```
import pandas as pd
import os
import numpy as np
import plotly as py
import warnings
warnings.filterwarnings('ignore')
import seaborn as sns
import matplotlib.pyplot as plt
from plotly.offline import init_notebook_mode
import statsmodels.api as sm
from statsmodels.formula.api import ols
import statistics
import scipy.stats as stats
from scipy.stats import kendalltau
from scipy.stats import spearmanr
from scipy.stats import pearsonr
from statsmodels.graphics.regressionplots import plot_partregress_grid
os.chdir("E:\Ginu_StudyMaterials\Sem2\Dissertation\Data")
```

```
property_prices = pd.read_csv("PPR_ALL_v1.csv", na_values =("N/A",
"NA", "--", " "), encoding = 'unicode_escape')
property_prices
```

```
       Date of Sale (dd/mm/yyyy)  \
0                      01/01/2010
1                      03/01/2010
2                      04/01/2010
3                      04/01/2010
4                      04/01/2010
...                           ...
516581                 28/01/2022
516582                 28/01/2022
516583                 28/01/2022
516584                 28/01/2022
516585                 28/01/2022

                                               Address Postal Code
County  \
0                5 Braemor Drive, Churchtown, Co.Dublin         NaN
Dublin
1       134 Ashewood Walk, Summerhill Lane, Portlaoise         NaN
Laois
2                   1 Meadow Avenue, Dundrum, Dublin 14         NaN
Dublin
3                               1 The Haven, Mornington         NaN
Meath
4                         11 Melville Heights, Kilkenny         NaN
Kilkenny
...                                                ...         ...
...
```

```
516581                LACKEN, MULTYFARNHAM, MULLINGAR         NaN
Westmeath
516582                    LARCH HILL, COLMAN, FETHARD         NaN
Tipperary
516583            SHERRYS WOOD, BELLEWSTOWN, CO MEATH         NaN
Meath
516584                 ST JUDES, STONEYFORD, KILKENNY         NaN
Kilkenny
516585                      SYLVAN, DUBLIN ROAD, BRAY         NaN
Wicklow

        Price (€) Not Full Market Price VAT Exclusive  \
0          343000                    No            No
1          185000                    No           Yes
2          438500                    No            No
3          400000                    No            No
4          160000                    No            No
...           ...                   ...           ...
516581     305000                    No            No
516582     300000                    No            No
516583     450000                    No            No
516584     242000                    No            No
516585     620000                    No            No

                      Description of Property  \
0       Second-Hand Dwelling house /Apartment
1               New Dwelling house /Apartment
2       Second-Hand Dwelling house /Apartment
3       Second-Hand Dwelling house /Apartment
4       Second-Hand Dwelling house /Apartment
...                                       ...
516581  Second-Hand Dwelling house /Apartment
516582  Second-Hand Dwelling house /Apartment
516583  Second-Hand Dwelling house /Apartment
516584  Second-Hand Dwelling house /Apartment
516585  Second-Hand Dwelling house /Apartment

                                Property Size Description
0                                                     NaN
1       greater than or equal to 38 sq metres and less...
2                                                     NaN
3                                                     NaN
4                                                     NaN
...                                                   ...
516581                                                NaN
516582                                                NaN
516583                                                NaN
516584                                                NaN
516585                                                NaN
```

```
[516586 rows x 9 columns]
```

```
property_prices.rename({'Date of Sale (dd/mm/yyyy)':'date_of_sale',
'Address':'address', 'Postal Code':'postal_code', 'County':'county',
'Price (()':'price','Not Full Market Price':'FMP', 'VAT
Exclusive':'VAT_exclusive','Description of
Property':'property_description','Property Size
Description':'property_size_description'   }, axis=1, inplace=True)
```

```
town_list = pd.read_csv("ie_towns_sample.csv", na_values =("N/A",
"NA", "--", " "))
town_list
```

```
        id             name               irish_name     county  \
0        1         Abartagh                 Abartach  Waterford   
1        2     Abberanville             Abberanville     Galway   
2        3    Abbernadoorny                      NaN    Donegal   
3        4           Abbert                 An Abart     Galway   
4        5   Abbert Demesne        Diméin na hAbarta     Galway   
...    ...              ...                      ...        ...   
2035  2036       Ayle Lower      An Aill Íochtarach      Clare   
2036  2037       Ayle Upper      An Aill Uachtarach      Clare   
2037  2038      Aylmerstown  Baile an Aighlmearaigh    Kildare   
2038  2039     Aylwardstown  Baile an Aighleartaigh   Kilkenny   
2039  2040      Ayresfields  Páirceanna an Iarsaigh   Kilkenny   

                  country eircode grid_reference  easting  northing 
latitude  \
0     Republic of Ireland     P36        X121851   212171     85195 
52.01916   
1     Republic of Ireland     H62        M609232   160965    223221 
53.25817   
2     Republic of Ireland     F94        G898822   189874    382219 
54.68795   
3     Republic of Ireland     H54        M539410   153970    241071 
53.41798   
4     Republic of Ireland     H54        M545421   154524    242155 
53.42776   
...                   ...     ...            ...      ...       ... 
...   
2035  Republic of Ireland     V94        R535836   153502    183628 
52.90183   
2036  Republic of Ireland     V94        R525847   152520    184776 
52.91206   
2037  Republic of Ireland     R14        S805888   280572    188877 
52.94497   
2038  Republic of Ireland     Y34        S662213   266278    121350 
52.34021   
2039  Republic of Ireland     R95        S496567   249670    156738 
52.65994   
```

```
      longitude postal_town              local_government_area
province  \
0      -7.82345     Youghal  Waterford City And County Council
Munster
1      -8.58564    Loughrea              Galway County Council
Connacht
2      -8.15776     Donegal             Donegal County Council
Ulster
3      -8.69303        Tuam              Galway County Council
Connacht
4      -8.68485        Tuam              Galway County Council
Connacht
...         ...         ...                                ...        .
..
2035   -8.69172    Limerick               Clare County Council
Munster
2036   -8.70649    Limerick               Clare County Council
Munster
2037   -6.80217        Athy             Kildare County Council
Leinster
2038   -7.02831    New Ross            Kilkenny County Council
Leinster
2039   -7.26668    Kilkenny            Kilkenny County Council
Leinster

     nuts3_region      type
0      South-East  Townland
1            West  Townland
2          Border  Townland
3            West  Townland
4            West  Townland
...           ...       ...
