```
import pandas as pd
          import matplotlib.pyplot as plt
          %matplotlib inline
          import seaborn as sns
          import statsmodels.formula.api as smf
          import statsmodels.api as sm
          from statsmodels.graphics.regressionplots import influence_plot
          import warnings
          warnings.filterwarnings("ignore")
In [2]:
          df = pd.read_csv("ToyotaCorolla.csv")
In [3]:
          df.head()
            ld
                   Model
                          Price Age_08_04 Mfg_Month Mfg_Year
                                                                 KM Fuel_Type HP Met_Color ... Central_Lock
Out[3]:
                 TOYOTA
                Corolla 2.0
                    D4D
            1
                          13500
                                       23
                                                  10
                                                          2002 46986
                                                                          Diesel
                                                                                 90
                                                                                            1 ...
                                                                                                            1
                 HATCHB
                  TERRA
                2/3-Doors
                 TOYOTA
                Corolla 2.0
                    D4D
         1 2
                         13750
                                       23
                                                  10
                                                          2002 72937
                                                                          Diesel
                                                                                90
                                                                                            1 ...
                                                                                                            1
                 HATCHB
                  TERRA
                2/3-Doors
               ♦TOYOTA
                Corolla 2.0
                    D4D
                          13950
                                       24
                                                   9
                                                          2002 41711
                                                                                                            0
         2 3
                                                                          Diesel 90
                                                                                            1 ...
                 HATCHB
                  TERRA
                2/3-Doors
                 TOYOTA
                Corolla 2.0
                    D4D
                                       26
                                                   7
                                                                                                            0
         3
                          14950
                                                          2002 48000
                                                                                 90
                                                                                            0 ...
                                                                          Diesel
                 HATCHB
                  TERRA
                2/3-Doors
                 TOYOTA
                Corolla 2.0
                    D4D
                         13750
                                       30
                                                          2002 38500
                                                                          Diesel
                                                                                            0 ...
                 HATCHB
                 SOL 2/3-
                   Doors
        5 rows × 38 columns
In [4]:
          df.tail()
                      Model
                              Price Age_08_04 Mfg_Month Mfg_Year
                                                                     KM Fuel_Type
                                                                                   HP Met_Color ... Central_L(
Out[4]:
```

In [1]:

import numpy as np

		Id	Model	Price	Age_08_04	Mfg_Month	Mfg_Year	KM	Fuel_Type	HP	Met_Color	 Central_L
	1431	1438	TOYOTA Corolla 1.3 16V HATCHB G6 2/3- Doors	7500	69	12	1998	20544	Petrol	86	1	
	1432	1439	TOYOTA Corolla 1.3 16V HATCHB LINEA TERRA 2/3	10845	72	9	1998	19000	Petrol	86	0	
	1433	1440	TOYOTA Corolla 1.3 16V HATCHB LINEA TERRA 2/3	8500	71	10	1998	17016	Petrol	86	0	
	1434	1441	TOYOTA Corolla 1.3 16V HATCHB LINEA TERRA 2/3	7250	70	11	1998	16916	Petrol	86	1	
	1435	1442	TOYOTA Corolla 1.6 LB LINEA TERRA 4/5- Doors	6950	76	5	1998	1	Petrol	110	0	
	5 rows	s × 38	columns									
In [5]:	df.s	shape										
Out[5]:	(143	6, 38)									
In [6]:	df.:	info())									
	<pre><class #="" 'pandas.core.fr="" (total="" 0="" 1="" 10="" 1436="" 2="" 3="" 38="" 4="" 5="" 6="" 7="" 8="" 9="" age_08_04="" color<="" column="" columns="" data="" entri="" fuel_type="" hp="" id="" km="" met_color="" mfg_month="" mfg_year="" model="" pre="" price="" rangeindex:=""></class></pre>				s, 0 to 14	Count Dtypull into the count of	 64 ect 64 64 64 64 ect 64 ect					

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11

12

Automatic

СС

1436 non-null

1436 non-null

1436 non-null

int64

int64

int64

```
14
    Cylinders
                      1436 non-null
                                      int64
15
                      1436 non-null
   Gears
                                      int64
   Quarterly_Tax
                      1436 non-null
                                      int64
17
   Weight
                      1436 non-null
                                      int64
   Mfr_Guarantee
                      1436 non-null
                                      int64
   BOVAG_Guarantee
                      1436 non-null
                                      int64
   Guarantee_Period 1436 non-null
20
                                      int64
21
   ABS
                      1436 non-null
                                      int64
   Airbag_1
                      1436 non-null
                                      int64
23
                      1436 non-null
                                      int64
   Airbag_2
   Airco
                      1436 non-null
                                      int64
   Automatic_airco
                      1436 non-null
                                      int64
   Boardcomputer
                      1436 non-null
                                      int64
27
   CD_Player
                      1436 non-null
                                      int64
28
   Central_Lock
                      1436 non-null
                                      int64
   Powered_Windows
29
                      1436 non-null
                                      int64
   Power_Steering
                      1436 non-null
                                      int64
31
   Radio
                      1436 non-null
                                      int64
32
   Mistlamps
                      1436 non-null
                                      int64
33
   Sport_Model
                      1436 non-null
                                      int64
   Backseat_Divider 1436 non-null
                                      int64
   Metallic_Rim
                      1436 non-null
                                      int64
36
   Radio_cassette
                      1436 non-null
                                      int64
37
   Tow_Bar
                      1436 non-null
                                      int64
```

dtypes: int64(35), object(3) memory usage: 426.4+ KB

Checking Null Values

```
In [7]:
             df.isnull().sum()
                                    0
   Out[7]:
            Model
                                    0
            Price
                                    0
            Age_08_04
                                    0
            Mfg_Month
                                    0
            Mfg_Year
                                    0
            \mathsf{KM}
            Fuel_Type
                                    0
            ΗP
                                    0
            Met_Color
                                    0
            Color
            Automatic
                                    0
                                    0
            CC
            Doors
            Cylinders
            Gears
                                    0
            Quarterly_Tax
                                    0
            Weight
                                    0
            Mfr_Guarantee
                                    0
            BOVAG_Guarantee
                                    0
            Guarantee_Period
                                    0
            Airbag_1
                                    0
            Airbag_2
                                    0
            Airco
                                    0
            Automatic_airco
            Boardcomputer
                                    0
            CD_Player
                                    0
            Central_Lock
            Powered_Windows
            Power_Steering
                                    0
            Radio
            Mistlamps
                                    0
            Sport_Model
                                    0
            <u>Backseat_Divid</u>er
                                    0
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                                    0
```

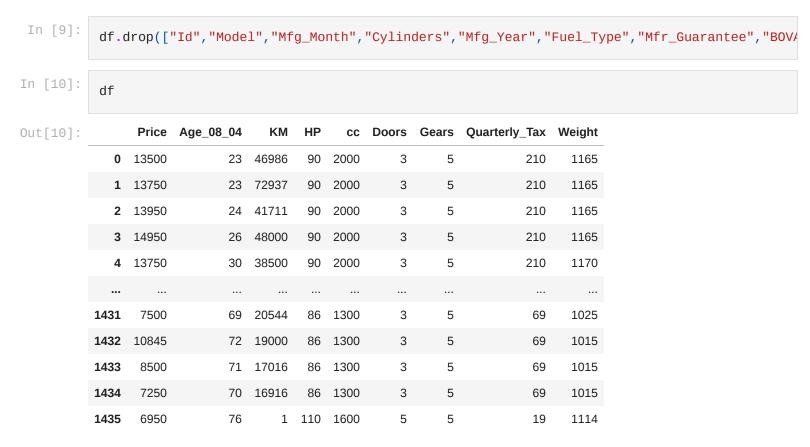
Radio_cassette 0 Tow_Bar 0 dtype: int64

Checking Duplicate Values

```
In [8]: df[df.duplicated()]
Out[8]: Id Model Price Age_08_04 Mfg_Month Mfg_Year KM Fuel_Type HP Met_Color ... Central_Lock Powered
```

0 rows × 38 columns

Dropping Columns which are not used for Predictions



1436 rows × 9 columns

Renaming Columns name

```
In [11]:
           df1=df.rename({"Age_08_04":"Age", "Quarterly_Tax":"QT", "cc":"CC"}, axis=1)
           df1
                                         CC Doors
                                                            QT Weight
                 Price Age
                                   HP
Out[11]:
                              ΚM
                                                    Gears
             0 13500
                        23
                            46986
                                    90
                                       2000
                                                 3
                                                        5
                                                           210
                                                                  1165
             1 13750
                            72937
                                       2000
                                                        5
                                                           210
                                                                  1165
                        23
                                    90
                13950
                            41711
                                        2000
                                                 3
                                                           210
                                                                  1165
             3 14950
                            48000
                                    90 2000
                                                        5 210
                                                                  1165
                        26
```

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	Price	Age	KM	HP	CC	Doors	Gears	QT	Weight
4	13750	30	38500	90	2000	3	5	210	1170
1431	7500	69	20544	86	1300	3	5	69	1025
1432	10845	72	19000	86	1300	3	5	69	1015
1433	8500	71	17016	86	1300	3	5	69	1015
1434	7250	70	16916	86	1300	3	5	69	1015
1435	6950	76	1	110	1600	5	5	19	1114

1436 rows × 9 columns

Checking Co-linearity

In [12]:

df1.corr()

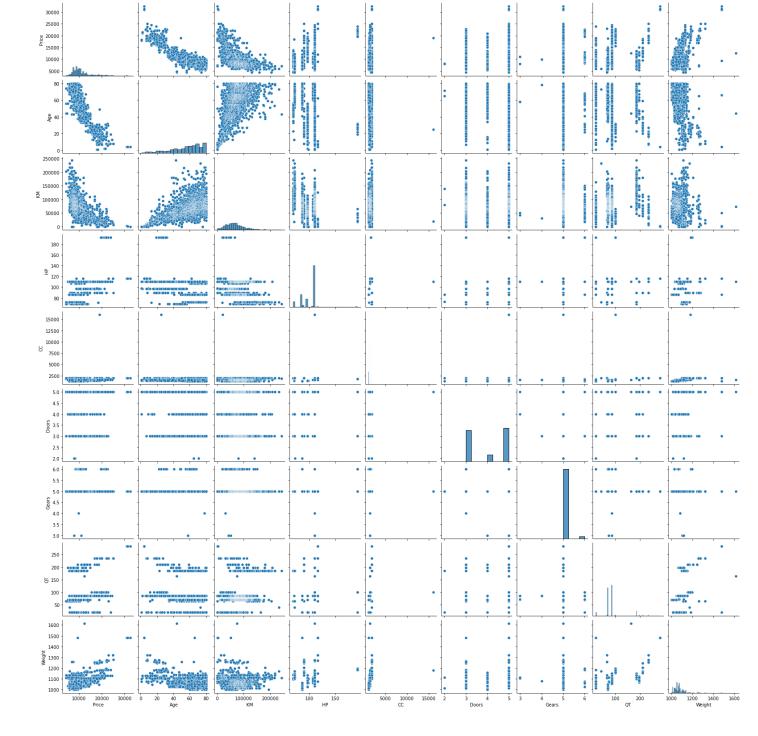
Out[12]:

	Price	Age	KM	HP	CC	Doors	Gears	QT	Weight
Price	1.000000	-0.876590	-0.569960	0.314990	0.126389	0.185326	0.063104	0.219197	0.581198
Age	-0.876590	1.000000	0.505672	-0.156622	-0.098084	-0.148359	-0.005364	-0.198431	-0.470253
KM	-0.569960	0.505672	1.000000	-0.333538	0.102683	-0.036197	0.015023	0.278165	-0.028598
HP	0.314990	-0.156622	-0.333538	1.000000	0.035856	0.092424	0.209477	-0.298432	0.089614
CC	0.126389	-0.098084	0.102683	0.035856	1.000000	0.079903	0.014629	0.306996	0.335637
Doors	0.185326	-0.148359	-0.036197	0.092424	0.079903	1.000000	-0.160141	0.109363	0.302618
Gears	0.063104	-0.005364	0.015023	0.209477	0.014629	-0.160141	1.000000	-0.005452	0.020613
QT	0.219197	-0.198431	0.278165	-0.298432	0.306996	0.109363	-0.005452	1.000000	0.626134
Weight	0.581198	-0.470253	-0.028598	0.089614	0.335637	0.302618	0.020613	0.626134	1.000000

In [13]:

sns.pairplot(df1)

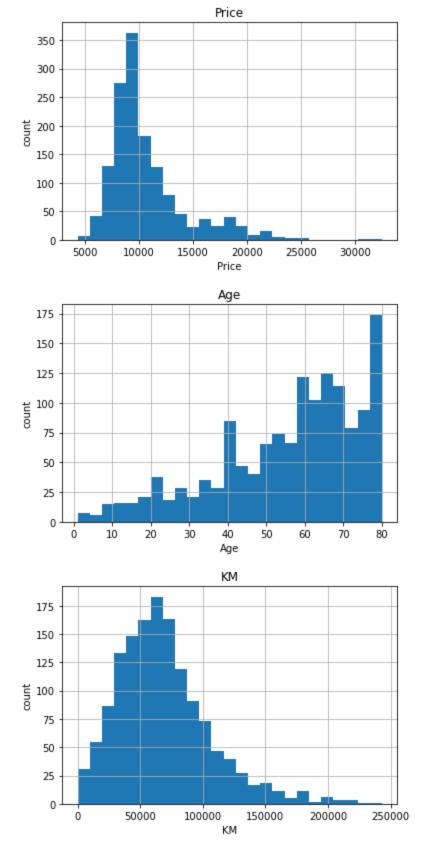
plt.show()

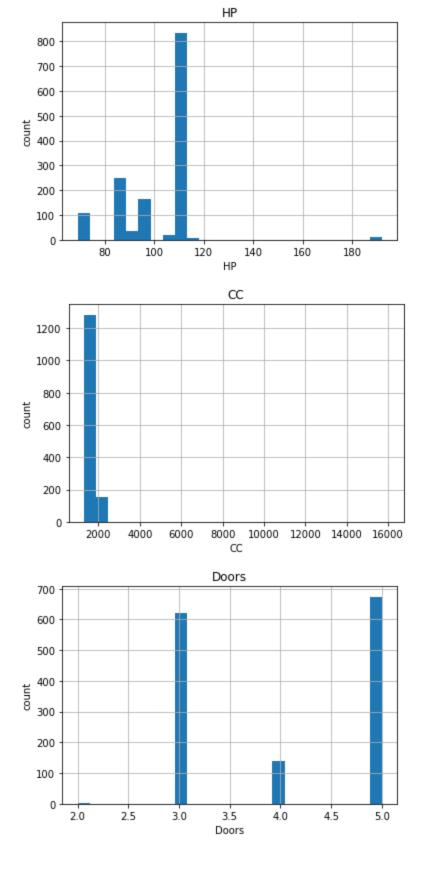


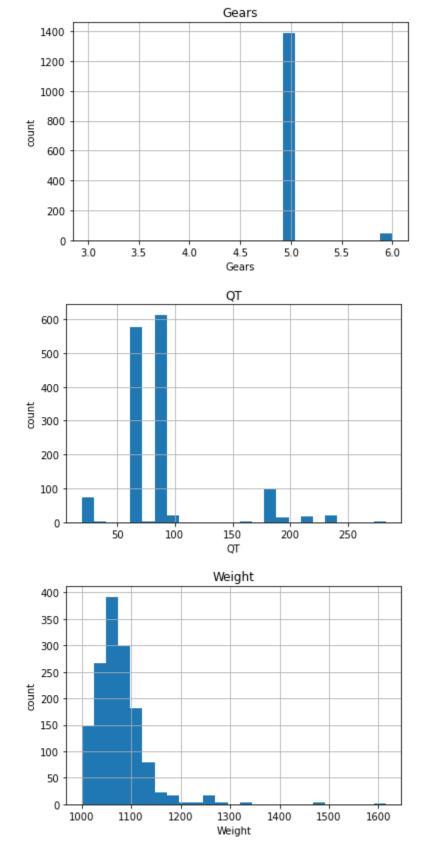
Observation

As we can see there is not correlation between features but between Ages and KM having negatively co-relation

```
for feature in df1:
    data=df1.copy()
    data[feature].hist(bins=25)
    plt.xlabel(feature)
    plt.ylabel("count")
    plt.title(feature)
    plt.show()
```

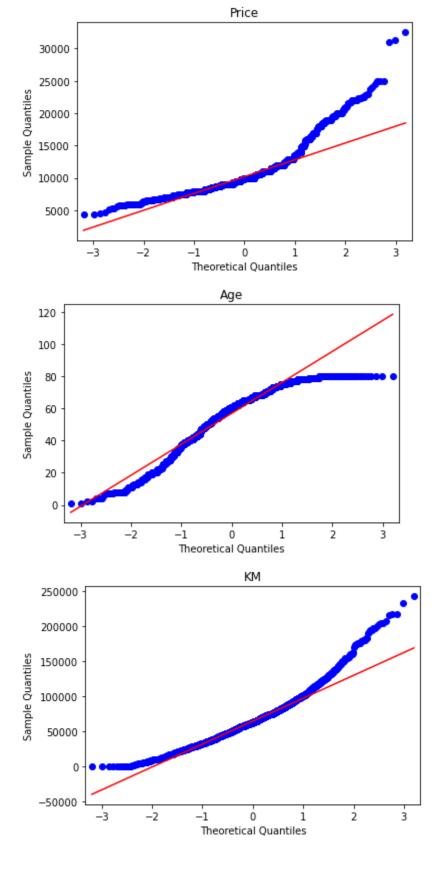


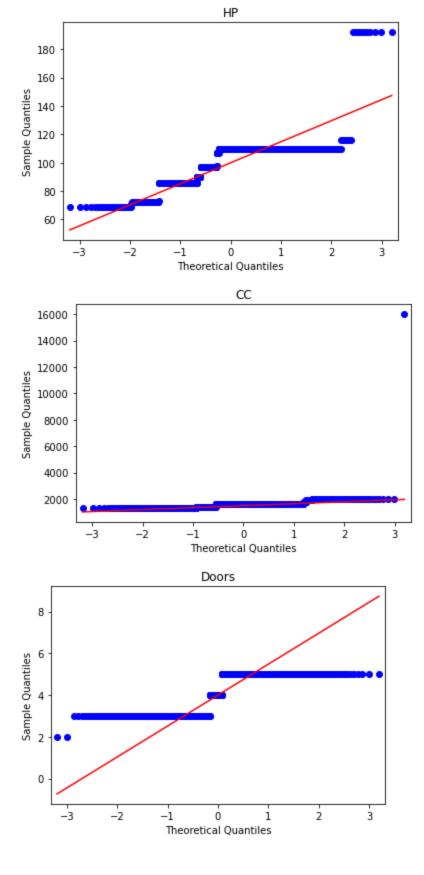


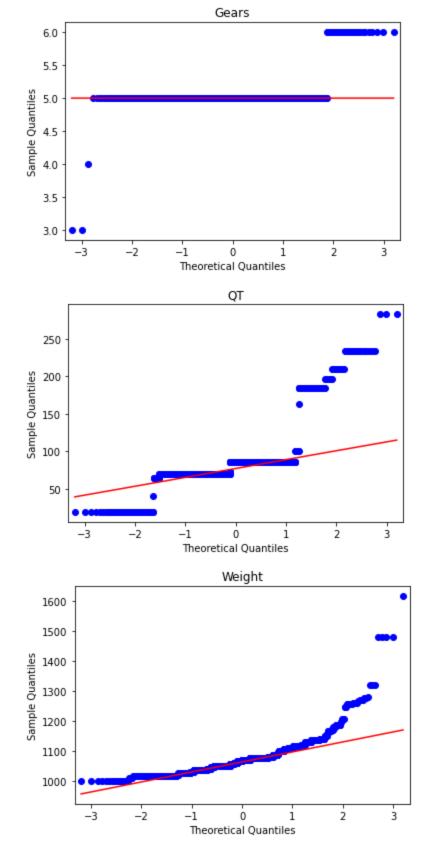


QQ-Plot for Raw Data

```
for feature in df1:
    data = df1.copy()
    sm.qqplot(data[feature], line='q')
    plt.title(feature)
    plt.show()
```



