Lab2

June 20, 2023

0.1

[ ]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import scipy.stats as stats
```

[ ]:
```
data = pd.read_csv("cars2.csv")
```

[ ]:
```
data.head()
```

[ ]:

	mileage	make	model	fuel	gear	offerType	price	hp	year
0	235000	BMW	316	Diesel	Manual	Used	6800	116.0	2011
1	92800	Volkswagen	Golf	Gasoline	Manual	Used	6877	122.0	2011
2	149300	SEAT	Exeo	Gasoline	Manual	Used	6900	160.0	2011
3	96200	Renault	Megane	Gasoline	Manual	Used	6950	110.0	2011
4	156000	Peugeot	308	Gasoline	Manual	Used	6950	156.0	2011

[ ]:
```
data_features = list(zip(
[i for i in data.columns], #
zip(
    [str(i) for i in data.dtypes], #
    [i for i in data.isnull().sum()] #
)))
data_features #
```

[ ]:
```
[('mileage', ('int64', 0)),
 ('make', ('object', 0)),
 ('model', ('object', 143)),
 ('fuel', ('object', 0)),
 ('gear', ('object', 182)),
 ('offerType', ('object', 0)),
 ('price', ('int64', 0)),
 ('hp', ('float64', 29)),
 ('year', ('int64', 0))]
```

0.2

```
[ ]: #    (    )
     [(c, data[c].isnull().mean()) for c in data.columns]
```

```
[ ]: [('mileage', 0.0),
      ('make', 0.0),
      ('model', 0.0030815644865854973),
      ('fuel', 0.0),
      ('gear', 0.003921991164745178),
      ('offerType', 0.0),
      ('price', 0.0),
      ('hp', 0.0006249326581187372),
      ('year', 0.0)]
```

```
[ ]: #          ,
     data.dropna(axis=1, how='any')
```

```
[ ]:        mileage        make              fuel       offerType  price  year
     0       235000         BMW            Diesel            Used   6800  2011
     1        92800  Volkswagen          Gasoline            Used   6877  2011
     2       149300        SEAT          Gasoline            Used   6900  2011
     3        96200     Renault          Gasoline            Used   6950  2011
     4       156000     Peugeot          Gasoline            Used   6950  2011
     …         …          …                 …              …     …    …
     46400       99        Fiat  Electric/Gasoline  Pre-registered  12990  2021
     46401       99        Fiat  Electric/Gasoline  Pre-registered  12990  2021
     46402       99        Fiat  Electric/Gasoline  Pre-registered  12990  2021
     46403       99        Fiat  Electric/Gasoline  Pre-registered  12990  2021
     46404       99        Fiat  Electric/Gasoline  Pre-registered  12990  2021

     [46405 rows x 6 columns]
```

```
[ ]: #                          (    50%)
     data.dropna(axis=1, thresh=23202)
```

```
[ ]:        mileage        make   model              fuel    gear       offerType  \
     0       235000         BMW     316            Diesel  Manual            Used
     1        92800  Volkswagen    Golf          Gasoline  Manual            Used
     2       149300        SEAT    Exeo          Gasoline  Manual            Used
     3        96200     Renault  Megane          Gasoline  Manual            Used
     4       156000     Peugeot     308          Gasoline  Manual            Used
     …         …          …     …                 …     …              …
     46400       99        Fiat     500  Electric/Gasoline  Manual  Pre-registered
     46401       99        Fiat     500  Electric/Gasoline  Manual  Pre-registered
     46402       99        Fiat     500  Electric/Gasoline  Manual  Pre-registered
     46403       99        Fiat     500  Electric/Gasoline  Manual  Pre-registered
     46404       99        Fiat     500  Electric/Gasoline  Manual  Pre-registered
```

```
       price     hp  year
0       6800  116.0  2011
1       6877  122.0  2011
2       6900  160.0  2011
3       6950  110.0  2011
4       6950  156.0  2011
…       …     …    …
46400  12990   71.0  2021
46401  12990   71.0  2021
46402  12990   71.0  2021
46403  12990   71.0  2021
46404  12990   71.0  2021