2035     Mid-West  Townland
2036     Mid-West  Townland
2037     Mid-East  Townland
2038   South-East  Townland
2039   South-East  Townland

[2040 rows x 16 columns]
```

```
province_list = town_list[['county', 'province']]
```

```
province_list['province'].unique()
```

```
array(['Munster', 'Connacht', 'Ulster', 'Leinster'], dtype=object)
```

```
df1 = province_list.drop_duplicates(subset= ['county'], keep='first')
df1
```

```
        county  province
0    Waterford   Munster
1       Galway  Connacht
2      Donegal    Ulster
5    Tipperary   Munster
6         Cork   Munster
11    Limerick   Munster
12    Longford  Leinster
13   Roscommon  Connacht
15       Kerry   Munster
16     Wexford  Leinster
17       Clare   Munster
24    Kilkenny  Leinster
25        Mayo  Connacht
28       Cavan    Ulster
29     Kildare  Leinster
31       Meath  Leinster
33   Westmeath  Leinster
44     Wicklow  Leinster
50       Laois  Leinster
55       Sligo  Connacht
64      Dublin  Leinster
72      Offaly  Leinster
73       Louth  Leinster
74      Carlow  Leinster
109    Leitrim  Connacht
114   Monaghan    Ulster
```

```
df1['county'].unique()
```

```
array(['Waterford', 'Galway', 'Donegal', 'Tipperary', 'Cork',
'Limerick',
       'Longford', 'Roscommon', 'Kerry', 'Wexford', 'Clare',
'Kilkenny',
       'Mayo', 'Cavan', 'Kildare', 'Meath', 'Westmeath', 'Wicklow',
       'Laois', 'Sligo', 'Dublin', 'Offaly', 'Louth', 'Carlow',
'Leitrim',
       'Monaghan'], dtype=object)
```

```
from opencage.geocoder import OpenCageGeocode
key = '40d783cbf75143b48b8528d1804a3ccd'  # get api key from:
https://opencagedata.com

geocoder = OpenCageGeocode(key)

list_lat = []   # create empty lists

list_long = []

for index, row in df1.iterrows(): # iterate over rows in dataframe
```

```
    City = row['county']
    State = row['province']
    query = str(City)+','+str(State)
    #loc = row['temp_add']
    #query = str(loc)

    results = geocoder.geocode(query)
    lat = results[0]['geometry']['lat']
    long = results[0]['geometry']['lng']

    list_lat.append(lat)
    list_long.append(long)

# create new columns from lists

df1['lat'] = list_lat

df1['lon'] = list_long

df_merge_col = pd.merge(property_prices, df1, on='county', how='left')

df_merge_col
```

```
       date_of_sale                                         address  \
0        01/01/2010          5 Braemor Drive, Churchtown, Co.Dublin
1        03/01/2010  134 Ashewood Walk, Summerhill Lane, Portlaoise
2        04/01/2010             1 Meadow Avenue, Dundrum, Dublin 14
3        04/01/2010                         1 The Haven, Mornington
4        04/01/2010                   11 Melville Heights, Kilkenny
...             ...                                             ...
516581   28/01/2022                 LACKEN, MULTYFARNHAM, MULLINGAR
516582   28/01/2022                     LARCH HILL, COLMAN, FETHARD
516583   28/01/2022             SHERRYS WOOD, BELLEWSTOWN, CO MEATH
516584   28/01/2022                  ST JUDES, STONEYFORD, KILKENNY
516585   28/01/2022                       SYLVAN, DUBLIN ROAD, BRAY

       postal_code     county   price FMP VAT_exclusive  \
0              NaN     Dublin  343000  No            No
1              NaN      Laois  185000  No           Yes
2              NaN     Dublin  438500  No            No
3              NaN      Meath  400000  No            No
4              NaN   Kilkenny  160000  No            No
...            ...        ...     ...  ..           ...
516581         NaN  Westmeath  305000  No            No
516582         NaN  Tipperary  300000  No            No
516583         NaN      Meath  450000  No            No
516584         NaN   Kilkenny  242000  No            No
516585         NaN    Wicklow  620000  No            No
```

```
                         property_description  \
0       Second-Hand Dwelling house /Apartment
1               New Dwelling house /Apartment
2       Second-Hand Dwelling house /Apartment
3       Second-Hand Dwelling house /Apartment
4       Second-Hand Dwelling house /Apartment
...                                       ...
516581  Second-Hand Dwelling house /Apartment
516582  Second-Hand Dwelling house /Apartment
516583  Second-Hand Dwelling house /Apartment
516584  Second-Hand Dwelling house /Apartment
516585  Second-Hand Dwelling house /Apartment

                                property_size_description  province  \
0                                                     NaN  Leinster
1       greater than or equal to 38 sq metres and less...  Leinster
2                                                     NaN  Leinster
3                                                     NaN  Leinster
4                                                     NaN  Leinster
...                                                   ...       ...
516581                                                NaN  Leinster
516582                                                NaN   Munster
516583                                                NaN  Leinster
516584                                                NaN  Leinster
516585                                                NaN  Leinster

              lat       lon
0       53.349764 -6.260273
1       52.998458 -7.398034
2       53.349764 -6.260273
3       53.649784 -6.588529
4       52.651022 -7.248495
...           ...       ...
516581  53.557790 -7.347856
516582  52.684821 -7.898128
516583  53.649784 -6.588529
516584  52.651022 -7.248495
516585  52.958147 -6.381971

[516586 rows x 12 columns]
```

```
df_merge_col.drop_duplicates()
```

```
       date_of_sale                                          address  \
0        01/01/2010           5 Braemor Drive, Churchtown, Co.Dublin
1        03/01/2010  134 Ashewood Walk, Summerhill Lane, Portlaoise
2        04/01/2010              1 Meadow Avenue, Dundrum, Dublin 14
3        04/01/2010                          1 The Haven, Mornington
4        04/01/2010                    11 Melville Heights, Kilkenny
...             ...                                              ...
```

```
516581   28/01/2022                 LACKEN, MULTYFARNHAM, MULLINGAR
516582   28/01/2022                     LARCH HILL, COLMAN, FETHARD
516583   28/01/2022             SHERRYS WOOD, BELLEWSTOWN, CO MEATH
516584   28/01/2022                  ST JUDES, STONEYFORD, KILKENNY
516585   28/01/2022                       SYLVAN, DUBLIN ROAD, BRAY

       postal_code     county   price FMP VAT_exclusive  \
0              NaN     Dublin  343000  No            No   
1              NaN      Laois  185000  No           Yes   
2              NaN     Dublin  438500  No            No   
3              NaN      Meath  400000  No            No   
4              NaN   Kilkenny  160000  No            No   
...            ...        ...     ...  ..           ...   
516581         NaN  Westmeath  305000  No            No   
516582         NaN  Tipperary  300000  No            No   
516583         NaN      Meath  450000  No            No   
516584         NaN   Kilkenny  242000  No            No   
516585         NaN    Wicklow  620000  No            No   

                         property_description  \
0       Second-Hand Dwelling house /Apartment   
1               New Dwelling house /Apartment   
2       Second-Hand Dwelling house /Apartment   
3       Second-Hand Dwelling house /Apartment   
4       Second-Hand Dwelling house /Apartment   
...                                       ...   
516581  Second-Hand Dwelling house /Apartment   
516582  Second-Hand Dwelling house /Apartment   
516583  Second-Hand Dwelling house /Apartment   
516584  Second-Hand Dwelling house /Apartment   
516585  Second-Hand Dwelling house /Apartment   

                                property_size_description  province  \
0                                                     NaN  Leinster   
1       greater than or equal to 38 sq metres and less...  Leinster   
2                                                     NaN  Leinster   
3                                                     NaN  Leinster   
4                                                     NaN  Leinster   
...                                                   ...       ...   