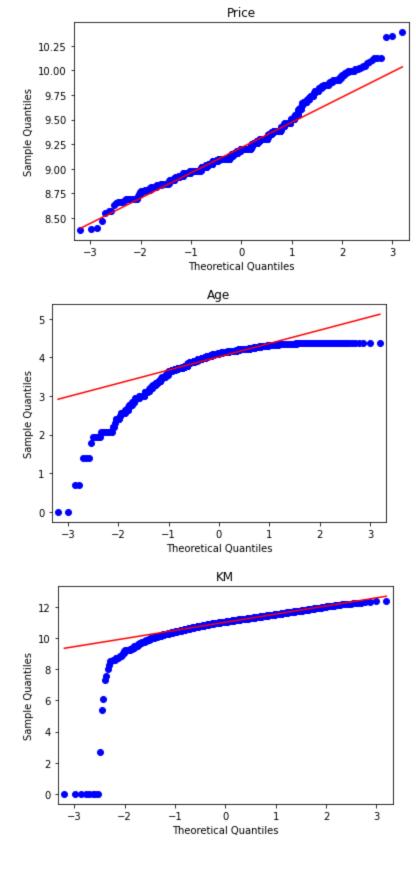


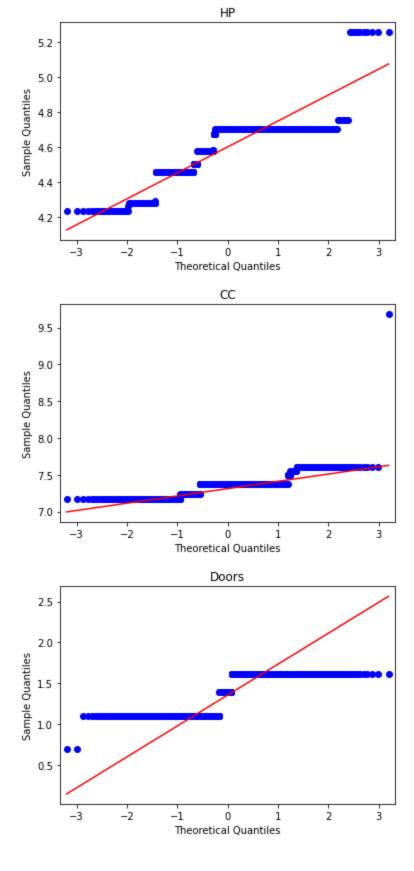


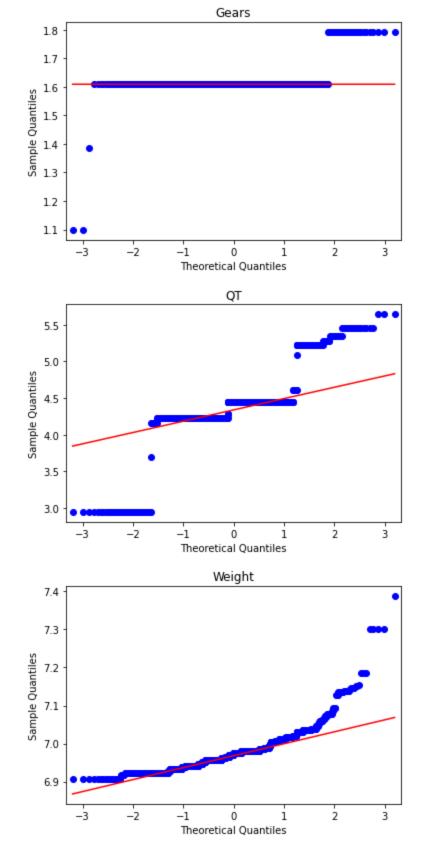
QQ-Plot For Log Transformation

```
for feature in df1:
    data = df1.copy()
    data[feature]=np.log(data[feature])
    sm.qqplot(data[feature], line='q')
    plt.title(feature)
    plt.show()
```

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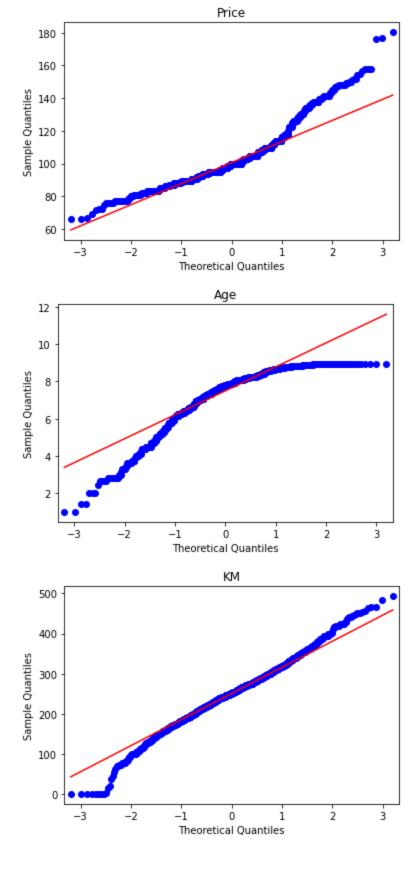


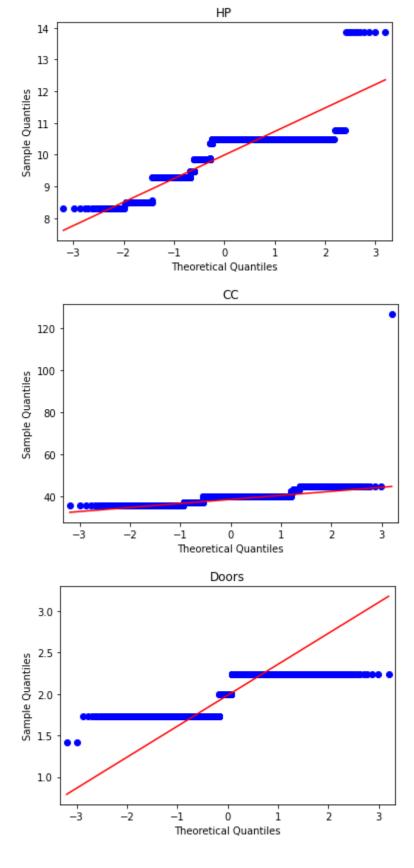


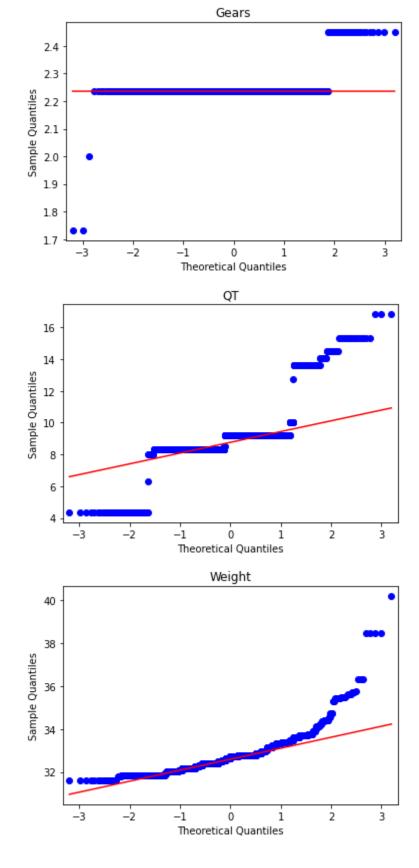


QQ-Plot For Squareroot Transformation

```
for feature in df1:
    data = df1.copy()
    data[feature]=np.sqrt(data[feature])
    sm.qqplot(data[feature],line='q')
    plt.title(feature)
    plt.show()
```

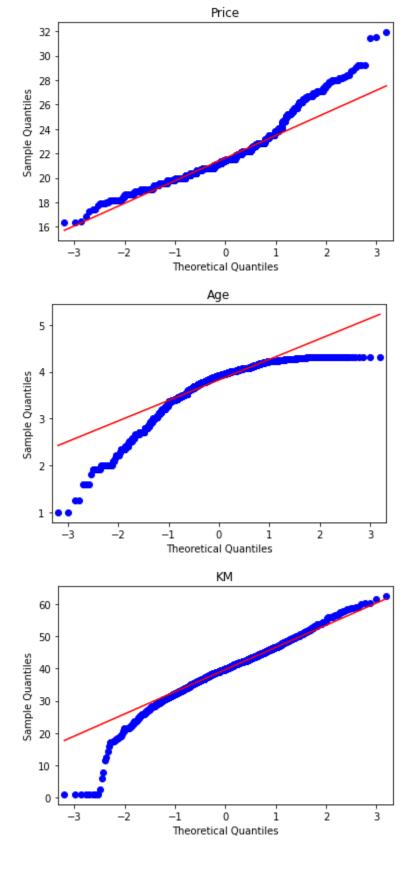


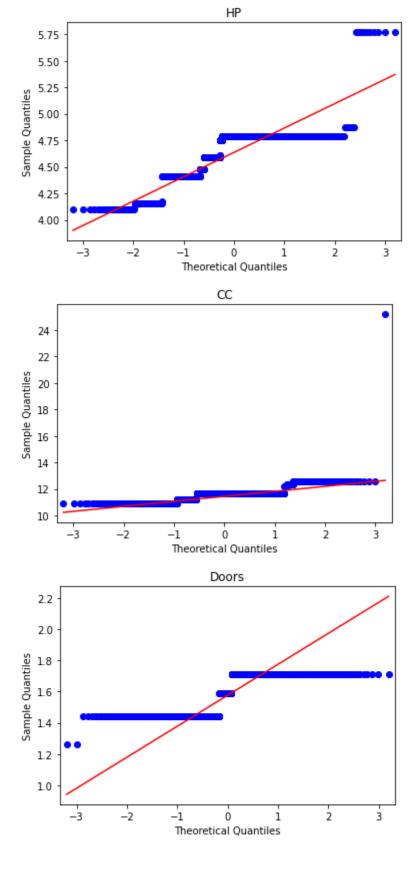


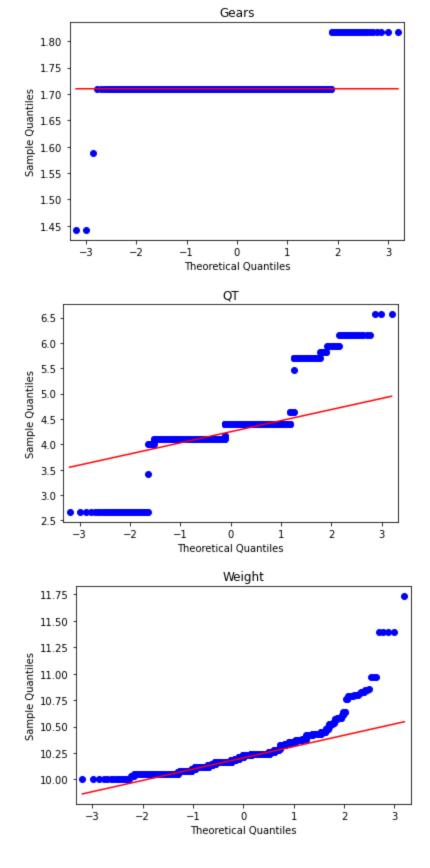


QQ-Plot for Cuberoot Transformation

```
for feature in df1:
    data = df1.copy()
    data[feature]=np.cbrt(data[feature])
    sm.qqplot(data[feature],line='q')
    plt.title(feature)
    plt.show()
```