[46405 rows x 9 columns]
```

[ ]:
```
#            hp
def impute_na(df, variable, value):
    df[variable].fillna(value, inplace=True)
impute_na(data, 'hp', data['hp'].mean())
```

[ ]:
```
#     ,         hp
data.isnull().sum()
```

[ ]:
```
mileage        0
make           0
model        143
fuel           0
gear         182
offerType      0
price          0
hp             0
year           0
dtype: int64
```

0.3

[ ]:
```
from sklearn.preprocessing import LabelEncoder
```

[ ]:
```
le = LabelEncoder()
cat_enc_le = le.fit_transform(data['gear'])
```

[ ]:
```
data['gear'].unique()
```

[ ]:
```
array(['Manual', 'Automatic', nan, 'Semi-automatic'], dtype=object)
```

[ ]:
```
np.unique(cat_enc_le)
```

[ ]:
```
array([0, 1, 2, 3])
```

[ ]:
```
le.inverse_transform([0, 1, 2, 3])
```

[ ]:
```
array(['Automatic', 'Manual', 'Semi-automatic', nan], dtype=object)
```

[ ]:
```
data['make'].unique()
```

[ ]:
```
array(['BMW', 'Volkswagen', 'SEAT', 'Renault', 'Peugeot', 'Toyota',
       'Opel', 'Mazda', 'Ford', 'Mercedes-Benz', 'Chevrolet', 'Audi',
       'Fiat', 'Kia', 'Dacia', 'MINI', 'Hyundai', 'Skoda', 'Citroen',
       'Infiniti', 'Suzuki', 'SsangYong', 'smart', 'Cupra', 'Volvo',
       'Jaguar', 'Porsche', 'Nissan', 'Honda', 'Lada', 'Mitsubishi',
       'Others', 'Lexus', 'Jeep', 'Maserati', 'Bentley', 'Land', 'Alfa',
       'Subaru', 'Dodge', 'Microcar', 'Lamborghini', 'Baic', 'Tesla',
       'Chrysler', '9ff', 'McLaren', 'Aston', 'Rolls-Royce', 'Alpine',
       'Lancia', 'Abarth', 'DS', 'Daihatsu', 'Ligier', 'Ferrari',
       'Caravans-Wohnm', 'Aixam', 'Piaggio', 'Zhidou', 'Morgan',
       'Maybach', 'Tazzari', 'Trucks-Lkw', 'RAM', 'Iveco', 'DAF',
       'Alpina', 'Polestar', 'Brilliance', 'FISKER', 'Cadillac',
       'Trailer-Anhänger', 'Isuzu', 'Corvette', 'DFSK', 'Estrima'],
      dtype=object)
```

[ ]:
```
pip install category_encoders
```

```
Requirement already satisfied: category_encoders in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (2.6.1)
Requirement already satisfied: numpy>=1.14.0 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (1.25.0)
Requirement already satisfied: scikit-learn>=0.20.0 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (1.2.2)
Requirement already satisfied: scipy>=1.0.0 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (1.10.1)
Requirement already satisfied: statsmodels>=0.9.0 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (0.14.0)
Requirement already satisfied: pandas>=1.0.5 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (2.0.2)
Requirement already satisfied: patsy>=0.5.1 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
category_encoders) (0.5.3)
Requirement already satisfied: python-dateutil>=2.8.2 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
pandas>=1.0.5->category_encoders) (2.8.2)
```