516581                                                NaN  Leinster   
516582                                                NaN   Munster   
516583                                                NaN  Leinster   
516584                                                NaN  Leinster   
516585                                                NaN  Leinster   

              lat       lon  
0       53.349764 -6.260273  
1       52.998458 -7.398034  
2       53.349764 -6.260273  
3       53.649784 -6.588529  
```

```
4       52.651022 -7.248495
...           ...       ...
516581  53.557790 -7.347856
516582  52.684821 -7.898128
516583  53.649784 -6.588529
516584  52.651022 -7.248495
516585  52.958147 -6.381971

[515792 rows x 12 columns]
```

```
df_merge_col['property_description'] =
df_merge_col['property_description'].replace(['Teach/Árasán Cónaithe
Atháimhe','Teach/Árasán Cónaithe Nua','Teach/?ras?n C?naithe Nua'],
['Second-Hand Dwelling house /Apartment','New Dwelling house
/Apartment','New Dwelling house /Apartment'])

df_merge_col['property_size_description'] =
df_merge_col['property_size_description'].replace(['n?os l? n? 38 m?
adar cearnach','níos mó ná nó cothrom le 38 méadar cearnach agus níos
lú ná 125 méadar cearnach'],['less than 38 sq metres','greater than or
equal to 38 sq metres and less than 125 sq metres'])

df_merge_col['county'] = df_merge_col['county'].replace(['Baile ?tha
Cliath','Ní Bhaineann'],['Dublin',''])

df_merge_col['postal_code'] =
df_merge_col['postal_code'].replace(['Baile Átha Cliath 3','Baile Átha
Cliath 4','Baile Átha Cliath 5','Baile Átha Cliath 9','Baile Átha
Cliath 14','Baile Átha Cliath 15','Baile Átha Cliath 18','Baile ?tha
Cliath 17','Ní Bhaineann'],['Dublin 3','Dublin 4','Dublin 5','Dublin
9','Dublin 14','Dublin 15','Dublin 18','Dublin 17',''])

df_merge_col['property_description'] =
df_merge_col['property_description'].replace(['Second-Hand Dwelling
house /Apartment','New Dwelling house /Apartment'],['Second-Hand',
'NewHouse'])

df_merge_col['property_size_description'] =
df_merge_col['property_size_description'].replace(['greater than 125
sq metres'],['greater than or equal to 125 sq metres'])

df_merge_col['address'] = df_merge_col['address'].str.title()

#df_merge_col['price'] =df_merge_col['price'].str.replace('£','')
#df_merge_col['price'] = df_merge_col['price'].str.replace(',', '')

# changing the date to pandas datetime format

pd.to_datetime(df_merge_col['date_of_sale'].astype(str), format
='%d/%m/%Y')
```

```
0        2010-01-01
1        2010-01-03
2        2010-01-04
3        2010-01-04
4        2010-01-04
            ...
516581   2022-01-28
516582   2022-01-28
516583   2022-01-28
516584   2022-01-28
516585   2022-01-28
Name: date_of_sale, Length: 516586, dtype: datetime64[ns]
```

```
cd_date1 = pd.to_datetime(df_merge_col['date_of_sale'].astype(str),
format ='%d/%m/%Y')
#pd.to_datetime(df_merge_col['date_of_sale'].astype(str), format
='%d/%m/%Y')
df_merge_col['month_year'] =
pd.to_datetime(df_merge_col['date_of_sale']).dt.to_period('M')


df_merge_col['year'] = cd_date1.dt.year
df_merge_col['month'] = cd_date1.dt.month

df_merge_col = df_merge_col.assign(location=df_merge_col["county"])

# Split the location between Dublin and outside Dublin
df_merge_col['location'] = df_merge_col['location'].map({
 "Cork": "Outside", "Galway": "Outside", "Kildare": "Outside",
"Meath": "Outside", "Limerick": "Outside",
 "Wexford": "Outside", "Wicklow": "Outside", "Kerry": "Outside",
"Donegal": "Outside", "Waterford": "Outside",
 "Tipperary": "Outside", "Louth": "Outside", "Mayo": "Outside",
"Clare": "Outside", "Westmeath": "Outside",
 "Cavan": "Outside", "Sligo": "Outside", "Kilkenny": "Outside",
"Laois": "Outside", "Roscommon": "Outside",
 "Offaly": "Outside", "Carlow": "Outside", "Leitrim": "Outside",
"Longford": "Outside", "Monaghan": "Outside",
 "Dublin": "Dublin"})
df_merge_col.head()
```

```
  date_of_sale                                         address
postal_code  \
0   01/01/2010          5 Braemor Drive, Churchtown, Co.Dublin
NaN
1   03/01/2010  134 Ashewood Walk, Summerhill Lane, Portlaoise
NaN
2   04/01/2010             1 Meadow Avenue, Dundrum, Dublin 14
NaN
3   04/01/2010                         1 The Haven, Mornington
NaN
4   04/01/2010                   11 Melville Heights, Kilkenny
```

```
NaN

     county   price FMP VAT_exclusive property_description  \
0    Dublin  343000  No            No          Second-Hand   
1     Laois  185000  No           Yes             NewHouse   
2    Dublin  438500  No            No          Second-Hand   
3     Meath  400000  No            No          Second-Hand   
4  Kilkenny  160000  No            No          Second-Hand   

                           property_size_description  province
lat  \
0                                                NaN  Leinster
53.349764   
1  greater than or equal to 38 sq metres and less...  Leinster
52.998458   
2                                                NaN  Leinster
53.349764   
3                                                NaN  Leinster
53.649784   
4                                                NaN  Leinster
52.651022   

        lon month_year  year  month location  
0 -6.260273    2010-01  2010      1   Dublin  
1 -7.398034    2010-03  2010      1  Outside  
2 -6.260273    2010-04  2010      1   Dublin  
3 -6.588529    2010-04  2010      1  Outside  
4 -7.248495    2010-04  2010      1  Outside  
```

```
df_merge_col.info()
```

```
<class 'pandas.core.frame.DataFrame'>
Int64Index: 516586 entries, 0 to 516585
Data columns (total 16 columns):
 #   Column                     Non-Null Count   Dtype    
---  ------                     --------------   -----    
 0   date_of_sale               516586 non-null  object   
 1   address                    516586 non-null  object   
 2   postal_code                97243 non-null   object   
 3   county                     516586 non-null  object   
 4   price                      516586 non-null  int64    
 5   FMP                        516586 non-null  object   
 6   VAT_exclusive              516586 non-null  object   
 7   property_description       516586 non-null  object   
 8   property_size_description  52800 non-null   object   
 9   province                   516586 non-null  object   
 10  lat                        516586 non-null  float64  
 11  lon                        516586 non-null  float64  
 12  month_year                 516586 non-null  period[M]
 13  year                       516586 non-null  int64    
 14  month                      516586 non-null  int64
 15  location                   516586 non-null  object
dtypes: float64(2), int64(3), object(10), period[M](1)
memory usage: 67.0+ MB
```

```
df_merge_col['price'].astype('int64')
```

```
0         343000
1         185000
2         438500
3         400000
4         160000
           ...