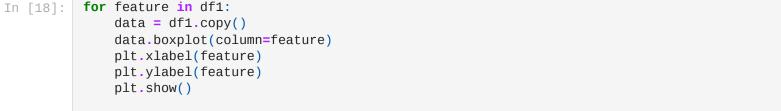


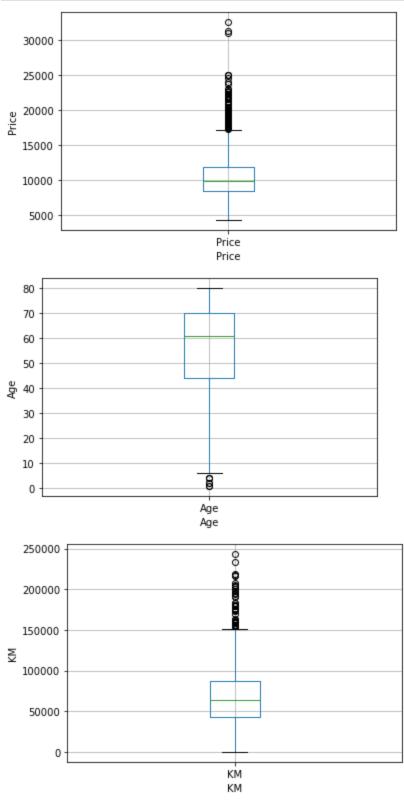


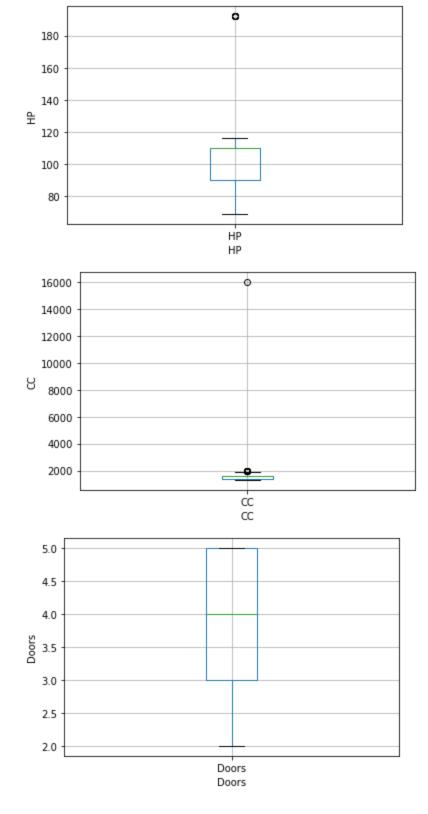
Observation

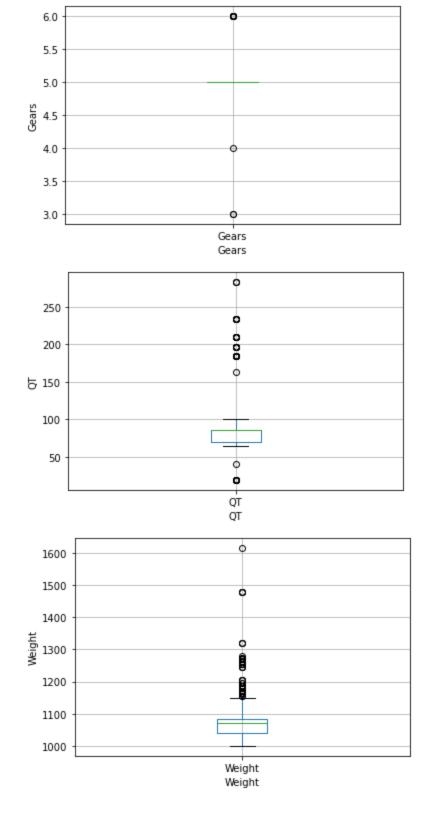
At normal raw data the data is not in normally distributed and after doing transformation the data is remained the same as it is so we use raw data for predictions

Checking Outliers Using Raw Data



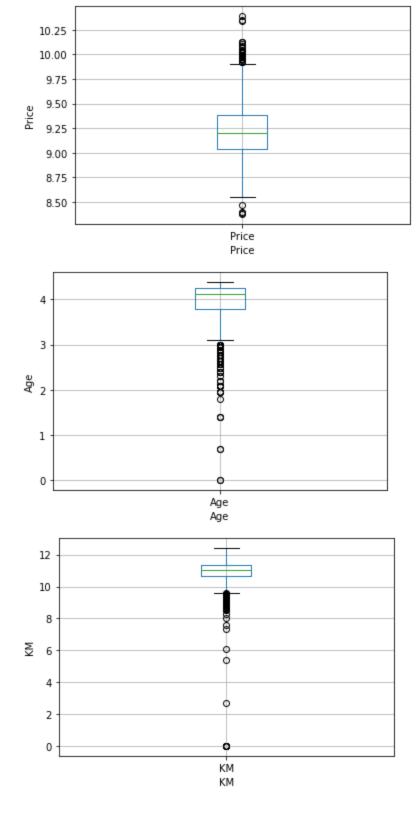


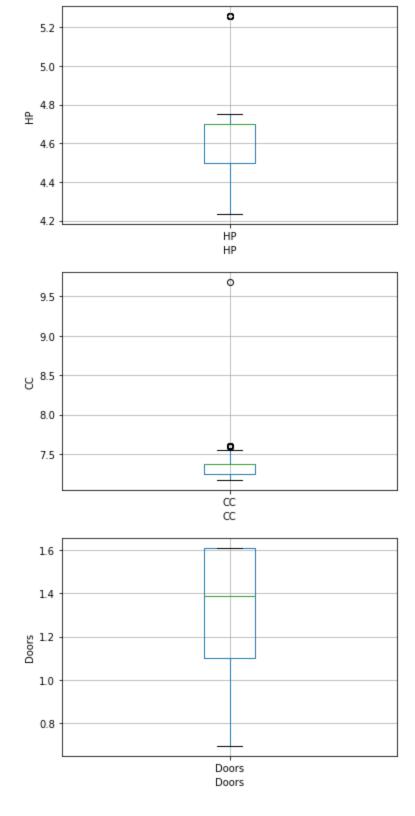


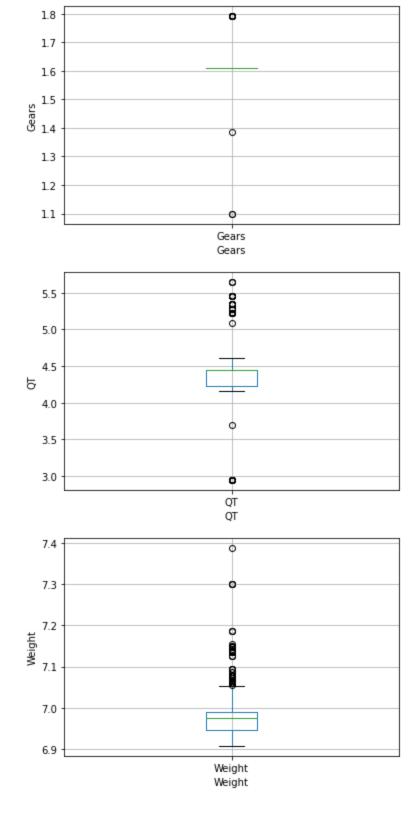


Checking Outliers using Log Transformation

```
for feature in df1:
    data = df1.copy()
    data[feature]=np.log(data[feature])
    data.boxplot(column=feature)
    plt.xlabel(feature)
    plt.ylabel(feature)
    plt.show()
```

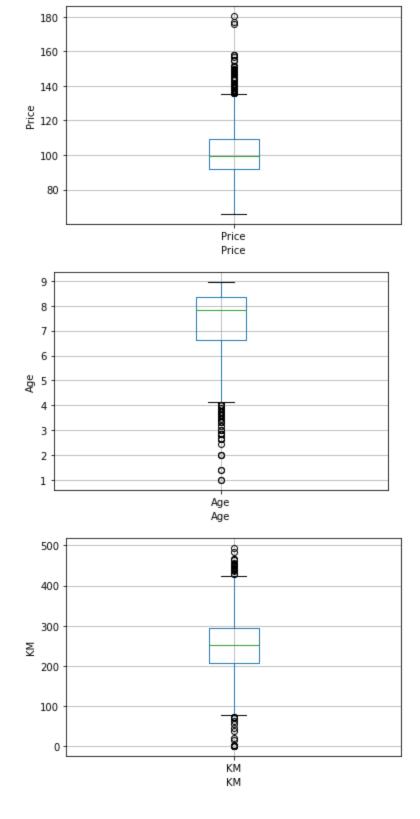


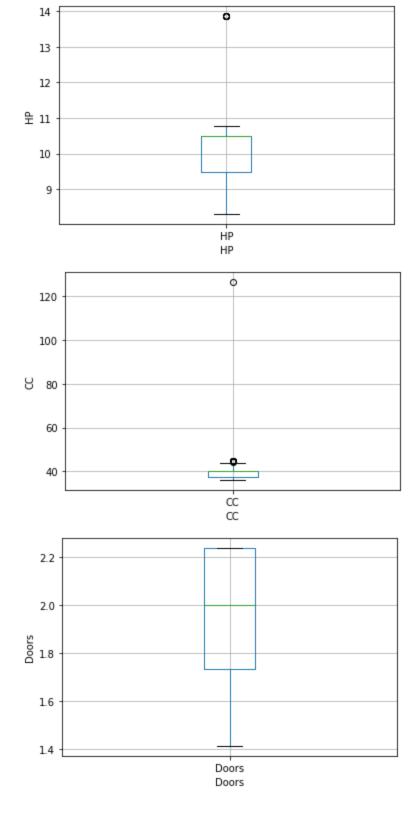


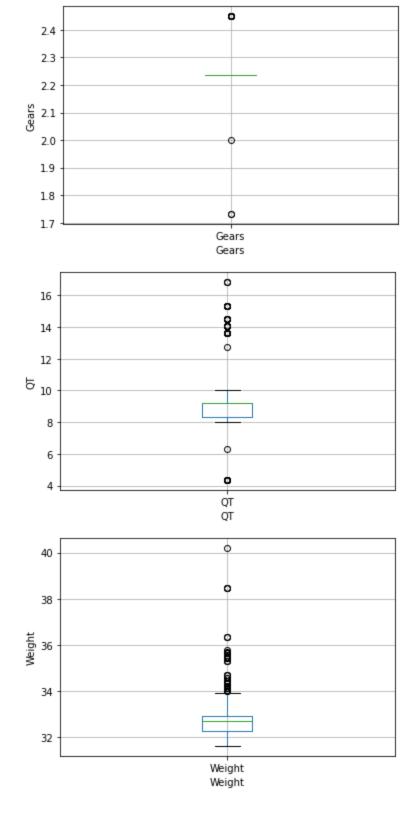


Checking Outliers Using Squareroot Transformation

```
for feature in df1:
    data = df1.copy()
    data[feature]=np.sqrt(data[feature])
    data.boxplot(column=feature)
    plt.xlabel(feature)
    plt.ylabel(feature)
    plt.show()
```

