh]

+ Options

Mfr Name	Models ▼ 1
BMW	86
General Motors	59
Volkswagen Group of	55

Tableau Result:



2) **Find the top average fuel economy for the city and highway driving from the given data set.**

Pandas:

Top fuel economy for the city and highway driving

```
data_15['City FE'].max()
```

```
44
```

```
data_15['Highway FE'].max()
```

```
46
```

Average fuel economy for the city and highway driving

```
round(data_15['City FE'].mean(),2)
```

```
20.08
```

```
round(data_15['Highway FE'].mean(),2)
```

```
28.23
```

SQL for Average FEs:

```
MariaDB [fueleconomy]> SELECT ROUND(AVG(`City FE`),2) AS AVG_CityFE,
    -> ROUND(AVG(`Highway FE`),2) AS AVG_HighwayFE FROM data15;
+------------+---------------+
| AVG_CityFE | AVG_HighwayFE |
+------------+---------------+
|      20.08 |         28.23 |
+------------+---------------+
1 row in set (0.002 sec)
```

3) Find good and bad average fuel economy from all transmission types.

Pandas:

```
bad_auto = (min(auto['City FE']) + min(auto['Highway FE']))/2
bad_auto
```

```
11.5
```

```
good_auto = (max(auto['City FE']) + max(auto['Highway FE']))/2
good_auto
```

```
44.5
```

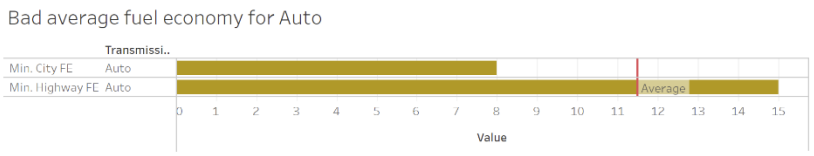
```
bad_manual= (min(manual['City FE']) + min(manual['Highway FE']))/2
bad_manual
```

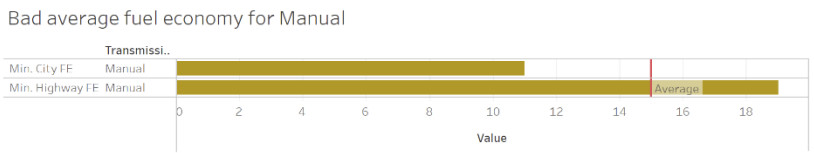
```
15.0
```

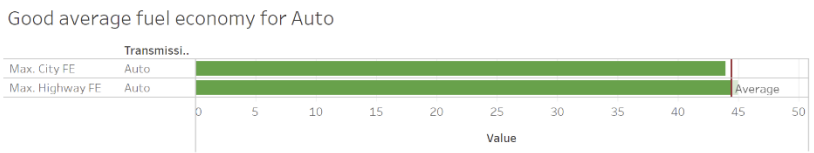
```
good_manual= (max(manual['City FE']) + max(manual['Highway FE']))/2
good_manual
```

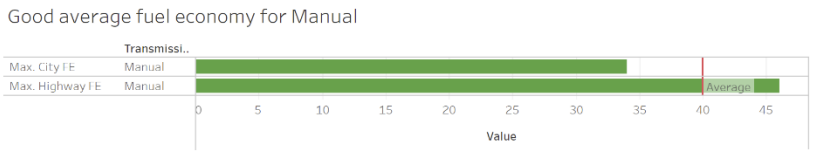
```
40.0
```

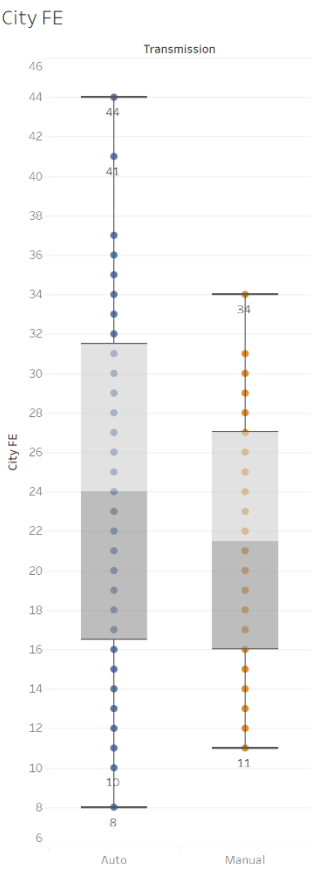
Tableau:

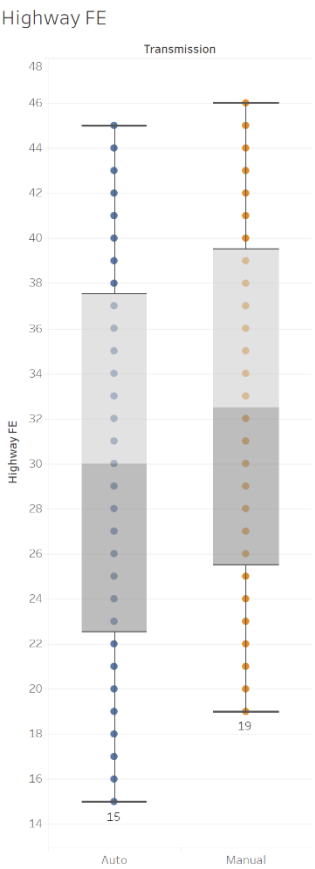












4) Find car manufacturers, which have 4WD (4-wheel drive) and 2WD (2-wheel drive) with engine power is more than 3.5.