516581    305000
516582    300000
516583    450000
516584    242000
516585    620000
Name: price, Length: 516586, dtype: int64
```

```
for county in df_merge_col['county'].unique():
    print('County {}; max house price €{:.0f}m'.format(county,
(df_merge_col[df_merge_col['county'] == county]
['price'].max())/10**6))
```

```
County Dublin; max house price €182m
County Laois; max house price €21m
County Meath; max house price €8m
County Kilkenny; max house price €13m
County Limerick; max house price €13m
County Carlow; max house price €5m
County Cork; max house price €70m
County Clare; max house price €33m
County Sligo; max house price €6m
County Cavan; max house price €5m
County Tipperary; max house price €6m
County Wicklow; max house price €24m
County Roscommon; max house price €2m
County Wexford; max house price €14m
County Mayo; max house price €8m
County Donegal; max house price €4m
County Longford; max house price €2m
County Galway; max house price €35m
County Offaly; max house price €1m
County Kildare; max house price €26m
County Waterford; max house price €8m
County Louth; max house price €7m
County Kerry; max house price €9m
County Westmeath; max house price €14m
County Monaghan; max house price €2m
County Leitrim; max house price €2m
```

```
county = df_merge_col['county'].unique()
```

```
max_house_prices = [(df_merge_col[df_merge_col['county'] == county]
['price'].max())/10**6 for county in df_merge_col['county'].unique()]
```

```
max_house_prices
```

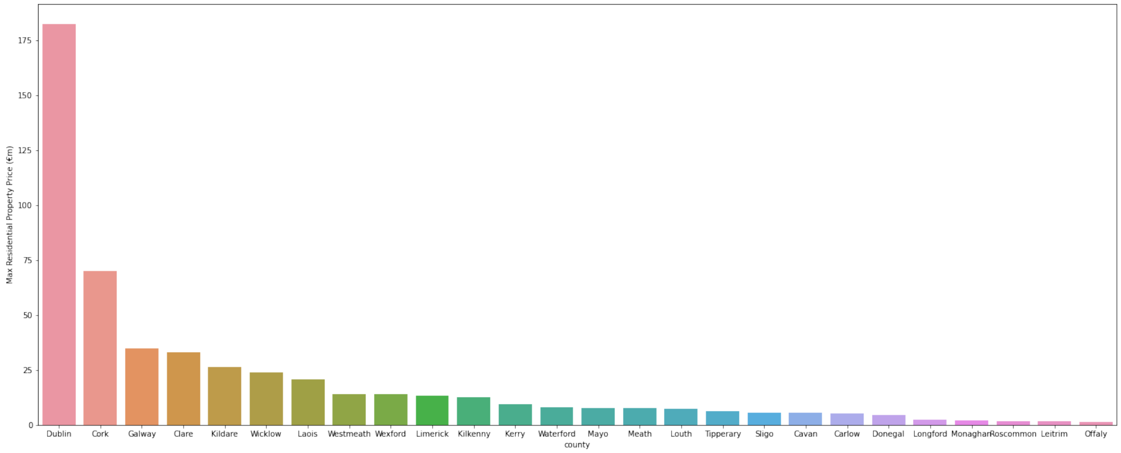
```
[182.378855,
 20.8,
 7.704846,
 12.6,
 13.151162,
 5.101322,
 69.873482,
 33.18,
 5.559481,
 5.4,
 6.230344,
 23.885325,
 1.67,
 13.995,
 7.762438,
 4.464915,
 2.49,
 34.781,
 1.46,
 26.5,
 7.929515,
 7.2,
 9.41,
 14.0,
 2.151174,
 1.546256]
```

```
county_price = pd.DataFrame(county)
county_price['max_house_prices'] = max_house_prices
county_price.rename(columns={0:'county'},inplace=True)
county_price
```

```
       county  max_house_prices
0      Dublin        182.378855
1       Laois         20.800000
2       Meath          7.704846
3    Kilkenny         12.600000
4    Limerick         13.151162
5      Carlow          5.101322
6        Cork         69.873482
7       Clare         33.180000
8       Sligo          5.559481
9       Cavan          5.400000
10  Tipperary          6.230344
```

```
11    Wicklow        23.885325
12  Roscommon         1.670000
13    Wexford        13.995000
14       Mayo         7.762438
15    Donegal         4.464915
16   Longford         2.490000
17     Galway        34.781000
18     Offaly         1.460000
19    Kildare        26.500000
20  Waterford         7.929515
21      Louth         7.200000
22      Kerry         9.410000
23  Westmeath        14.000000
24   Monaghan         2.151174
25    Leitrim         1.546256
```

```
fig, ax = plt.subplots(figsize=(25, 10))
plt.ylabel('Max Residential Property Price (€m)')