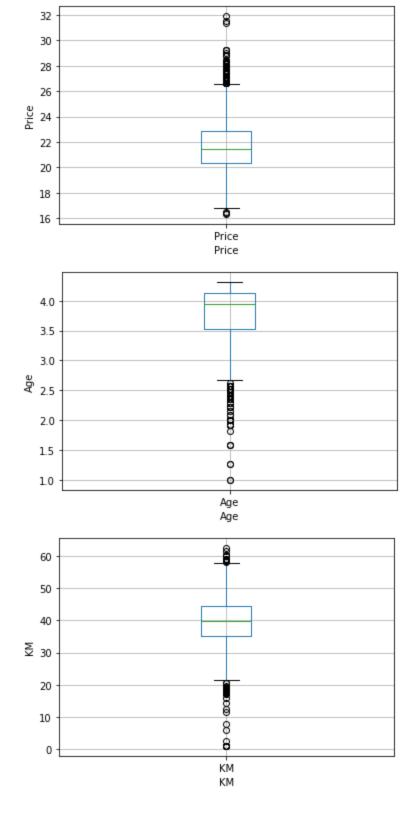


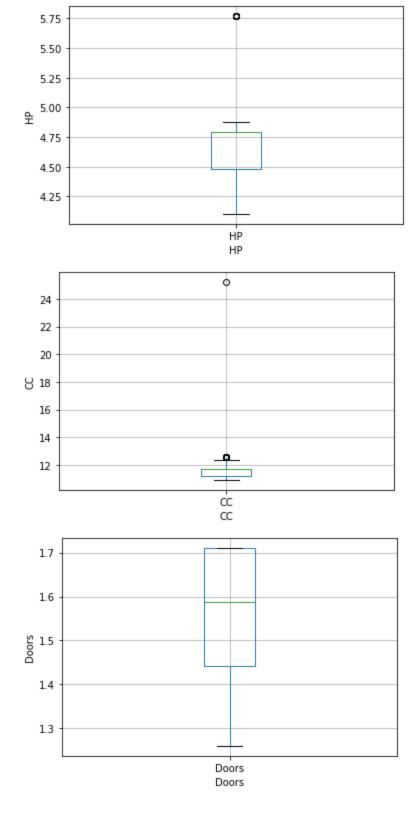


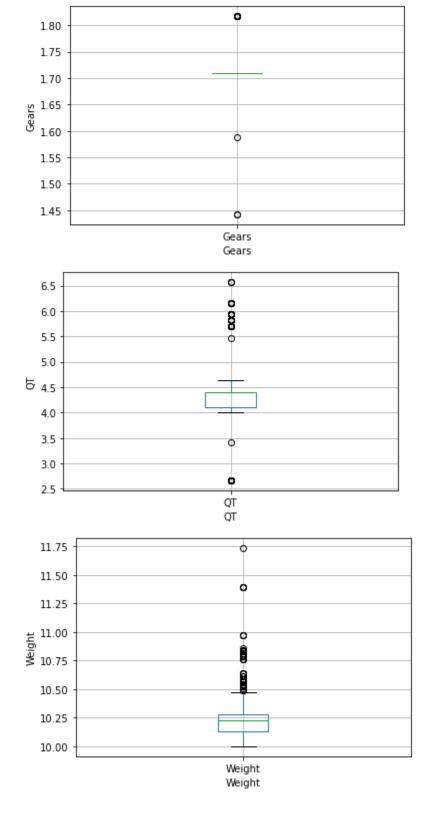


Checking Outliers using Cuberoot Transformation

```
for feature in df1:
    data = df1.copy()
    data[feature]=np.cbrt(data[feature])
    data.boxplot(column=feature)
    plt.xlabel(feature)
    plt.ylabel(feature)
    plt.show()
```







Observation

As we can see the raw data having an outlier and also after doing transformation the outlier in the data increases so we can choose the raw data for my predictions

Creating First Model

```
Out[21]:
                                    OLS Regression Results
                 Dep. Variable:
                                                                             0.864
                                             Price
                                                           R-squared:
                                              OLS
                                                      Adj. R-squared:
                        Model:
                                                                             0.863
                       Method:
                                    Least Squares
                                                           F-statistic:
                                                                             1131.
                          Date:
                                 Sun, 10 Apr 2022
                                                    Prob (F-statistic):
                                                                              0.00
                         Time:
                                          20:01:21
                                                      Log-Likelihood:
                                                                           -12376.
             No. Observations:
                                             1436
                                                                        2.477e+04
                                                                  AIC:
                  Df Residuals:
                                             1427
                                                                  BIC: 2.482e+04
                      Df Model:
                                                 8
             Covariance Type:
                                         nonrobust
                              coef
                                       std err
                                                          P>|t|
                                                                     [0.025]
                                                                                 0.975]
             Intercept
                        -5573.1064
                                    1411.390
                                                 -3.949
                                                         0.000
                                                                 -8341.728
                                                                             -2804.485
                         -121.6584
                                                -46.512
                                                         0.000
                  Age
                                         2.616
                                                                   -126.789
                                                                              -116.527
                           -0.0208
                                                -16.622
                  KM
                                         0.001
                                                         0.000
                                                                     -0.023
                                                                                 -0.018
                   HP
                           31.6809
                                         2.818
                                                 11.241
                                                         0.000
                                                                    26.152
                                                                                37.209
                   CC
                           -0.1211
                                         0.090
                                                 -1.344
                                                         0.179
                                                                     -0.298
                                                                                 0.056
```

Omnibus:	151.719	Durbin-Watson:	1.543
Prob(Omnibus):	0.000	Jarque-Bera (JB):	1011.853
Skew:	-0.219	Prob(JB):	1.90e-220
Kurtosis:	7.089	Cond. No.	3.13e+06

40.006

197.055

1.310

1.068

-0.040

3.016

3.015

15.880

0.968

0.003

0.003

0.000

-80.093

207.771

1.379

14.864

76.859

980.869

6.519

19.054

-1.6166

594.3199

3.9491

16.9586

Notes:

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Doors

Gears

Weight

QT

- [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
- [2] The condition number is large, 3.13e+06. This might indicate that there are strong multicollinearity or other numerical problems.

Simple linear Regression

```
In [22]:
            model2 = smf.ols("Price~Age", data=df1).fit()
            model2.summary()
                                 OLS Regression Results
Out[22]:
                Dep. Variable:
                                                                      0.768
                                         Price
                                                      R-squared:
                      Model:
                                          OLS
                                                 Adj. R-squared:
                                                                      0.768
                     Method:
                                 Least Squares
                                                      F-statistic:
                                                                      4758.
                        Date:
                              Sun, 10 Apr 2022
                                                Prob (F-statistic):
                                                                        0.00
```

Time:			20:	01:21 L	og-Like	lihood:	-12756.	
No. Obser	vations	S:		1436		AIC:	2.552e+04	
Df Re	siduals	S:		1434		BIC:	2.553e+04	
D	f Mode	l:	1					
Covariance Type:			nonr	obust				
		coef	std err	t	P> t	[0.025	0.975]	
Intercept	2.0296	e+04	146.097	138.908	0.000	2e+04	2.06e+04	
Age	-170.9	9336	2.478	-68.978	0.000	-175.795	-166.073	
Omi	nibus:	359.	275 D	urbin-Wat	son:	1.214		
Prob(Omn	ibus):	0.	000 Jar o	que-Bera ((JB) : 2	774.226		
;	Skew:	0.	946	Prob((JB):	0.00		
Kuı	rtosis:	9.	541	Cond	No.	187.		

Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

```
In [23]:
            model3=smf.ols("Price~KM", data=df1).fit()
            model3.summary()
                                 OLS Regression Results
Out[23]:
                Dep. Variable:
                                          Price
                                                      R-squared:
                                                                       0.325
                      Model:
                                          OLS
                                                  Adj. R-squared:
                                                                       0.324
                                 Least Squares
                     Method:
                                                       F-statistic:
                                                                       690.0
                                                                   1.76e-124
                        Date:
                               Sun, 10 Apr 2022
                                                Prob (F-statistic):
                                                  Log-Likelihood:
                       Time:
                                       20:01:22
                                                                     -13525.
            No. Observations:
                                          1436
                                                            AIC: 2.705e+04
                Df Residuals:
                                          1434
                                                            BIC: 2.706e+04
                    Df Model:
            Covariance Type:
                                     nonrobust
                                   std err
                                                    P>|t|
                                                             [0.025
                                                                       0.975]
                           coef
            Intercept 1.451e+04
                                 163.915
                                           88.510 0.000
                                                          1.42e+04
                                                                    1.48e+04
                 KM
                         -0.0551
                                    0.002 -26.268 0.000
                                                             -0.059
                                                                        -0.051
                  Omnibus: 390.716
                                        Durbin-Watson:
                                                            0.386
            Prob(Omnibus):
                               0.000
                                      Jarque-Bera (JB):
                                                         1115.783
                     Skew:
                               1.388
                                             Prob(JB): 5.14e-243
```

Cond. No.