Pandas: (Manufacturers with number of cars)

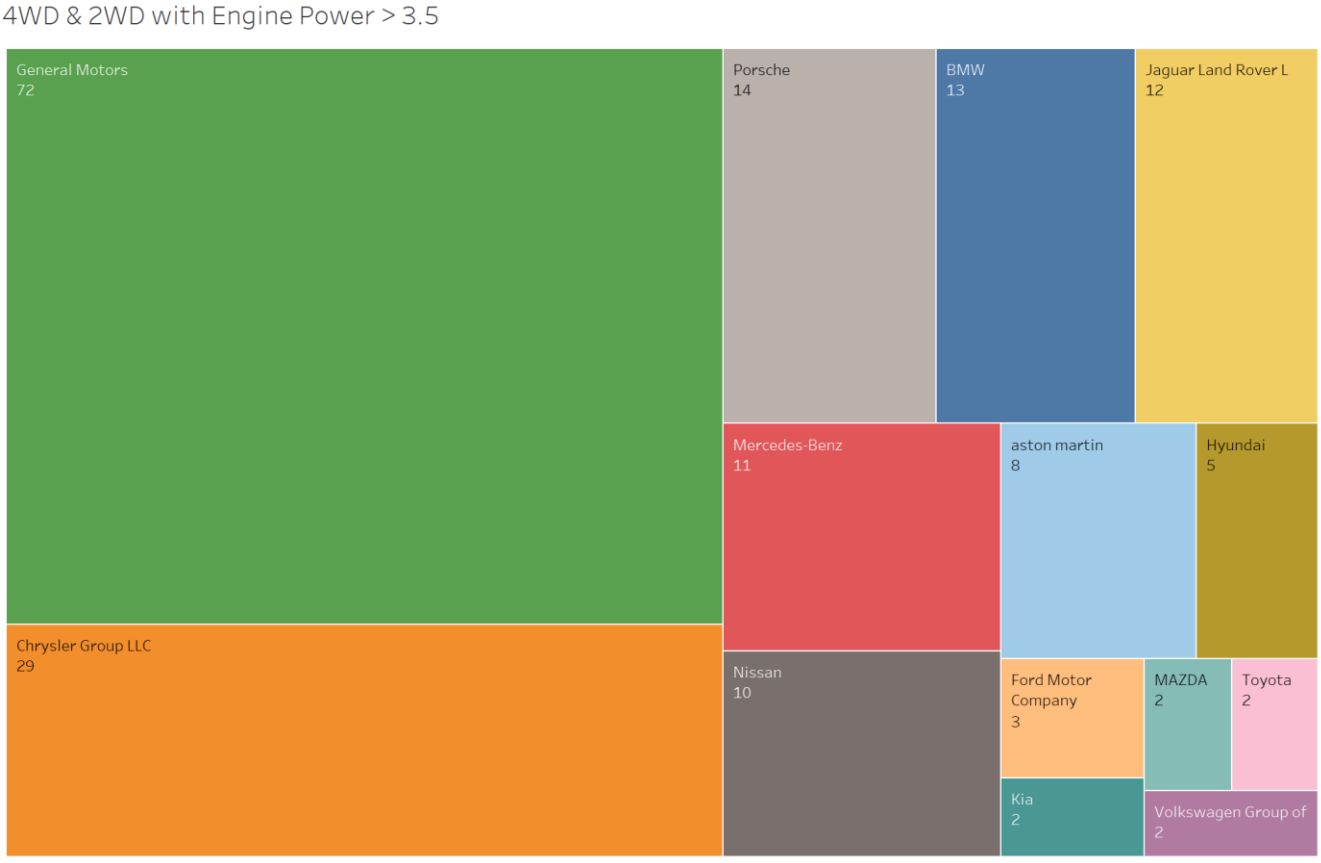
Mfr Name	Num_Cars
BMW	13
Chrysler Group LLC	29
Ford Motor Company	3
General Motors	72
Hyundai	5
Jaguar Land Rover L	12
Kia	2
MAZDA	2
Mercedes-Benz	11
Nissan	10
Porsche	14
Toyota	2
Volkswagen Group of	2
aston martin	8

SQL:

```
MariaDB [fueleconomy]> CREATE VIEW question_4 AS
    -> SELECT `Mfr Name`, `Drive Desc`, `Engine Displacement` FROM data15 WHERE `Engine Displacement` >= 3.6
    -> AND (`Drive Desc` LIKE '2-Wheel%' OR `Drive Desc` LIKE '4-Wheel%')
    -> ORDER BY `Mfr Name` DESC ;
Query OK, 0 rows affected (0.016 sec)

MariaDB [fueleconomy]> SELECT DISTINCT(`Mfr Name`) FROM question_4;
+---------------------+
| Mfr Name            |
+---------------------+
| Volkswagen Group of |
| Toyota              |
| Porsche             |
| Nissan              |
| Mercedes-Benz       |
| MAZDA               |
| Kia                 |
| Jaguar Land Rover L |
| Hyundai             |
| General Motors      |
| Ford Motor Company  |
| Chrysler Group LLC  |
| BMW                 |
| aston martin        |
+---------------------+
14 rows in set (0.002 sec)
```

Tableau:



5) Top 3 car manufacturer that have the lowest average CO2 for city and highway for 2015 ?