sns.barplot(x= county_price['county'], y=
max_house_prices,order=county_price.sort_values('max_house_prices',
ascending =False).county )
plt.show()
```



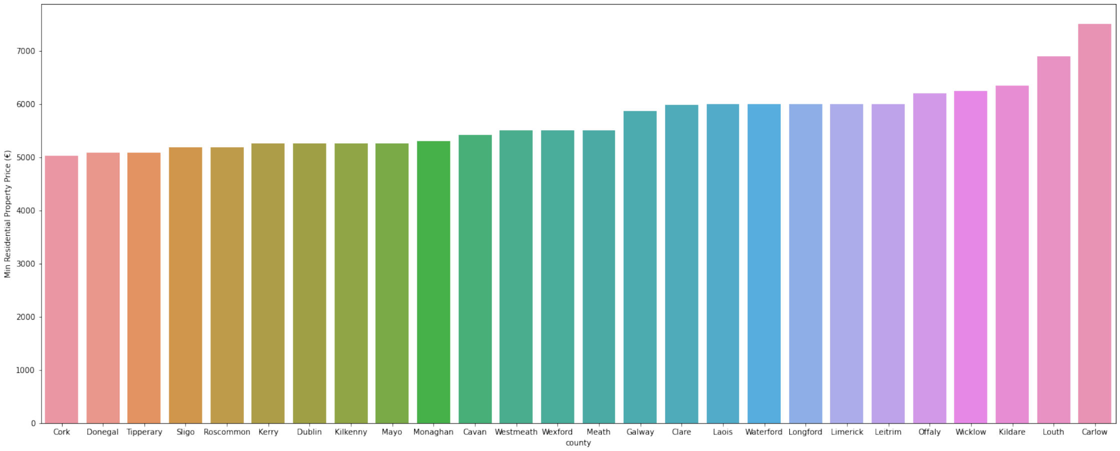
```
min_house_prices = [(df_merge_col[df_merge_col['county'] == county]
['price'].min()) for county in df_merge_col['county'].unique()]
```

```
county_price_min = pd.DataFrame(county)
county_price_min['min_house_prices'] = min_house_prices
county_price_min.rename(columns={0:'county'},inplace=True)
county_price_min
```

```
      county  min_house_prices
0     Dublin              5250
1      Laois              6000
2      Meath              5500
3   Kilkenny              5250
4   Limerick              6000
```

```
5      Carlow              7500
6        Cork              5031
7       Clare              5987
8       Sligo              5177
9       Cavan              5412
10  Tipperary              5080
11    Wicklow              6248
12  Roscommon              5179
13    Wexford              5500
14       Mayo              5254
15    Donegal              5079
16   Longford              6000
17     Galway              5864
18     Offaly              6200
19    Kildare              6348
20  Waterford              6000
21      Louth              6900
22      Kerry              5250
23  Westmeath              5500
24   Monaghan              5298
25    Leitrim              6000
```

```
fig, ax = plt.subplots(figsize=(25, 10))
plt.ylabel('Min Residential Property Price (€)')
sns.barplot(x=county_price_min['county'], y= min_house_prices,
order=county_price_min.sort_values('min_house_prices').county )
plt.show()
```



```
property_sizes =
np.delete(df_merge_col['property_size_description'].unique(), 0)
property_sizes
```

```
array(['greater than or equal to 38 sq metres and less than 125 sq
metres',
       'greater than or equal to 125 sq metres', 'less than 38 sq
metres'],
      dtype=object)
```

```
median_per_property_size = [df_merge_col['price']
[df_merge_col['property_size_description']==property_size].median()
for property_size in property_sizes]
```

```
median_per_property_size
```

```
[205000.0, 263436.0, 162832.0]
```

```
#property_sizes = list(map(lambda x: x.replace('greater than 125 sq
metres', '= 125 Sqm'), property_sizes))
```

```
property_sizes = list(map(lambda x: x.replace('greater than or equal
to 38 sq metres and less than 125 sq metres', '>=38 & <125 Sqm'),
property_sizes))
```

```
property_sizes = list(map(lambda x: x.replace('less than 38 sq
metres', '< 38 Sqm'), property_sizes))
```

```
property_sizes = list(map(lambda x: x.replace('greater than or equal
to 125 sq metres', '>= 125 Sqm'), property_sizes))
```

```
property_sizes
```

```
['>=38 & <125 Sqm', '>= 125 Sqm', '< 38 Sqm']
```

```
size_price = pd.DataFrame(property_sizes)
size_price
```

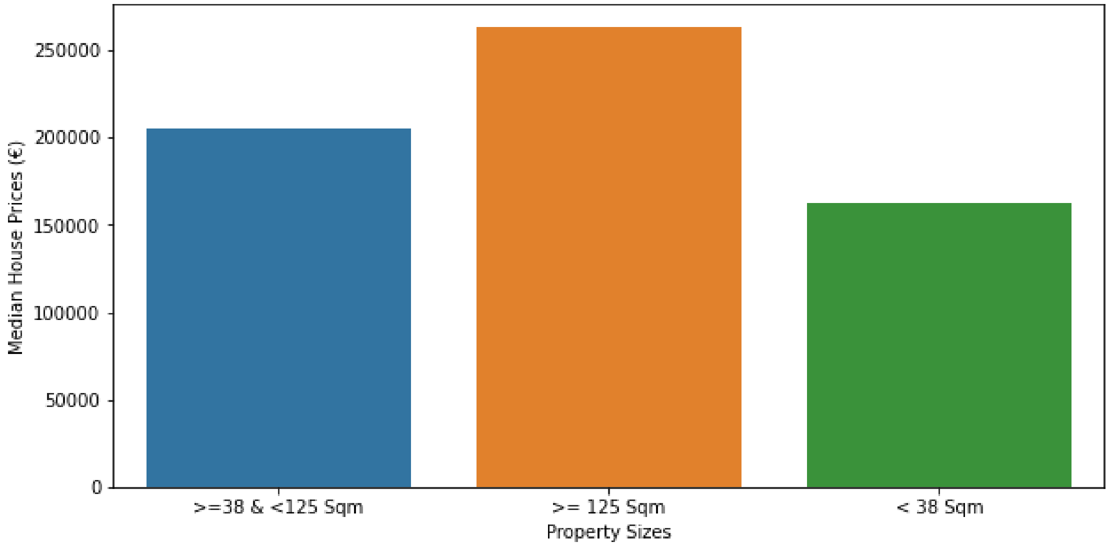
```
                 0
0  >=38 & <125 Sqm