```
Requirement already satisfied: pytz>=2020.1 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
pandas>=1.0.5->category_encoders) (2023.3)
Requirement already satisfied: tzdata>=2022.1 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
pandas>=1.0.5->category_encoders) (2023.3)
Requirement already satisfied: six in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
patsy>=0.5.1->category_encoders) (1.16.0)
Requirement already satisfied: joblib>=1.1.1 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from scikit-
learn>=0.20.0->category_encoders) (1.2.0)
Requirement already satisfied: threadpoolctl>=2.0.0 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from scikit-
learn>=0.20.0->category_encoders) (3.1.0)
Requirement already satisfied: packaging>=21.3 in
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-packages (from
statsmodels>=0.9.0->category_encoders) (23.1)
Note: you may need to restart the kernel to use updated packages.
```

[ ]:
```
#CountEncoder
from category_encoders.count import CountEncoder as ce_CountEncoder
```

[ ]:
```
ce_CountEncoder1 = ce_CountEncoder()
data_COUNT_ENC = ce_CountEncoder1.fit_transform(data[data.columns.
 ↪difference(['model'])])
```

[ ]:
```
data_COUNT_ENC.head()
```

[ ]:

	fuel	gear	hp	make	mileage	offerType	price	year
0	15244	30380	116.0	2405	235000	40122	6800	2011
1	28864	30380	122.0	6931	92800	40122	6877	2011
2	28864	30380	160.0	1924	149300	40122	6900	2011
3	28864	30380	110.0	2830	96200	40122	6950	2011
4	28864	30380	156.0	1232	156000	40122	6950	2011

[ ]:
```
data['offerType'].unique()
```

[ ]:
```
array(['Used', 'Demonstration', "Employee's car", 'Pre-registered', 'New'],
      dtype=object)
```

[ ]:
```
data_COUNT_ENC['offerType'].unique()
```

[ ]:
```
array([40122,  2368,  1122,  2780,    13])
```

[ ]:
```
ce_CountEncoder2 = ce_CountEncoder(normalize=True)
data_FREQ_ENC = ce_CountEncoder2.fit_transform(data[data.columns.
 ↪difference(['model'])])
```

[ ]:
```
data_FREQ_ENC['offerType'].unique()
```

[ ]:
```
array([8.64605107e-01, 5.10289839e-02, 2.41784290e-02, 5.99073376e-02,
       2.80142226e-04])
```

[ ]:
```
from category_encoders.helmert import HelmertEncoder as ce_HelmertEncoder
```

[ ]:
```
#HelmetEncoder
ce_HelmertEncoder1 = ce_HelmertEncoder()
data_HELM_ENC = ce_HelmertEncoder1.fit_transform(data[data.columns.
 ↪difference(['model'])], data['model'])
```