Pandas:

Mfr Name	Avg_City_CO2
Mitsubishi Motors Co	355.54
MAZDA	360.38
Kia	401.65

Mfr Name	Avg_Highway_CO2
MAZDA	267.88
Mitsubishi Motors Co	275.38
Hyundai	290.42

SQL:

```
SELECT DISTINCT(`Mfr Name`), ROUND(AVG(`City CO2`),2) AS AVG_CO2 FROM data15 GROUP BY `Mfr Name` ORDER BY AVG_CO2 ASC LIMIT 3;
```

Profiling [Edit inline] [Edit] [Explain SQL] [Create PHP code] [Refresh]

+ Options

Mfr Name	AVG_CO2 ▲ 1
Mitsubishi Motors Co	355.54
MAZDA	360.38
Kia	401.65

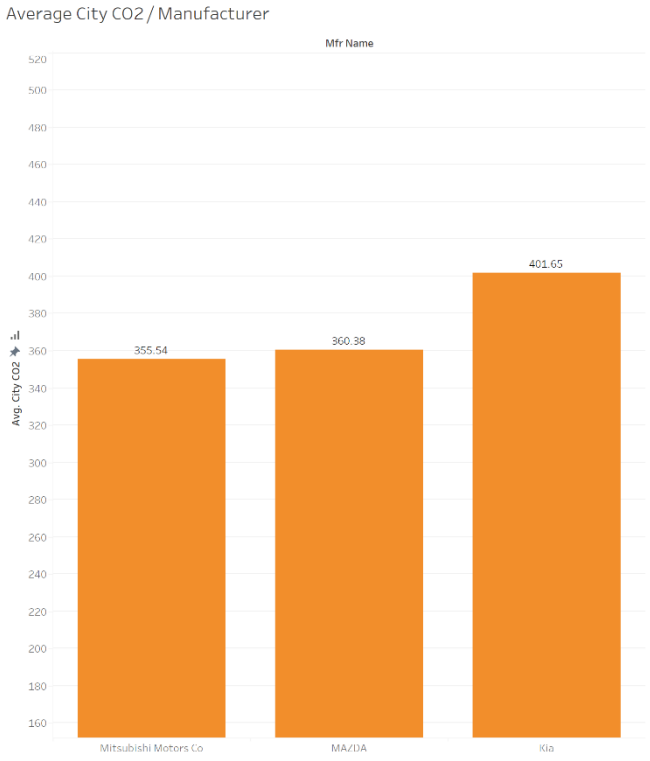
```
SELECT DISTINCT(`Mfr Name`), ROUND(AVG(`Highway CO2`),2) AS AVG_CO2 FROM data15 GROUP BY `Mfr Name` ORDER BY AVG_CO2 ASC LIMIT 3;
```

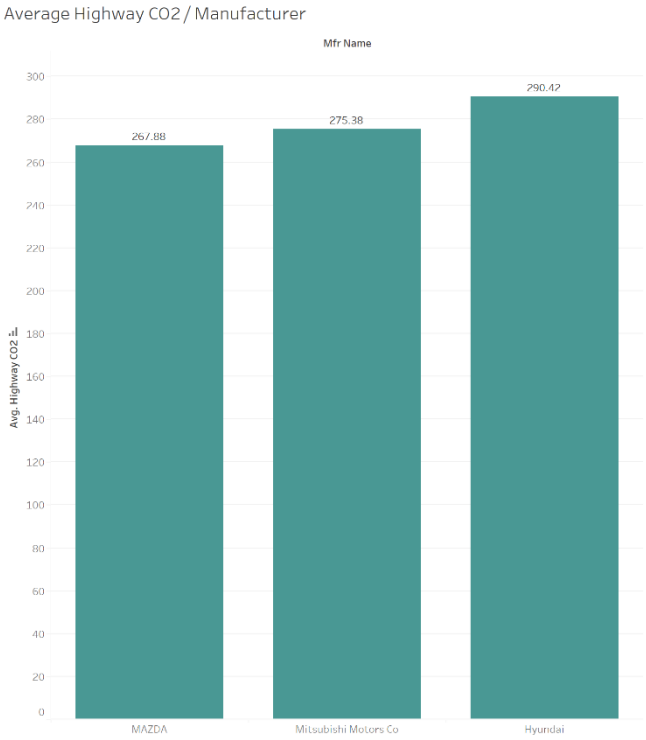
Profiling [Edit inline] [Edit] [Explain SQL] [Create PHP code] [Refresh]