1       >= 125 Sqm
2         < 38 Sqm
```

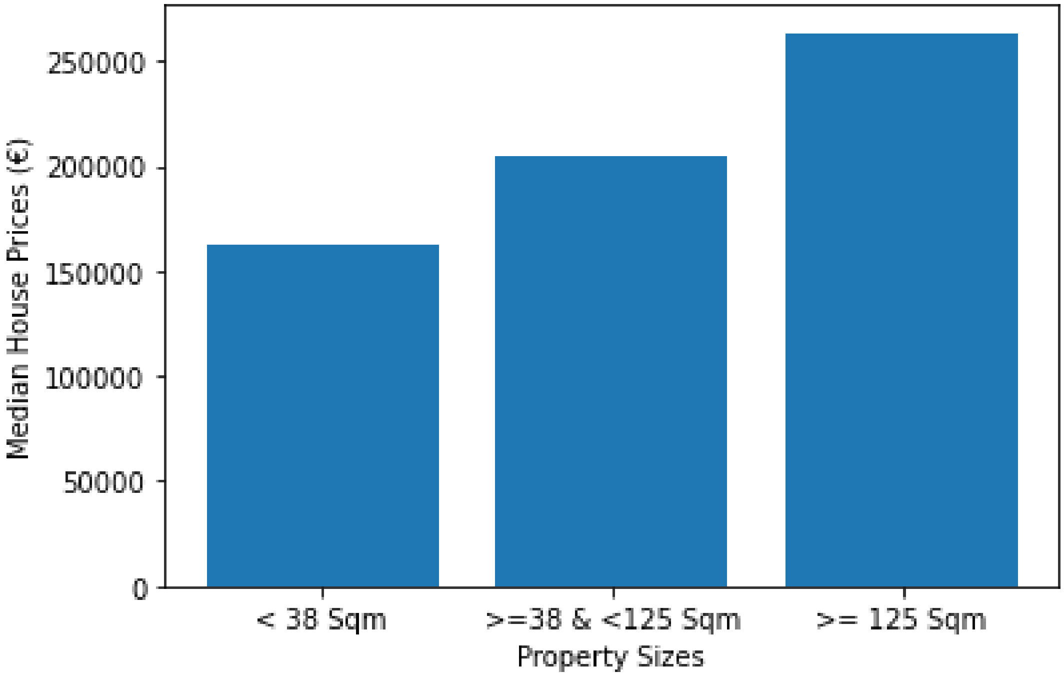
```
size_price['median_per_property_size'] = median_per_property_size
size_price.rename(columns={0:'property_sizes'},inplace=True)
size_price
```

```
    property_sizes  median_per_property_size
0  >=38 & <125 Sqm                  205000.0
1       >= 125 Sqm                  263436.0
2         < 38 Sqm                  162832.0
```

```
fig, ax = plt.subplots(figsize=(10, 5))
sns.barplot(size_price['property_sizes'],
size_price['median_per_property_size'],order=size_price.sort_values('p
roperty_sizes', ascending =False).property_sizes, )
#ax.set_xticklabels(labels=property_sizes,rotation=90)
plt.xlabel('Property Sizes')
#plt.xlabel(" Property Sizes, 0: <38 sqm, 1: =>38 sqm, 2: =>125 sqm")
plt.ylabel('Median House Prices (€)')
plt.show()
```

```
df_sorted = size_price.sort_values('median_per_property_size')
plt.bar('property_sizes', 'median_per_property_size', data=df_sorted)
plt.xlabel('Property Sizes')
#plt.xlabel(" Property Sizes, 0: <38 sqm, 1: =>38 sqm, 2: =>125 sqm")
plt.ylabel('Median House Prices (€)')
plt.show()
```





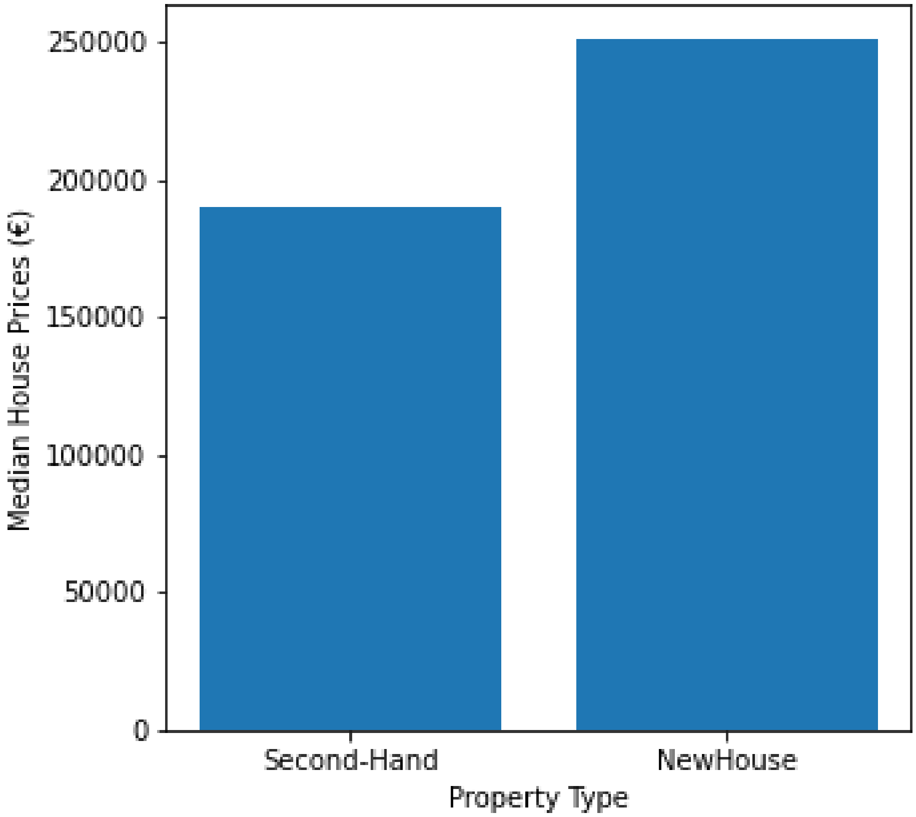
```
property_ = (df_merge_col['property_description'].unique())
property_
```

```
array(['Second-Hand', 'NewHouse'], dtype=object)
```

```
propertysize_house_prices =
[(df_merge_col[df_merge_col['property_description'] ==
property_description]['price'].median()) for property_description in
df_merge_col['property_description'].unique()]

propertysize_house_prices
```

```
[190000.0, 251101.0]
```

```
property_ = list(map(lambda x: x.replace('Second-Hand Dwelling
house /Apartment', 'UsedHouse'), property_))

property_ = list(map(lambda x: x.replace('New Dwelling house
/Apartment', 'NewHouse'), property_))

fig, ax = plt.subplots(figsize=(5, 5))
plt.bar(property_,propertysize_house_prices)
#ax.set_xticklabels(labels=property_,rotation=90)
plt.xlabel('Property Type')
plt.ylabel('Median House Prices (€)')
plt.show()
```



```
counties = df_merge_col['county'].unique()
counties
```

```
array(['Dublin', 'Laois', 'Meath', 'Kilkenny', 'Limerick', 'Carlow',
       'Cork', 'Clare', 'Sligo', 'Cavan', 'Tipperary', 'Wicklow',
       'Roscommon', 'Wexford', 'Mayo', 'Donegal', 'Longford',
'Galway',
       'Offaly', 'Kildare', 'Waterford', 'Louth', 'Kerry',
'Westmeath',
       'Monaghan', 'Leitrim'], dtype=object)
```

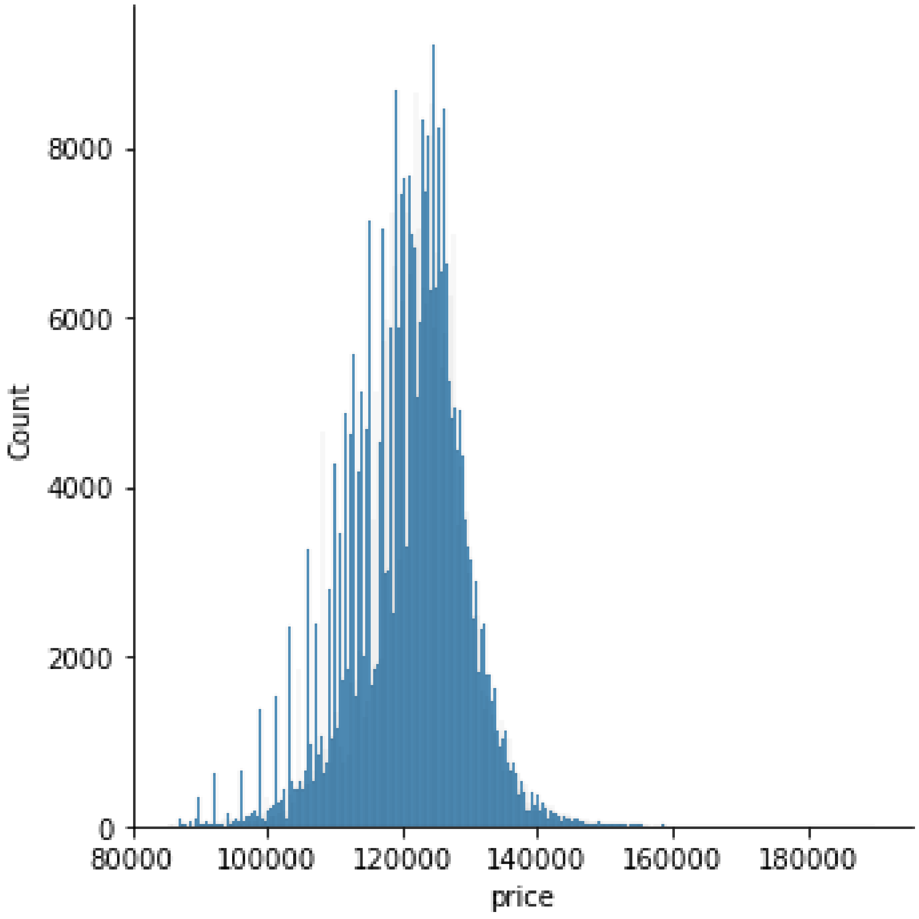
```
median_per_county = [df_merge_col['price']
[df_merge_col['county']==county].median() for county in counties]

median_per_county = np.asarray(median_per_county)
median_per_county
```

```
array([308370., 139995., 233480., 160000., 150000., 140000., 200000.,
       140000., 110000., 104225., 125000., 275000.,  89000., 150000.,
       110000., 101743.,  84000., 180000., 130000., 250000., 142000.,
       170000., 142500., 138000., 118000.,  87000.])