1.63e+05

Kurtosis:

6.308

- [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
- [2] The condition number is large, 1.63e+05. This might indicate that there are strong multicollinearity or other numerical problems.

```
In [24]:
             model4=smf.ols("Price~HP", data=df1).fit()
             model4.summary()
                                  OLS Regression Results
Out[24]:
                Dep. Variable:
                                                        R-squared:
                                                                         0.099
                                           Price
                       Model:
                                           OLS
                                                   Adj. R-squared:
                                                                         0.099
                      Method:
                                  Least Squares
                                                        F-statistic:
                                                                         158.0
                                Sun, 10 Apr 2022
                                                  Prob (F-statistic):
                                                                      1.93e-34
                        Time:
                                        20:01:22
                                                   Log-Likelihood:
                                                                       -13732.
            No. Observations:
                                           1436
                                                              AIC: 2.747e+04
                 Df Residuals:
                                           1434
                                                              BIC: 2.748e+04
                    Df Model:
                                              1
             Covariance Type:
                                      nonrobust
                            coef
                                   std err
                                                     P>|t|
                                                              [0.025
                                                                         0.975]
            Intercept
                       2990.2764
                                  622.568
                                             4.803
                                                    0.000
                                                           1769.035
                                                                      4211.518
                  HP
                         76.2600
                                     6.068 12.568 0.000
                                                                        88.163
                                                              64.357
```

 Omnibus:
 448.876
 Durbin-Watson:
 0.338

 Prob(Omnibus):
 0.000
 Jarque-Bera (JB):
 1327.172

 Skew:
 1.591
 Prob(JB):
 6.43e-289

 Kurtosis:
 6.472
 Cond. No.
 703.

Notes:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

```
In [25]:
             model5=smf.ols("Price~CC", data=df1).fit()
             model5.summary()
                                  OLS Regression Results
Out[25]:
                Dep. Variable:
                                                       R-squared:
                                                                        0.016
                                          Price
                       Model:
                                           OLS
                                                   Adj. R-squared:
                                                                        0.015
                     Method:
                                  Least Squares
                                                       F-statistic:
                                                                        23.28
                        Date:
                               Sun, 10 Apr 2022
                                                 Prob (F-statistic):
                                                                     1.55e-06
                        Time:
                                       20:01:23
                                                   Log-Likelihood:
                                                                      -13795.
            No. Observations:
                                          1436
                                                                   2.759e+04
                                                             AIC:
                                                                   2.760e+04
                Df Residuals:
                                          1434
                                                             BIC:
                    Df Model:
            Covariance Type:
                                      nonrobust
```

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```
coef
                      std err
                                        P>|t|
                                                 [0.025]
                                                            0.975]
                              24.694 0.000
Intercept 9027.5548
                     365.576
                                              8310.435 9744.675
                                4.825 0.000
     CC
             1.0802
                        0.224
                                                  0.641
                                                            1.519
     Omnibus: 465.181
                            Durbin-Watson:
                                                 0.267
Prob(Omnibus):
                   0.000
                          Jarque-Bera (JB):
                                              1390.401
         Skew:
                   1.649
                                  Prob(JB):
                                             1.20e-302
      Kurtosis:
                   6.516
                                  Cond. No.
                                              6.29e+03
```

- [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
- [2] The condition number is large, 6.29e+03. This might indicate that there are strong multicollinearity or other numerical problems.

```
In [26]:
             model6=smf.ols("Price~Doors", data=df1).fit()
             model6.summary()
                                  OLS Regression Results
Out[26]:
                                          Price
                                                       R-squared:
                                                                        0.034
                Dep. Variable:
                       Model:
                                           OLS
                                                   Adj. R-squared:
                                                                        0.034
                     Method:
                                  Least Squares
                                                       F-statistic:
                                                                        51.00
                        Date:
                               Sun, 10 Apr 2022
                                                 Prob (F-statistic):
                                                                     1.46e-12
                        Time:
                                       20:01:23
                                                   Log-Likelihood:
                                                                      -13782.
            No. Observations:
                                          1436
                                                             AIC: 2.757e+04
                Df Residuals:
                                                             BIC: 2.758e+04
                                          1434
                    Df Model:
                                              1
             Covariance Type:
                                      nonrobust
                                   std err
                                                    P>|t|
                                                             [0.025]
                                                                        0.975]
                            coef
                                                 t
            Intercept 7885.0058
                                  409.438
                                          19.258 0.000
                                                           7081.843
                                                                     8688.168
               Doors
                       705.5586
                                   98.795
                                            7.142 0.000
                                                            511.761
                                                                      899.356
                  Omnibus: 466.779
                                        Durbin-Watson:
                                                             0.287
            Prob(Omnibus):
                               0.000
                                      Jarque-Bera (JB):
                                                          1406.209
                     Skew:
                               1.651
                                              Prob(JB):
                                                         4.42e-306
```

Notes:

Kurtosis:

6.549

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Cond. No.

```
model7=smf.ols("Price~QT", data=df1).fit()
model7.summary()
```

19.0

```
OLS Regression Results
    Dep. Variable:
                               Price
                                            R-squared:
                                                             0.048
           Model:
                               OLS
                                       Adj. R-squared:
                                                             0.047
         Method:
                      Least Squares
                                            F-statistic:
                                                             72.38
            Date:
                   Sun, 10 Apr 2022
                                     Prob (F-statistic):
                                                          4.41e-17
                           20:01:24
                                       Log-Likelihood:
            Time:
                                                           -13771.
No. Observations:
                               1436
                                                  AIC: 2.755e+04
    Df Residuals:
                               1434
                                                  BIC: 2.756e+04
        Df Model:
                                  1
Covariance Type:
                          nonrobust
                       std err
                                         P>|t|
                                                  [0.025]
                                                             0.975]
Intercept 9046.7382
                      218.889
                               41.330
                                       0.000 8617.362 9476.115
     QT
             19.3301
                        2.272
                                8.507 0.000
                                                  14.873
                                                            23.787
      Omnibus: 369.212
                             Durbin-Watson:
                                                  0.276
Prob(Omnibus):
                    0.000
                           Jarque-Bera (JB):
                                                843.513
         Skew:
                    1.417
                                   Prob(JB):
                                              6.82e-184
```

Kurtosis:

5.462

Out[27]:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

226.

Cond. No.

```
In [28]:
             model8=smf.ols("Price~Age+HP", data=df1).fit()
             model8.summary()
                                  OLS Regression Results
Out[28]:
                Dep. Variable:
                                                       R-squared:
                                                                        0.801
                                          Price
                       Model:
                                           OLS
                                                   Adj. R-squared:
                                                                        0.801
                      Method:
                                  Least Squares
                                                       F-statistic:
                                                                        2880.
                               Sun, 10 Apr 2022
                                                 Prob (F-statistic):
                                                                         0.00
                        Time:
                                       20:01:25
                                                   Log-Likelihood:
                                                                       -12648.
                                                                   2.530e+04
            No. Observations:
                                          1436
                                                              AIC:
                 Df Residuals:
                                          1433
                                                              BIC: 2.532e+04
                    Df Model:
                                              2
             Covariance Type:
                                      nonrobust
                            coef
                                   std err
                                                     P>|t|
                                                              [0.025]
                                                                         0.975]
            Intercept
                      1.551e+04
                                  341.793
                                            45.367 0.000
                                                           1.48e+04
                                                                      1.62e+04
                 Age
                       -165.3701
                                    2.328
                                           -71.038 0.000
                                                            -169.937
                                                                       -160.804
                  HP
                         44.1027
                                     2.890
                                            15.259 0.000
                                                              38.433
                                                                        49.772
```

Omnibus: 361.527 Durbin-Watson: 1.335 Loading [MathJax]/extensions/Safe.js

Prob(Omnibus):	0.000	Jarque-Bera (JB):	2605.922
Skew:	0.975	Prob(JB):	0.00
Kurtosis:	9.305	Cond. No.	934.

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

```
In [29]:
             model9=smf.ols("Price~Age+HP+CC", data=df1).fit()
            model9.summary()
                                 OLS Regression Results
Out[29]:
                Dep. Variable:
                                          Price
                                                       R-squared:
                                                                        0.802
                                          OLS
                                                                        0.802
                       Model:
                                                  Adj. R-squared:
                     Method:
                                  Least Squares
                                                       F-statistic:
                                                                        1935.
                        Date:
                               Sun, 10 Apr 2022
                                                Prob (F-statistic):
                                                                         0.00
                                                  Log-Likelihood:
                        Time:
                                       20:01:26
                                                                      -12643.
            No. Observations:
                                          1436
                                                             AIC: 2.529e+04
                Df Residuals:
                                          1432
                                                             BIC: 2.532e+04
                                             3
                    Df Model:
            Covariance Type:
                                      nonrobust
                            coef
                                   std err
                                                     P>|t|
                                                              [0.025]
                                                                        0.975]
                                            39.573 0.000
            Intercept 1.499e+04
                                  378.735
                                                           1.42e+04
                                                                     1.57e+04
                       -164.6852
                                    2.331
                                          -70.649 0.000
                                                           -169.258
                                                                      -160.113
                 Age
                 HP
                         43.9143
                                    2.882
                                           15.237 0.000
                                                             38.261
                                                                        49.568
                 CC
                                    0.101
                                             3.136 0.002
                          0.3166
                                                              0.119
                                                                         0.515
                  Omnibus: 349.564
                                        Durbin-Watson:
                                                            1.329
            Prob(Omnibus):
                               0.000
                                      Jarque-Bera (JB):
                                                         2510.175
                     Skew:
                               0.937
                                              Prob(JB):
                                                             0.00
                               9.200
                                              Cond. No. 1.45e+04
```

Notes:

Loading [MathJax]/extensions/Safe.js

Kurtosis:

[1] Standard Errors assume that the covariance matrix of the errors is correctly specified.

Adj. R-squared:

[2] The condition number is large, 1.45e+04. This might indicate that there are strong multicollinearity or other numerical problems.

OLS

```
In [30]:
           model10=smf.ols("Price~Age+HP+CC+Doors", data=df1).fit()
           model10.summary()
                              OLS Regression Results
Out[30]:
              Dep. Variable:
                                      Price
                                                 R-squared:
                                                                0.804
```

0.803

	Method	:	Least	Squares		F	statistic:	1466.	
	Date	: S	Sun, 10 Apr 2022		P	Prob (F-statistic)		0.00	
	Time	:	2	20:01:28		Log-Likelihood:		-12637.	
No. Obser	vations	:		1436			AIC:	2.528e+04	
Df Re	siduals	:		1431			BIC:	2.531e+04	
D	f Model	:		4					
Covarian	се Туре	:	no	onrobust					
	С	oef	std e	rr	t	P> t	[0.025	0.975]	
Intercept	1.44e-	⊦ 04	413.37	8 34.8	327	0.000	1.36e+04	1.52e+04	
Age	-163.62	216	2.34	2 -69.8	371	0.000	-168.215	-159.028	
HP	43.22	136	2.87	8 15.0	016	0.000	37.569	48.859	
CC	0.29	937	0.10	1 2.9	914	0.004	0.096	0.491	
Doors	158.35	594	45.28	5 3.4	197	0.000	69.527	247.192	
Omi	nibus:	344.	.053	Durbin	-Wa	tson:	1.317		
Prob(Omn	ibus):	0.	.000 J	arque-E	Bera	(JB):	2507.167		
	Skew:	0.	.915	F	Prob	(JB):	0.00		
Kur	rtosis:	9.	.209	C	Conc	l. No.	1.60e+04		

Df Residuals:

Covariance Type:

Df Model:

- [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
- [2] The condition number is large, 1.6e+04. This might indicate that there are strong multicollinearity or other numerical problems.