+ Options

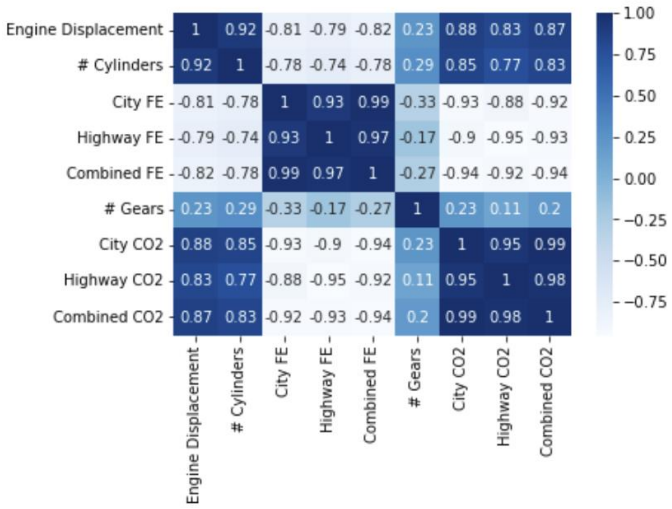
Mfr Name	AVG_CO2 ▲ 1
MAZDA	267.88
Mitsubishi Motors Co	275.38
Hyundai	290.42

Tableau:





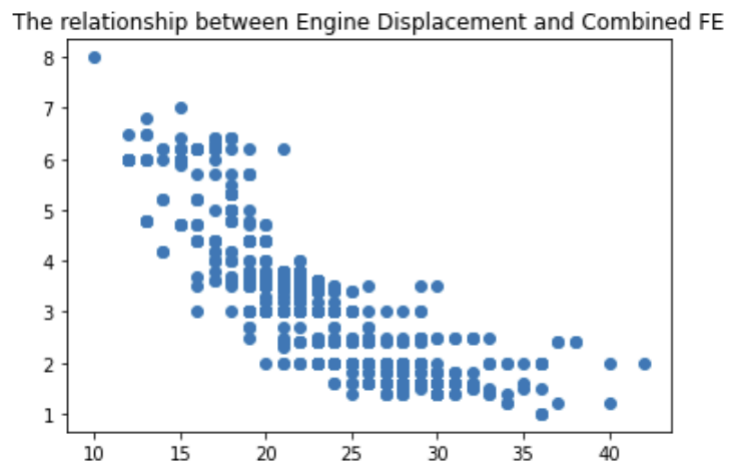
6) Which features are correlated with FE?



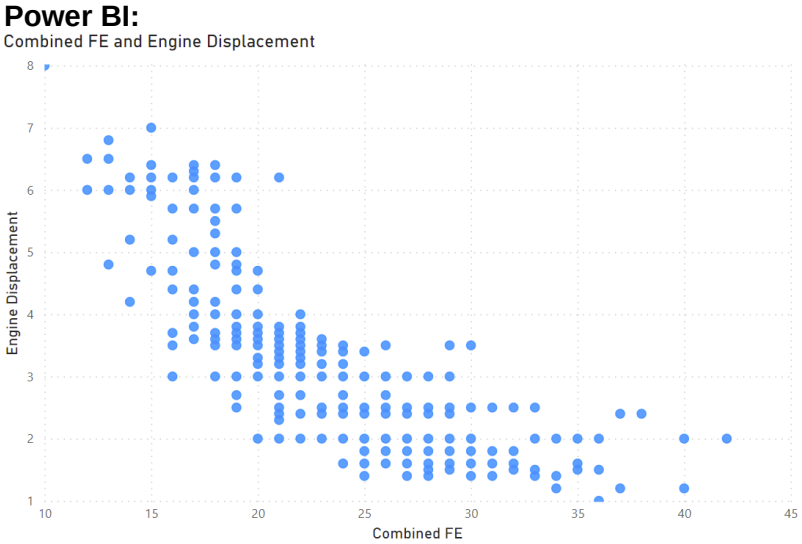
- There is a ***very strong negative correlation*** between Combined FE and Engine Displacement (-0.82). Cars with lower engine power have higher FE.
- There is a ***strong negative correlation*** between FE and # Cylinders (-0.78). Cars with less cylinders have higher FE.
- There is a ***weak negative correlation*** between FE and # Gears (-0.33).
- There is a ***very strong negative correlation*** between CO2. (-0.94). Cars with lower FE causes higher CO2 emissions.

Relationship between Engine Displacement and Combined FE

Pandas:

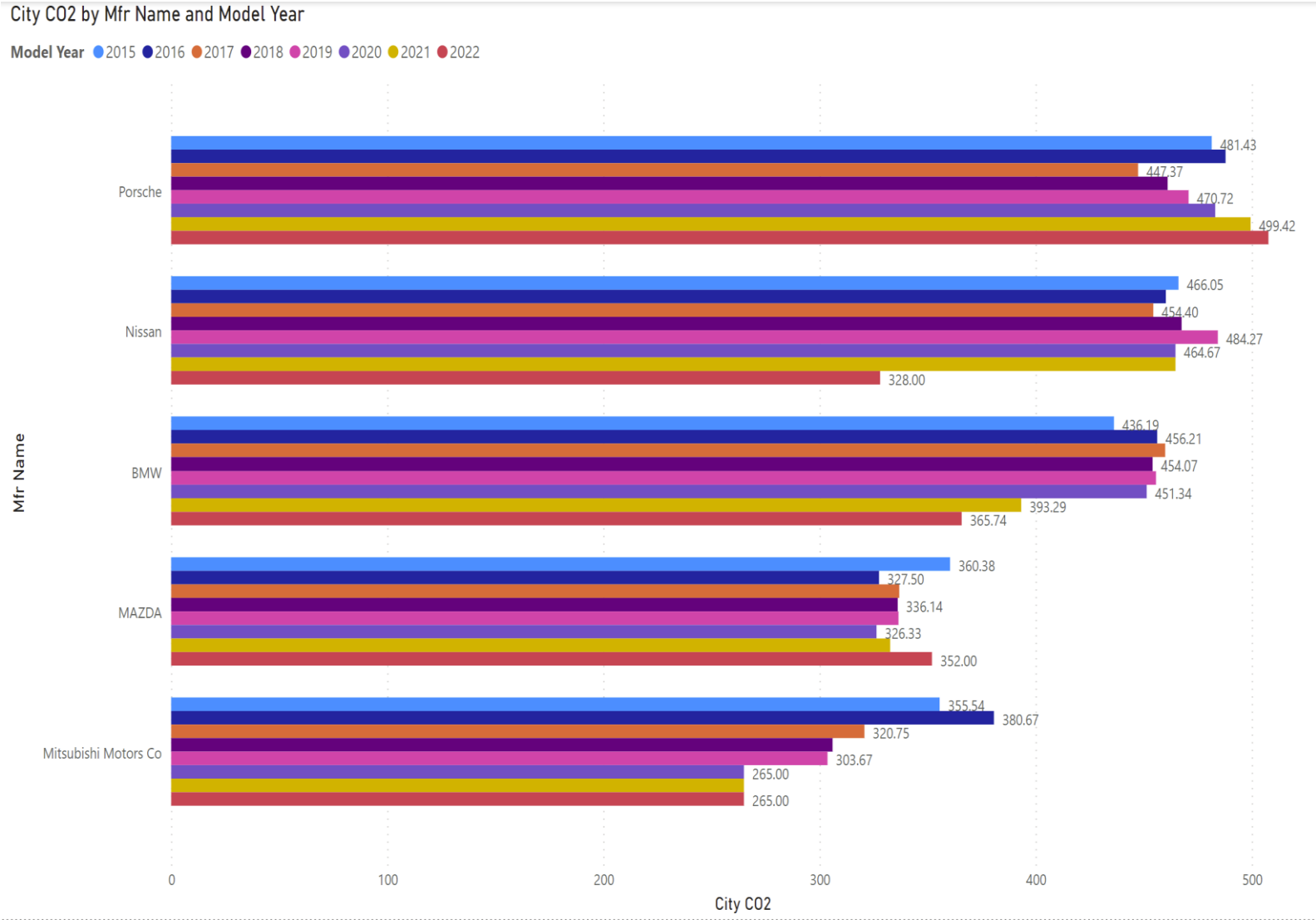


Power BI:



7) How has the city CO2 changed from 2015 to 2022 for the manufacturers which has records for all years (grams per mile)?