```

```
q=[]
for price in median_per_county:
    x = price
    q.append(x)

county_price = pd.DataFrame(q)

county_price['county'] = counties

county_price.rename(columns={0:'price'},inplace=True)
```

Univariate Plots

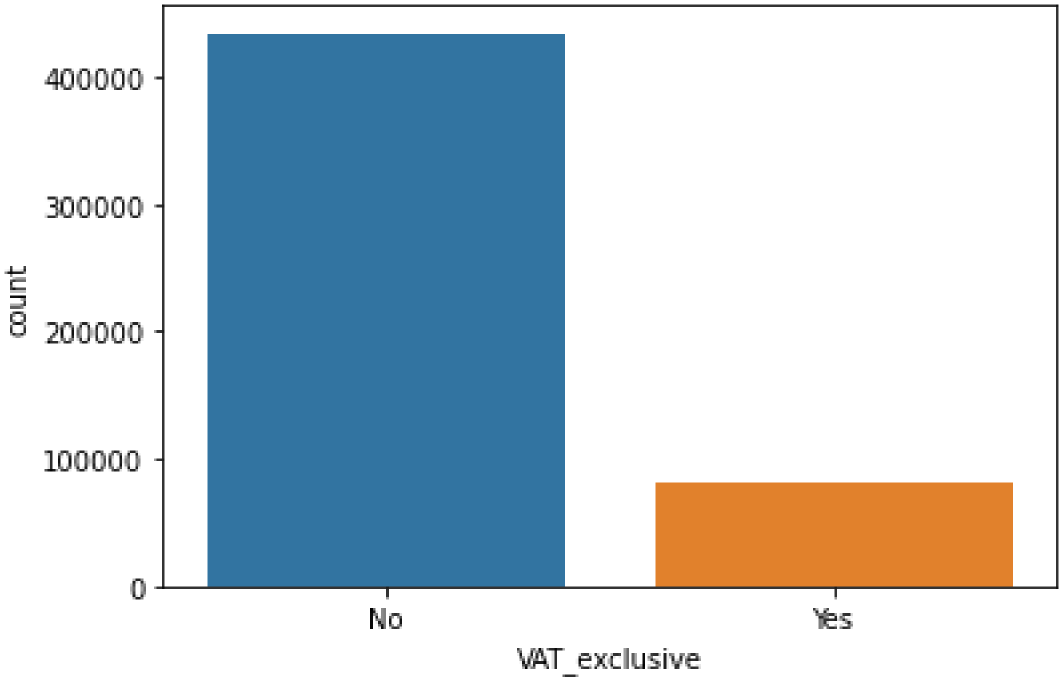
```
for county in df_merge_col['county'].unique():
    print('County {}; max house price €{:.0f}m'.format(county,
(df_merge_col[df_merge_col['county'] == county]
['price'].max())/10**6))

sns.displot(np.log(df_merge_col['price'])*10**4)
plt.show()
```



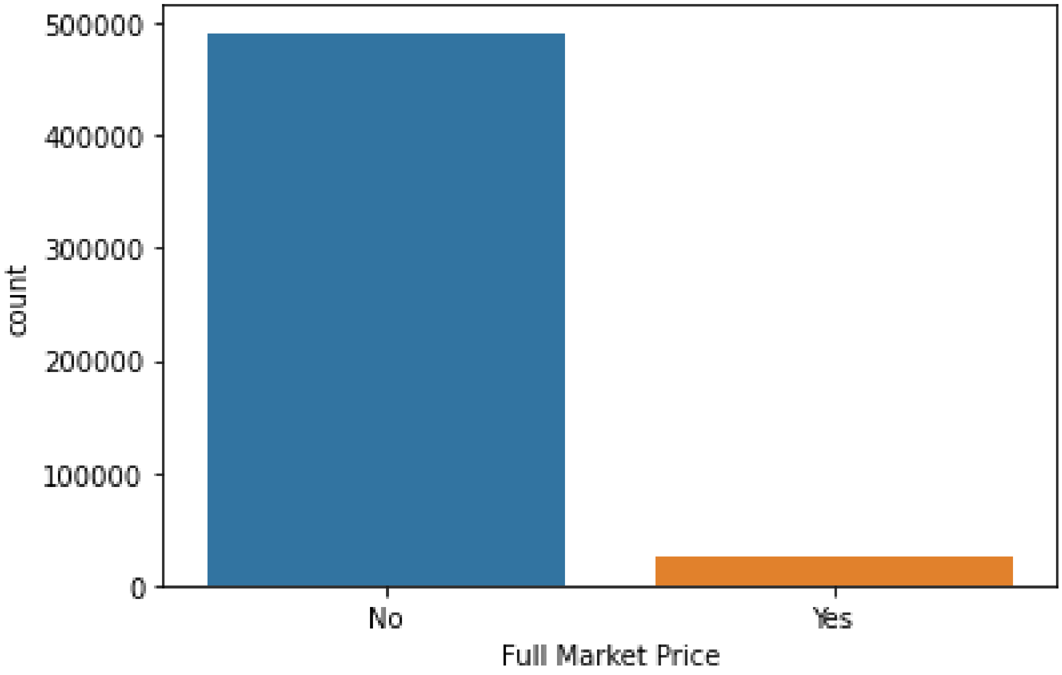
```
df_merge_col

       date_of_sale                                          address  \
0        01/01/2010           5 Braemor Drive, Churchtown, Co.Dublin
1        03/01/2010  134 Ashewood Walk, Summerhill Lane, Portlaoise
2        04/01/2010              1 Meadow Avenue, Dundrum, Dublin 14
3        04/01/2010                          1 The Haven, Mornington
4        04/01/2010                    11 Melville Heights, Kilkenny
...             ...                                              ...
516581   28/01/2022                  Lacken, Multyfarnham, Mullingar
516582   28/01/2022                      Larch Hill, Colman, Fethard
516583   28/01/2022              Sherrys Wood, Bellewstown, Co Meath
516584   28/01/2022                   St Judes, Stoneyford, Kilkenny
516585   28/01/2022                        Sylvan, Dublin Road, Bray

       postal_code     county   price FMP VAT_exclusive
property_description  \
0              NaN     Dublin  343000  No            No
Second-Hand
1              NaN      Laois  185000  No           Yes
NewHouse
2              NaN     Dublin  438500  No            No
```

```
Second-Hand
3              NaN      Meath  400000  No            No
Second-Hand
4              NaN   Kilkenny  160000  No            No
Second-Hand
...            ...        ...     ...  ..           ...