```
In [31]:
            model11=smf.ols("Price~Age+HP+KM+CC+Doors+QT", data=df1).fit()
            model11.summary()
                                OLS Regression Results
Out[31]:
               Dep. Variable:
                                        Price
                                                    R-squared:
                                                                     0.839
                      Model:
                                         OLS
                                                Adj. R-squared:
                                                                     0.838
                                                     F-statistic:
                                                                     1239.
                    Method:
                                Least Squares
                              Sun, 10 Apr 2022
                                               Prob (F-statistic):
                                                                      0.00
                       Time:
                                     20:01:29
                                                Log-Likelihood:
                                                                   -12497.
           No. Observations:
                                        1436
                                                           AIC: 2.501e+04
```

BIC: 2.504e+04

		coef	std err	t	P> t	[0.025	0.975]
	Intercept	1.295e+04	409.080	31.660	0.000	1.21e+04	1.38e+04
	Age	-136.5498	2.658	-51.366	0.000	-141.765	-131.335
Loading [MathJa	ax]/extensions	s/Safe.js 27	2.858	16.000	0.000	40.126	51.339

1429

nonrobust

```
-0.0198
                       0.001 -14.578 0.000
    KM
                                                -0.022
                                                          -0.017
                       0.097
                               1.063 0.288
                                                -0.087
                                                           0.292
     CC
             0.1028
  Doors
           134.2946
                      41.299
                               3.252 0.001
                                                53.281
                                                         215.308
            16.3993
                       1.149 14.272 0.000
                                                          18.653
     QT
                                                14.145
     Omnibus: 202.288
                           Durbin-Watson:
                                               1.378
Prob(Omnibus):
                  0.000 Jarque-Bera (JB):
                                             717.719
                  0.665
                                 Prob(JB): 1.41e-156
         Skew:
      Kurtosis:
                  6.198
                                Cond. No.
                                            8.30e+05
```

- [1] Standard Errors assume that the covariance matrix of the errors is correctly specified.
- [2] The condition number is large, 8.3e+05. This might indicate that there are strong multicollinearity or other numerical problems.

Calculating VIF

```
In [32]:
          rsq_Age = smf.ols('Age~HP+KM+Doors+QT+CC+Weight',data=data).fit().rsquared
          vif_Age = 1/(1-rsq_Age)
          rsq_HP = smf.ols('HP~Age+KM+Doors+Gears+QT+CC+Weight', data=data).fit().rsquared
          vif_{HP} = 1/(1-rsq_{HP})
          rsg_KM = smf.ols('KM~Age+HP+Doors+Gears+QT+CC+Weight', data=data).fit().rsguared
          vif_KM = 1/(1-rsq_KM)
          rsq_Doors = smf.ols('Doors~Age+HP+Gears+KM+QT+CC+Weight', data=data).fit().rsquared
          vif_Doors = 1/(1-rsq_Doors)
          rsq_Gears = smf.ols('Gears~Age+HP+Gears+KM+QT+CC+Weight',data=data).fit().rsquared
          vif_Gears = 1/(1-rsq_Gears)
          rsq_QT = smf.ols('QT~Age+HP+KM+Doors+Gears+CC+Weight', data=data).fit().rsquared
          vif_QT = 1/(1-rsq_QT)
          rsq_CC = smf.ols('CC~Age+HP+KM+Doors+Gears+QT+Weight', data=data).fit().rsquared
          vif_CC = 1/(1-rsq_CC)
          rsq_weight = smf.ols('Weight~Age+HP+KM+Doors+Gears+QT+CC',data=data).fit().rsquared
          vif_weight = 1/(1-rsq_weight)
          # Storing vif values in a data fram
          d1 = {'Variables':['Age','HP','KM',"Doors","Gears","QT","CC",'Weight'],'VIF':[vif_Age,vif_
          Vif_frame = pd.DataFrame(d1)
          Vif_frame
```

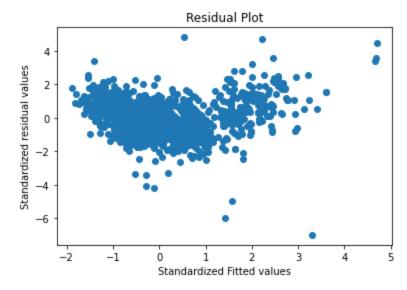
Out [32]: Variables VIF 0 Age 1.908532 1 HP 1.428423 2 KM 1.758792 Loading [MathJax]/extensions/Safe.js

	Variables	VIF
3	Doors	1.169183
4	Gears	inf
5	QT	2.343063
6	CC	1.168283
7	Weight	2.627265

Observation

The vif of the first model is very less as we can say that the feature does not having any co-linearity

Residuals For Homscedasticity



Observation

As We can see that the Features and Erros does not having co-linearity

Residual vs Regressor

```
In [35]: fig = plt.figure(figsize=(15,8))

Loading [MathJax]/extensions/Safe.js | hics.plot_regress_exog(model1, "Age", fig=fig)
```

plt.show()

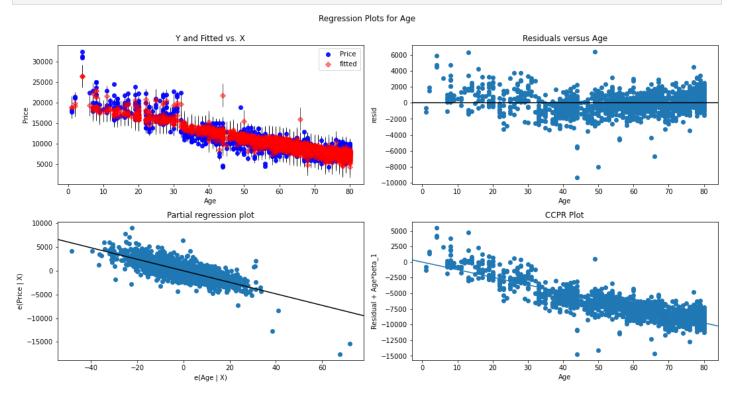
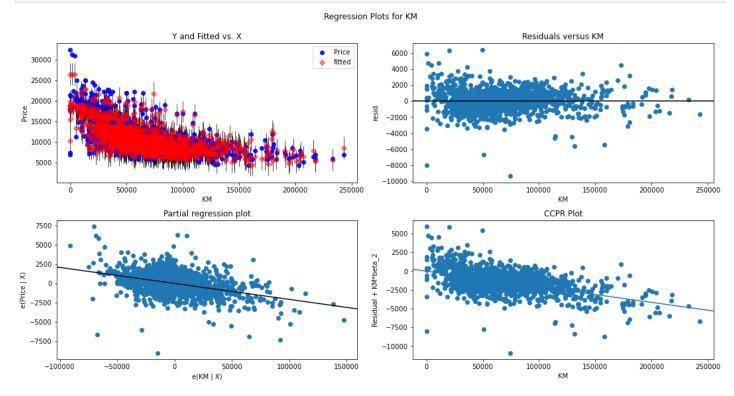
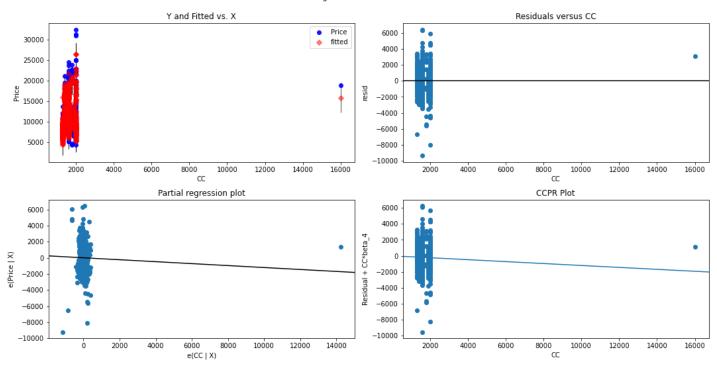


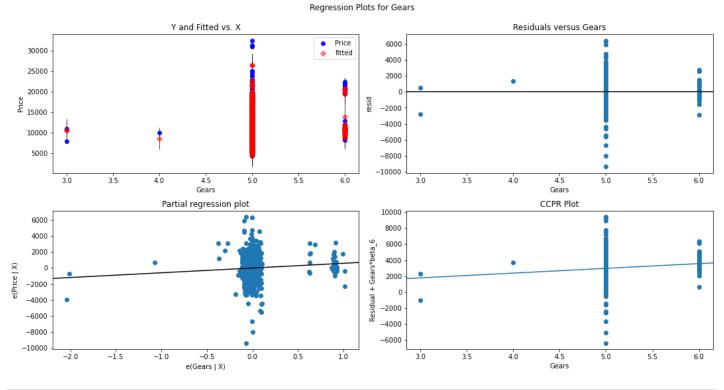
fig = plt.figure(figsize=(15,8))
fig = sm.graphics.plot_regress_exog(model1, "KM", fig=fig)
plt.show()



```
fig = plt.figure(figsize=(15,8))
fig = sm.graphics.plot_regress_exog(model1, "CC", fig=fig)
plt.show()
```



```
fig = plt.figure(figsize=(15,8))
fig = sm.graphics.plot_regress_exog(model1, "Gears", fig=fig)
plt.show()
```