5 manufacturers selected: Porsche, Nissan, BMW, MAZDA, Mitsubishi

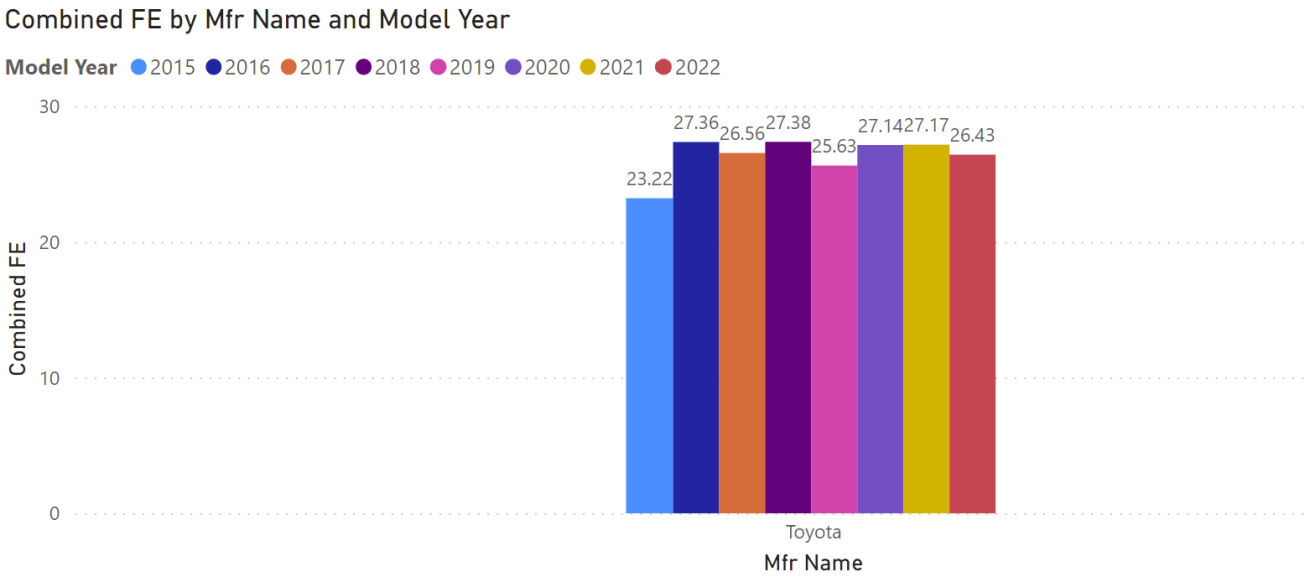


Porsche's average City CO2 emissions has increased from 481.43 to 499.42 (~ 5.5% ↑)
Nissan's average City CO2 emissions has decreased from 466.05 to 328 (~ 29.6% ↓)
BMW's average City CO2 emissions has decreased from 436.19 to 365.74 (~ 16.15% ↓)
Mazda's average City CO2 emissions has decreased from 360.38 to 352 (~ 2.3% ↓)
Mitsubishi's average City CO2 has been decreased from 355.54 to 265 (~ 25.5% ↓)

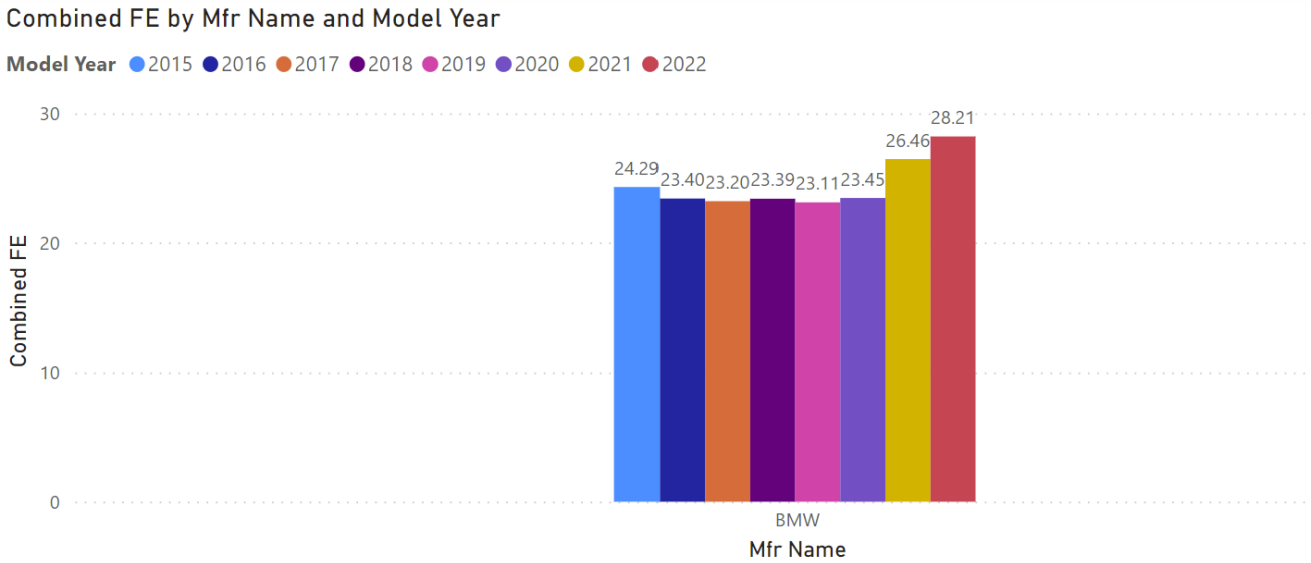
Based on the above percentages, we can say that Nissan has the highest improvement in terms of City CO2 emissions.

8) How has the average Combined FE changed from 2015 to 2022 for Toyota, BMW and Mercedes-Benz?