```
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-
packages/category_encoders/base_contrast_encoder.py:126: FutureWarning:
Intercept column might not be added anymore in future releases (c.f. issue #370)
  warnings.warn("Intercept column might not be added anymore in future releases
(c.f. issue #370)",
/Users/seralekhin/BMSTU_Labs/.env/lib/python3.11/site-
packages/category_encoders/base_contrast_encoder.py:126: FutureWarning:
Intercept column might not be added anymore in future releases (c.f. issue #370)
  warnings.warn("Intercept column might not be added anymore in future releases
(c.f. issue #370)",
```

[ ]:
```
data_HELM_ENC.head()
```

[ ]:

	intercept	fuel_0	fuel_1	fuel_2	fuel_3	fuel_4	fuel_5	fuel_6	fuel_7	\
0	1	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	
1	1	1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	
2	1	1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	
3	1	1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	
4	1	1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0	

	fuel_8	…	make_73	make_74	make_75	mileage	offerType_0	offerType_1	\
0	-1.0	…	-1.0	-1.0	-1.0	235000	-1.0	-1.0	
1	-1.0	…	-1.0	-1.0	-1.0	92800	-1.0	-1.0	
2	-1.0	…	-1.0	-1.0	-1.0	149300	-1.0	-1.0	
3	-1.0	…	-1.0	-1.0	-1.0	96200	-1.0	-1.0	
4	-1.0	…	-1.0	-1.0	-1.0	156000	-1.0	-1.0	

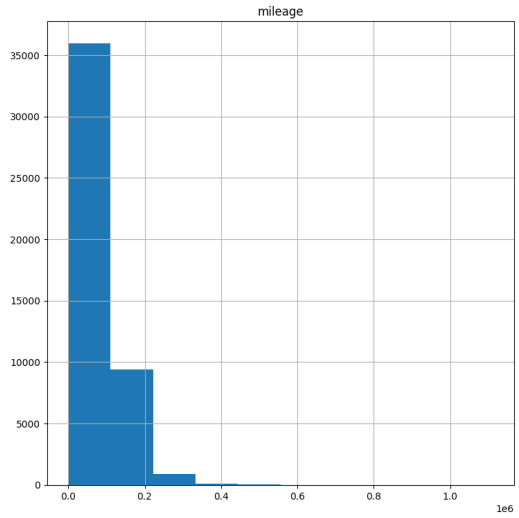
	offerType_2	offerType_3	price	year
0	-1.0	-1.0	6800	2011
1	-1.0	-1.0	6877	2011
2	-1.0	-1.0	6900	2011
3	-1.0	-1.0	6950	2011
4	-1.0	-1.0	6950	2011

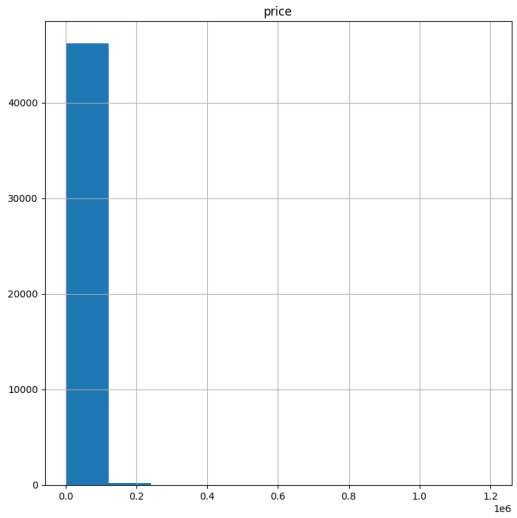
[5 rows x 98 columns]

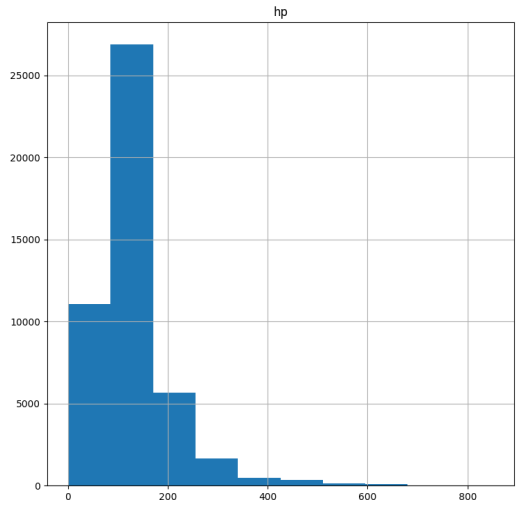
0.4