```
fig = plt.figure(figsize=(15,8))
fig = sm.graphics.plot_regress_exog(model1, "Doors", fig=fig)
plt.show()
```

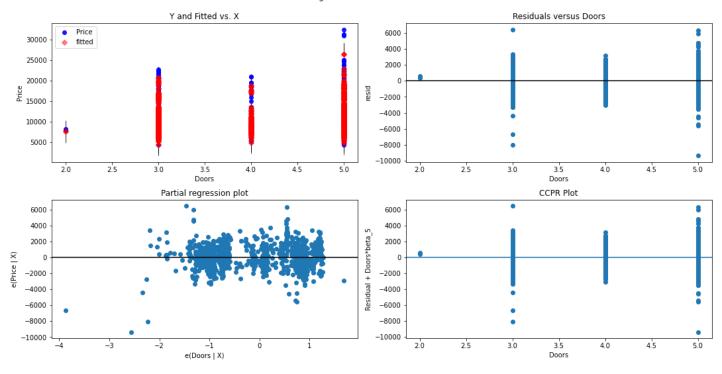
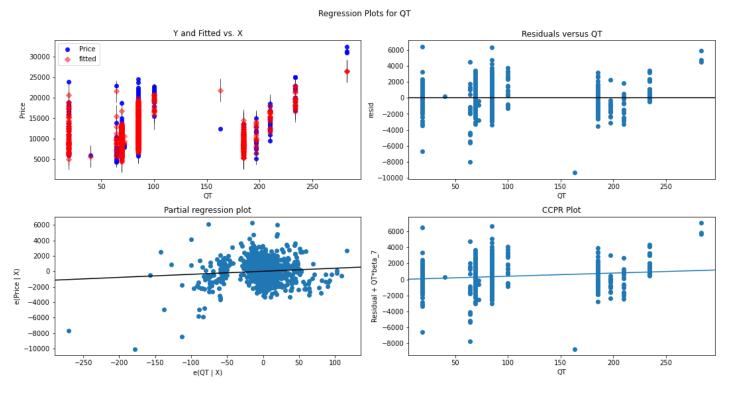
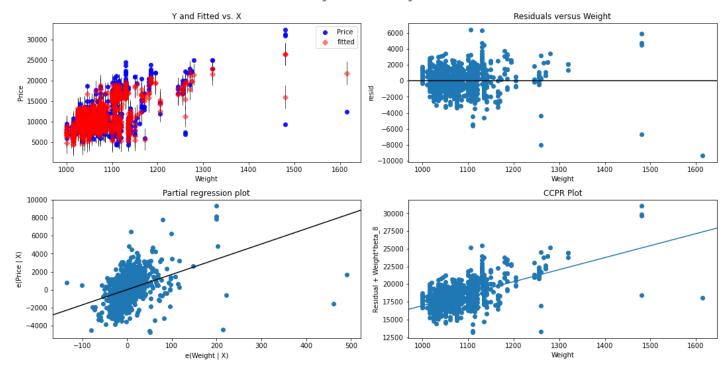


fig = plt.figure(figsize=(15,8))
fig = sm.graphics.plot_regress_exog(model1, "QT",fig=fig)
plt.show()



```
fig = plt.figure(figsize=(15,8))
fig = sm.graphics.plot_regress_exog(model1, "Weight", fig=fig)
plt.show()
```



Outlier Detection

Cook's Distance

```
In [42]:
            model1_influence=model1.get_influence()
            (c,_)=model1_influence.cooks_distance
In [44]:
            fig = plt.subplots(figsize=(20, 7))
            plt.stem(np.arange(len(df1)), np.round(c, 3))
            plt.xlabel('Row index')
           plt.ylabel('Cooks Distance')
           plt.show()
            70
            60
          Cooks Distance
            40
            30
            20
            10
                               200
                                            400
                                                                                                1200
                                                         600
                                                                                   1000
                                                                      800
                                                                Row index
```

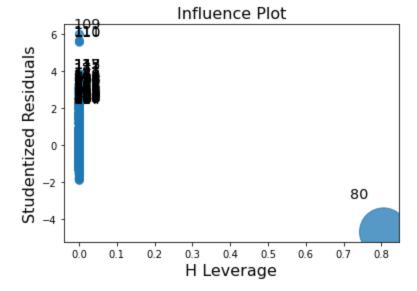
from statsmodels.graphics.regressionplots import influence_plot

Loading [MathJax]/extensions/Safe.js

plt.show()

influence_plot(model5)

In [45]:



```
In [46]:
    k = df1.shape[1]
    n = df1.shape[0]
    leverage_cutoff = 3*((k + 1)/n)
    leverage_cutoff
```

Out[46]: 0.020891364902506964

In [47]: (np.argmax(c),np.max(c))

Out[47]: (80, 79.5201062414182)

In [48]: df1[df.index.isin([80])]

Out[48]: Price Age KM HP CC Doors Gears QT Weight

80 18950 25 20019 110 16000 5 5 100 1180

In [49]: df2=df1.copy() df2

Out[49]:		Price	Age	KM	HP	СС	Doors	Gears	QT	Weight
	0	13500	23	46986	90	2000	3	5	210	1165
	1	13750	23	72937	90	2000	3	5	210	1165
	2	13950	24	41711	90	2000	3	5	210	1165
	3	14950	26	48000	90	2000	3	5	210	1165
	4	13750	30	38500	90	2000	3	5	210	1170
	1431	7500	69	20544	86	1300	3	5	69	1025
	1432	10845	72	19000	86	1300	3	5	69	1015
	1433	8500	71	17016	86	1300	3	5	69	1015
	1434	7250	70	16916	86	1300	3	5	69	1015
	1435	6950	76	1	110	1600	5	5	19	1114

```
In [50]:
           df2=df1.drop(data.index[[80]],axis=0).reset_index(drop=True)
           df2
               Price Age
                            KM
                                 HP
                                      CC
                                          Doors Gears
                                                        QT Weight
Out[50]:
            0 13500
                          46986
                                 90
                                     2000
                                                     5
                                                       210
                                                             1165
            1 13750
                      23 72937
                                     2000
                                                     5 210
                                                             1165
                                 90
            2 13950
                      24 41711
                                     2000
                                                     5 210
                                                             1165
            3 14950
                      26 48000
                                     2000
                                                     5 210
                                                             1165
                                 90
            4 13750
                      30 38500
                                     2000
                                                    5 210
                                                             1170
                                 90
          1430
                7500
                          20544
                                                    5
                                                        69
                                                             1025
                      69
                                 86
                                    1300
                                              3
          1431 10845
                      72 19000
                                 86
                                    1300
                                                        69
                                                             1015
          1432
                8500
                      71 17016
                                 86 1300
                                                    5
                                                        69
                                                             1015
          1433
                7250
                       70 16916
                                 86
                                    1300
                                                        69
                                                             1015
          1434
                6950
                              1 110 1600
                                                             1114
         1435 rows × 9 columns
In [51]:
           df1.shape
Out[51]:
         (1436, 9)
         Deleting Diagnostic and Improving Model
In [52]:
          while model1.rsquared < 0.90:</pre>
               for c in [np.max(c)>0.5]:
                   model1=smf.ols('Price~Age+KM+HP+CC+Doors+Gears+QT+Weight', data=df2).fit()
```

```
(c,_)=model1.get_influence().cooks_distance
                    np.argmax(c) , np.max(c)
                    df2=df2.drop(df2.index[[np.argmax(c)]],axis=0).reset_index(drop=True)
                    df2
                else:
                    Final_Model=smf.ols('Price~Age+KM+HP+CC+Doors+Gears+QT+Weight', data=df2).fit()
                    Final_Model.rsquared , Final_Model.aic
                    print("Thus model accuracy is improved to", Final_Model.rsquared)
           Thus model accuracy is improved to 0.8778445878599779
           Thus model accuracy is improved to 0.8851845904421739
           Thus model accuracy is improved to 0.8894191849749752
           Thus model accuracy is improved to 0.8914204825569461
           Thus model accuracy is improved to 0.8921467826162199
           Thus model accuracy is improved to 0.8934037497368835
           Thus model accuracy is improved to 0.8944954473640402
           Thus model accuracy is improved to 0.8958333530393431
           Thus model accuracy is improved to 0.8966334481080778
           Thus model accuracy is improved to 0.8941835374074523
           Thus model accuracy is improved to 0.8951069956497651
           Thus model accuracy is improved to 0.8965514940097824
Loading [MathJax]/extensions/Safe.js | uracy is improved to 0.8971531368893257
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         Thus model accuracy is improved to 0.8973242631620858
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         Thus model accuracy is improved to 0.8965027704321633
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         Thus model accuracy is improved to 0.8992884343762314
         Thus model accuracy is improved to 0.8995264042658646
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         Thus model accuracy is improved to 0.8999704768778106
         Thus model accuracy is improved to 0.9002238270483123
         Thus model accuracy is improved to 0.9003762532318559
In [54]:
          Final_Model.rsquared # The Model Accuracy has been Increased
Out[54]:
         0.9003762532318559
        MSE
In [55]:
          Final_Model.mse_resid
         952433.7824446883
Out[55]:
        RMSE
          np.sqrt(Final_Model.mse_resid)
Out[56]: 975.9271399262797
```

```
In [56]:
```

Predicting New values

```
In [57]:
           values = pd.DataFrame({"Age":26, "KM":20000, "HP":90, "CC":2000, "Gears":5, "Doors":3, "QT":200,
           values
                        HP
             Age
                    KM
                              CC
                                  Gears
                                        Doors
                                                QT Weight
Out[57]:
              26
                  20000
                         90
                            2000
                                      5
                                               200
                                                      1090
In [58]:
           pd.DataFrame(Final_Model.predict(values),columns=["Price"])
                    Price
Out[58]:
          0 13191.183227
```

Loading [MathJax]/extensions/Safe.js

Predicting Automatic Prices

```
In [59]:
           pred_y = Final_Model.predict(df2)
           pd.DataFrame(pred_y, columns=["New_Price"])
                  New_Price
Out[59]:
             0 15354.362106
             1 15415.237858
             2 15314.008799
             3 14749.534289
             4 17544.273936
          1325
                 7607.457292
          1326
                 9206.037539
          1327
                 8535.375501
          1328
                 8674.315161
          1329
                 8784.118985
         1330 rows × 1 columns
 In [ ]:
 In [ ]:
```