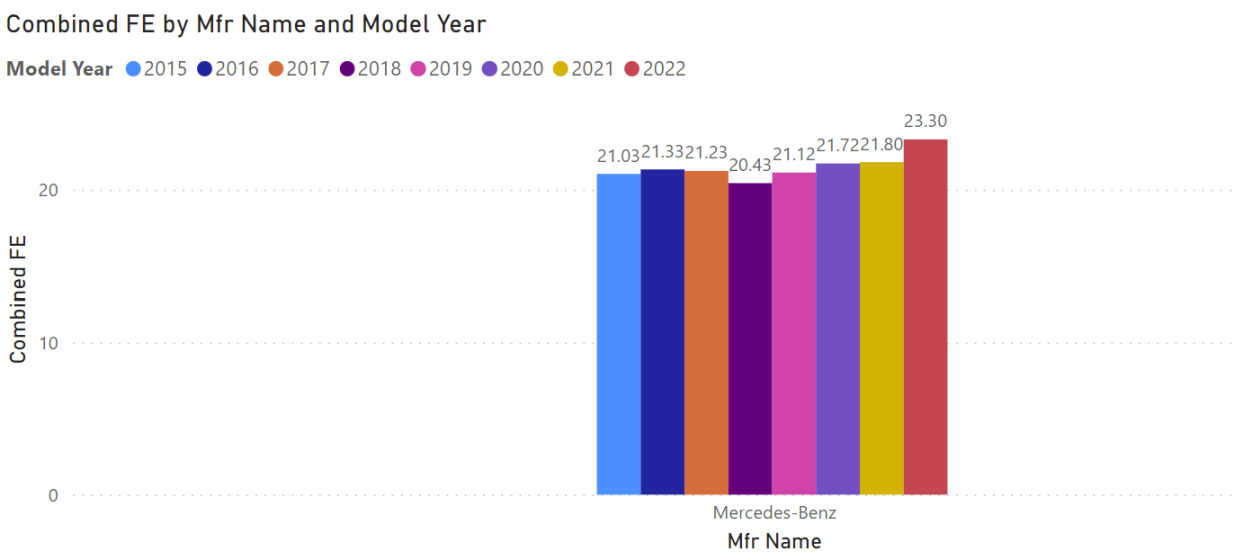
Toyota



BMW:



Mercedes-Benz:



9) How much has the combined FE improved in transmission types?

For 2015

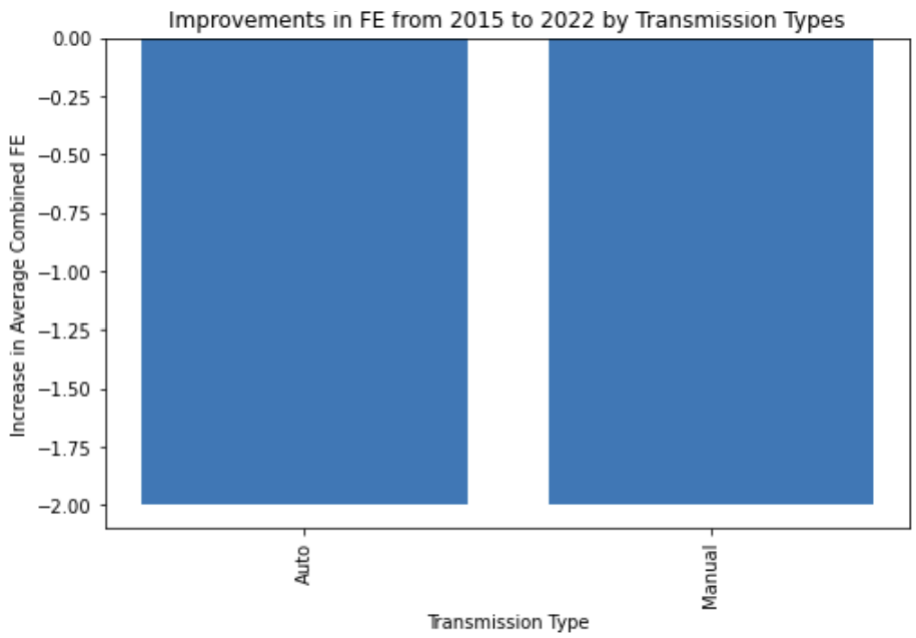
Transmission	AVG_Combined_FE
Auto	23.0
Manual	25.0

For 2022

Transmission	AVG_Combined_FE
Auto	21.0
Manual	23.0

Improvement:

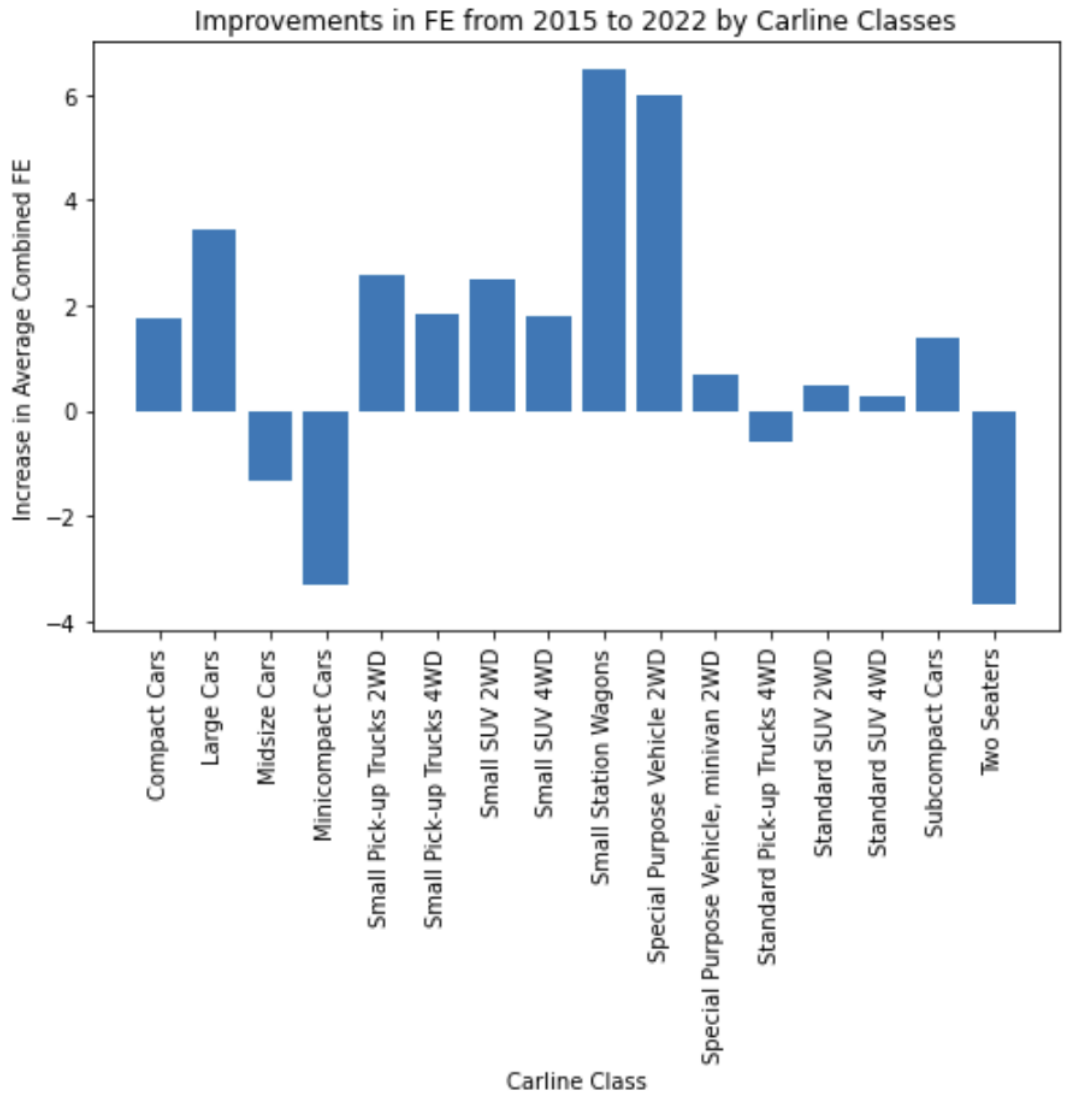
Transmission	AVG_Combined_FE
Auto	-2.0
Manual	-2.0