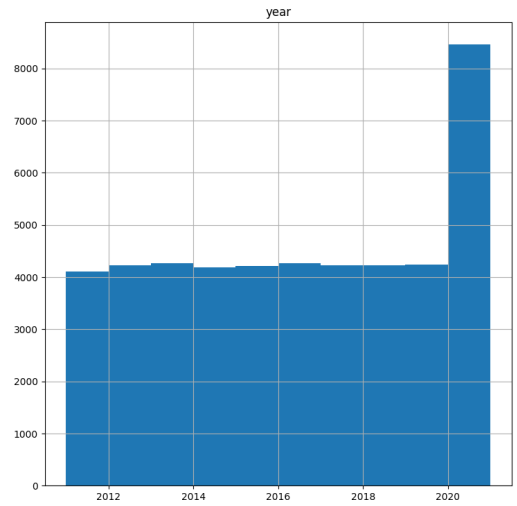
[ ]:
```
def diagnostic_plots(df, variable):
    plt.figure(figsize=(15,6))
    #
    plt.subplot(1, 2, 1)
    df[variable].hist(bins=30)
    ## Q-Q plot
    plt.subplot(1, 2, 2)
    stats.probplot(df[variable], dist="norm", plot=plt)
    plt.show()
```

[ ]:
```
data.hist(figsize=(20,20))
plt.show()
```

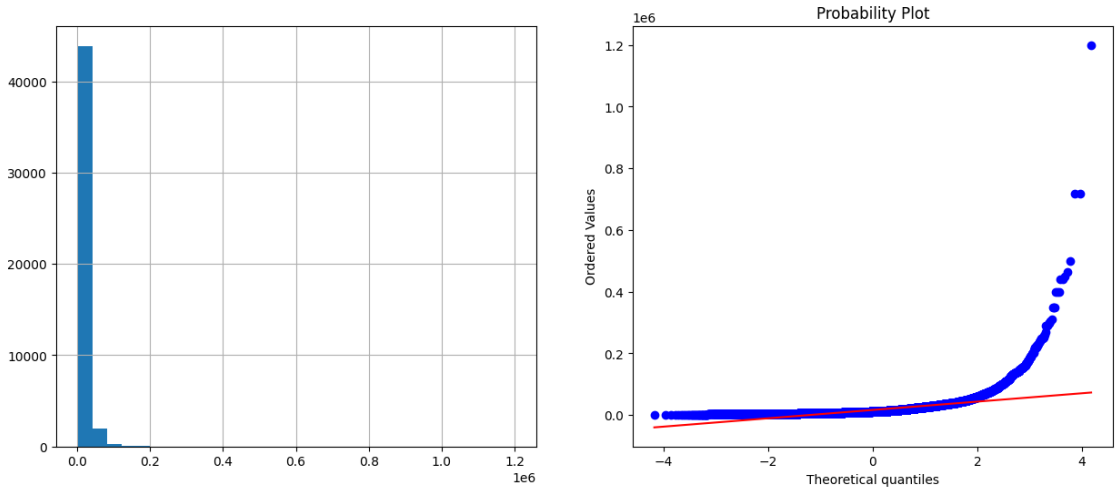




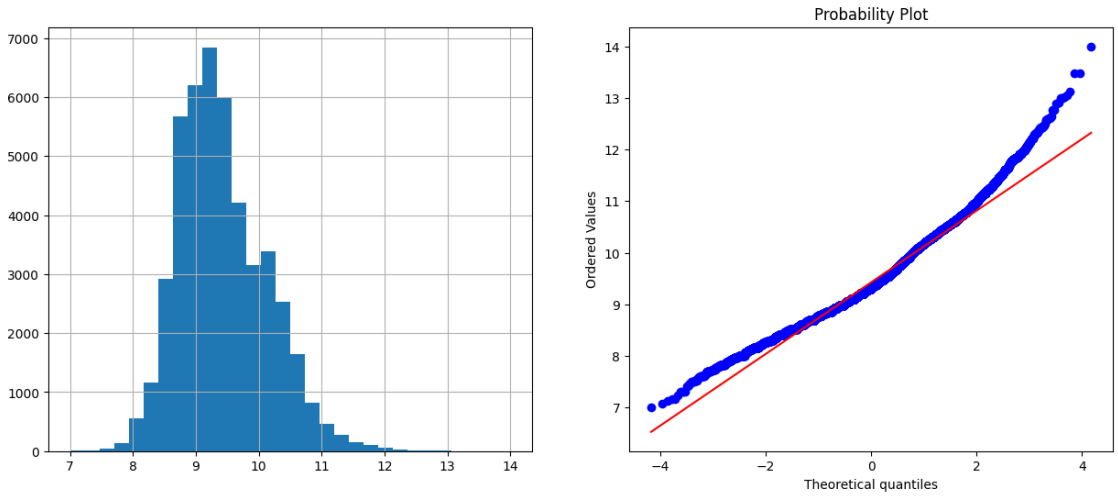




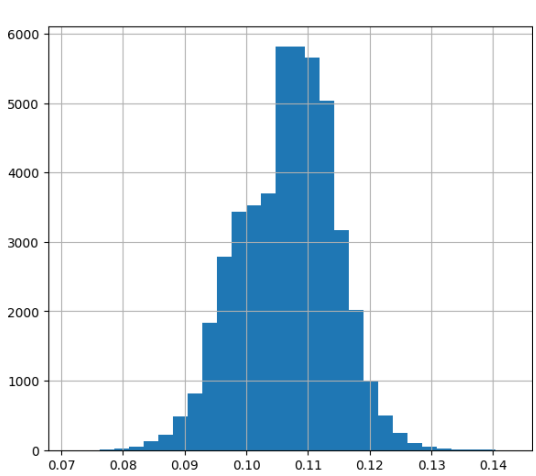
[ ]:
```
diagnostic_plots(data, 'price')
```

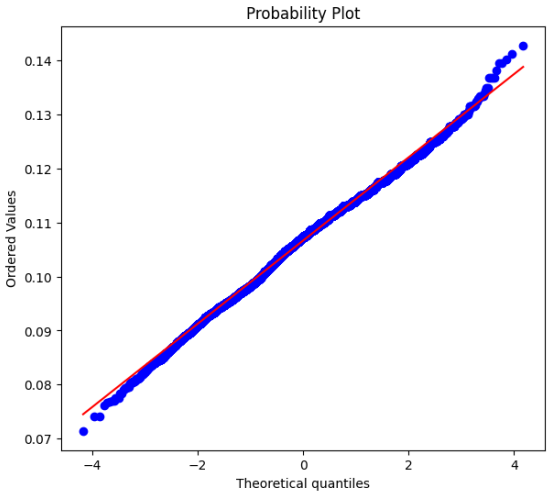


[ ]:
```
#
data['price'] = np.log(data['price'])
diagnostic_plots(data, 'price')
```

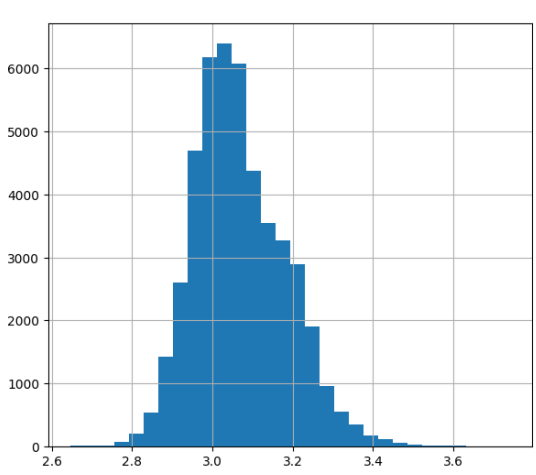


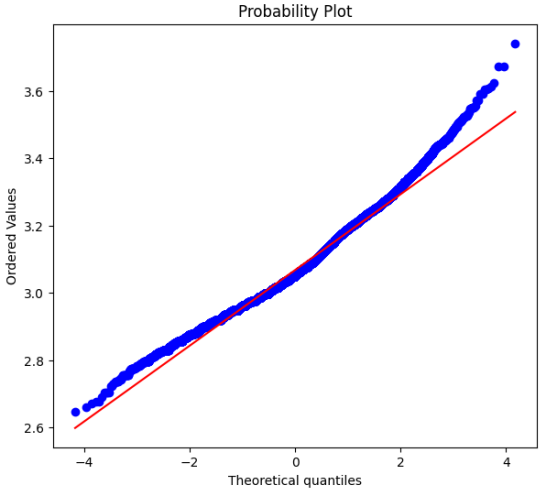
[ ]:
```
#
data['price_reciprocal'] = 1 / (data['price'])