10) How much has the combined FE improved in carline classes?

Improvement:

Carline Class Desc	AVG_Combined_FE
Compact Cars	1.76
Large Cars	3.43
Small Pick-up Trucks 2WD	2.57
Small Pick-up Trucks 4WD	1.84
Small SUV 2WD	2.51
Small SUV 4WD	1.81
Small Station Wagons	6.50
Special Purpose Vehicle 2WD	6.00
Special Purpose Vehicle, minivan 2WD	0.67
Standard SUV 2WD	0.48
Standard SUV 4WD	0.26
Subcompact Cars	1.36



11) For the years between 2015 to 2022, which manufacturer has the most polluting cars? (Cars with the SMOG rating 1 is the most polluting)

```
5      3866
3      2009
6      1740
7      1382
1       450
8       172
9        56
Mod      39
2        30
4        15
Name: SmogRating, dtype: int64
```

Top 5 polluting manufacturers:

Mfr Name	AVG_Combined_CO2
Volkswagen Group of	678.0
Pagani Automobili S	671.0
Koenigsegg	625.0
BMW	538.0
Maserati	525.0

Carlines for those 5 manufacturers:

Volkswagen:

Carline	AVG_Combined_CO2
Aventador Countach	787.0
Aventador Coupe	791.0
Aventador Roadster	798.0
Aventador S Coupe	731.0
Aventador S Roadster	751.0

Pagani Automobili S:

Carline	AVG_Combined_CO2
Huayra	671.0
Huayra Coupe	671.0

Koenigsegg:

Carline	AVG_Combined_CO2
Agera RS	654.0
REGERA	610.0

BMW:

Carline	AVG_Combined_CO2
M6 Convertible	537.5
M6 Gran Coupe	537.5

Maserati:

Carline	AVG_Combined_CO2
GHIBLI	460.0
GHIBLI S	460.0
GHIBLI S Q4	474.0
GHIBLI TROFEO	560.0
GRANTURISMO CONVERTIBLE	569.0

12) For the years between 2015 to 2022, which manufacturer is the cleanest?
(Cars with the SMOG rating 9 are cleanest)

Top 5 cleanest manufacturers:

Mfr Name	AVG_Combined_CO2
Honda	263.0
MAZDA	271.0
Hyundai	292.0
Kia	293.0
Volkswagen Group of	317.0

Carlines for those 5 manufacturers:

Honda:

Carline	AVG_Combined_CO2
ACCORD	297.0
CIVIC	252.0
CIVIC HF	253.0
CR-Z	250.0

Mazda:

Carline	AVG_Combined_CO2
MAZDA3 4-Door	268.0
MAZDA3 5-Door	274.0

Hyundai:

Carline	AVG_Combined_CO2
Sonata HYBRID	237.0
Sonata HYBRID LIMITED	239.0
Tucson AWD	401.0

Kia:

Carline	AVG_Combined_CO2
Optima HYBRID	237.0
Optima HYBRID EX	242.0
Sportage AWD	400.0

Volkswagen:

Carline	AVG_Combined_CO2
A3	328.0
A3 Cabriolet	314.0
A3 Cabriolet quattro	334.0
A3 quattro	323.0
GTI	315.0