diagnostic_plots(data, 'price_reciprocal')
```



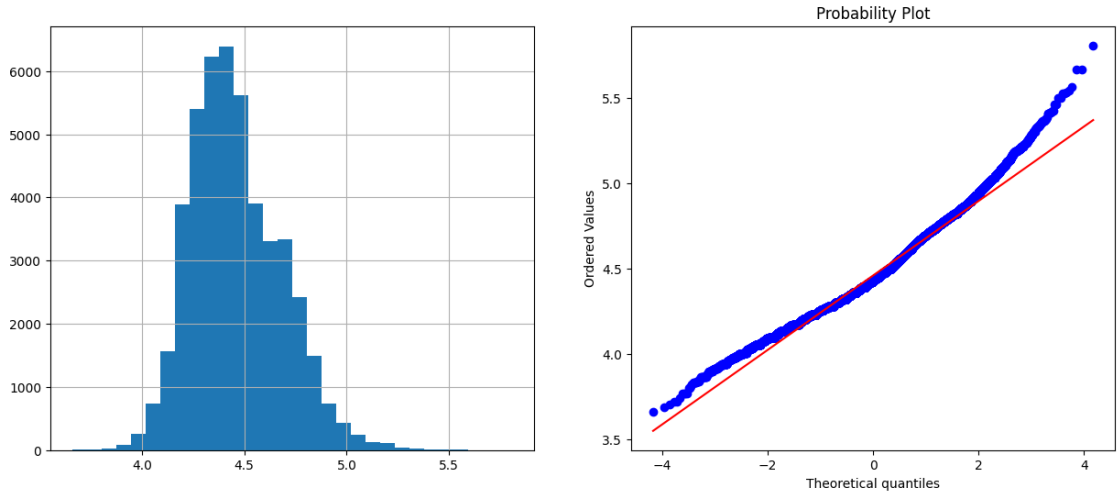


[ ]:
```
#
data['price_sqr'] = data['price']**(1/2)
diagnostic_plots(data, 'price_sqr')
```

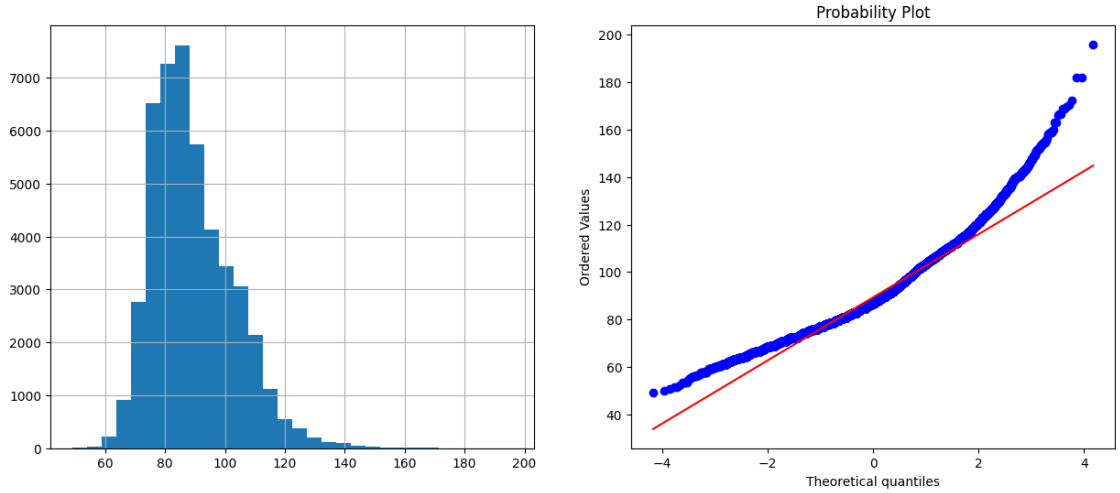




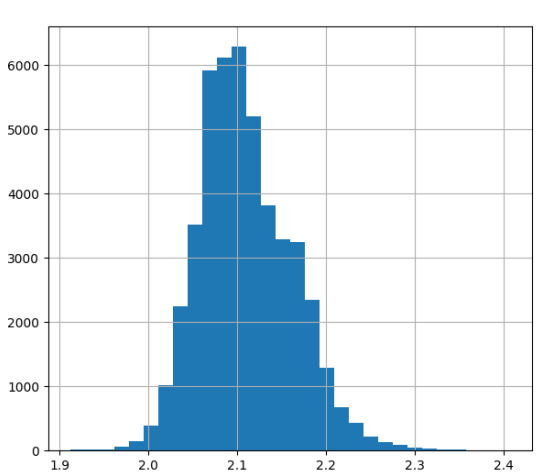
[ ]:
```
#
data['price_exp1'] = data['price']**(1/1.5)
diagnostic_plots(data, 'price_exp1')
```

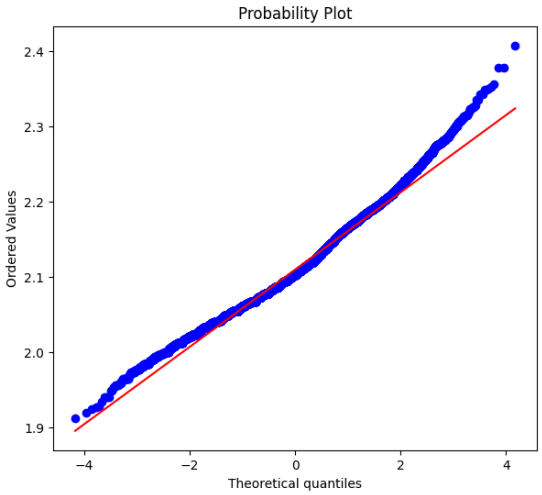


[ ]:
```
data['price_exp2'] = data['price']**(2)
diagnostic_plots(data, 'price_exp2')
```



[ ]:
```
data['price_exp3'] = data['price']**(0.333)
diagnostic_plots(data, 'price_exp3')
```





[ ]:
```
#            -
data['price_boxcox'], param = stats.boxcox(data['price'])
print('              = {}'.format(param))
diagnostic_plots(data, 'price_boxcox')
```

```
              = -1.8519809069200015
```