...
516581         NaN  Westmeath  305000  No            No
Second-Hand
516582         NaN  Tipperary  300000  No            No
Second-Hand
516583         NaN      Meath  450000  No            No
Second-Hand
516584         NaN   Kilkenny  242000  No            No
Second-Hand
516585         NaN    Wicklow  620000  No            No
Second-Hand

                                property_size_description  province  \
0                                                     NaN  Leinster
1       greater than or equal to 38 sq metres and less...  Leinster
2                                                     NaN  Leinster
3                                                     NaN  Leinster
4                                                     NaN  Leinster
...                                                   ...       ...
516581                                                NaN  Leinster
516582                                                NaN   Munster
516583                                                NaN  Leinster
516584                                                NaN  Leinster
516585                                                NaN  Leinster

              lat       lon month_year  year  month location
0       53.349764 -6.260273    2010-01  2010      1   Dublin
1       52.998458 -7.398034    2010-03  2010      1  Outside
2       53.349764 -6.260273    2010-04  2010      1   Dublin
3       53.649784 -6.588529    2010-04  2010      1  Outside
4       52.651022 -7.248495    2010-04  2010      1  Outside
...           ...       ...        ...   ...    ...      ...
516581  53.557790 -7.347856    2022-01  2022      1  Outside
516582  52.684821 -7.898128    2022-01  2022      1  Outside
516583  53.649784 -6.588529    2022-01  2022      1  Outside
516584  52.651022 -7.248495    2022-01  2022      1  Outside
516585  52.958147 -6.381971    2022-01  2022      1  Outside

[516586 rows x 16 columns]
```

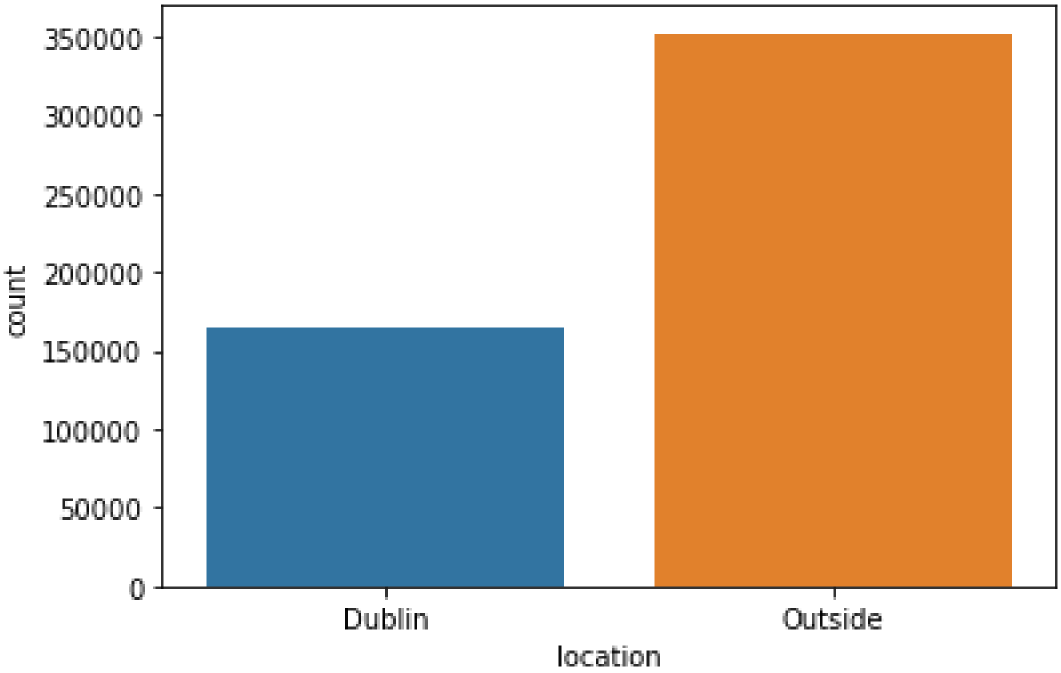
```
sns.countplot(x='VAT_exclusive', data=df_merge_col)
plt.show()
```



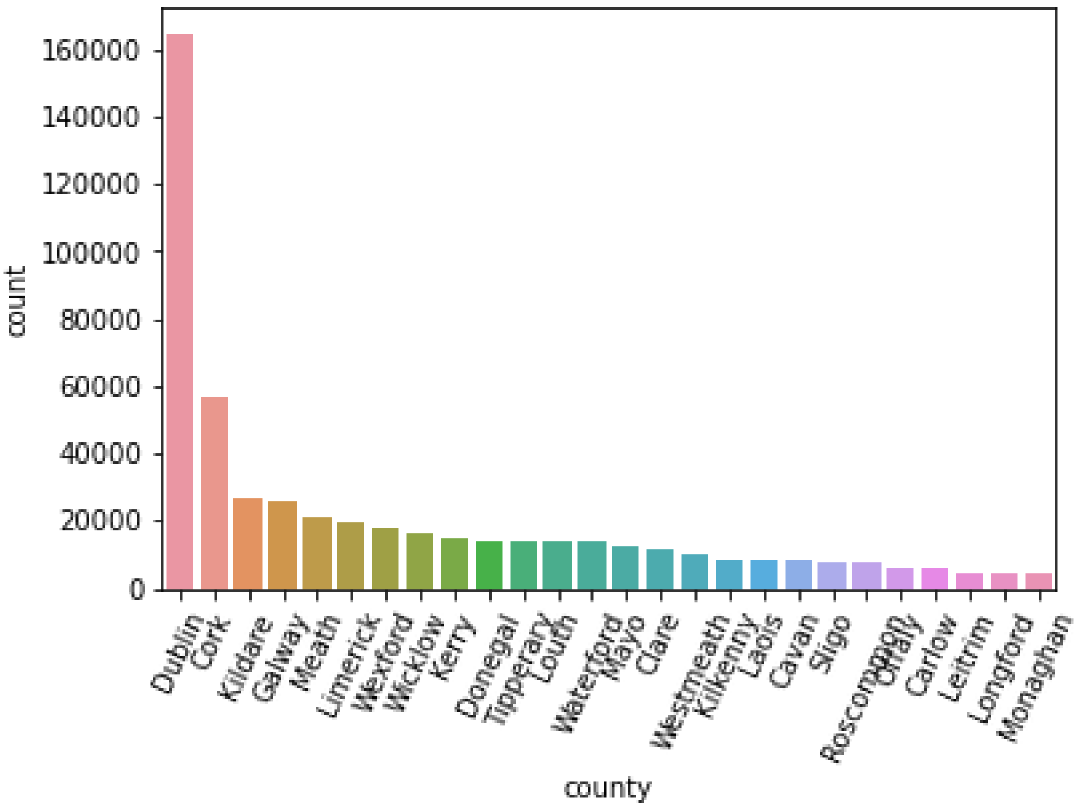
```
p1 = sns.countplot(x='FMP', data=df_merge_col)
p1.set_xlabel("Full Market Price")
plt.show()
```



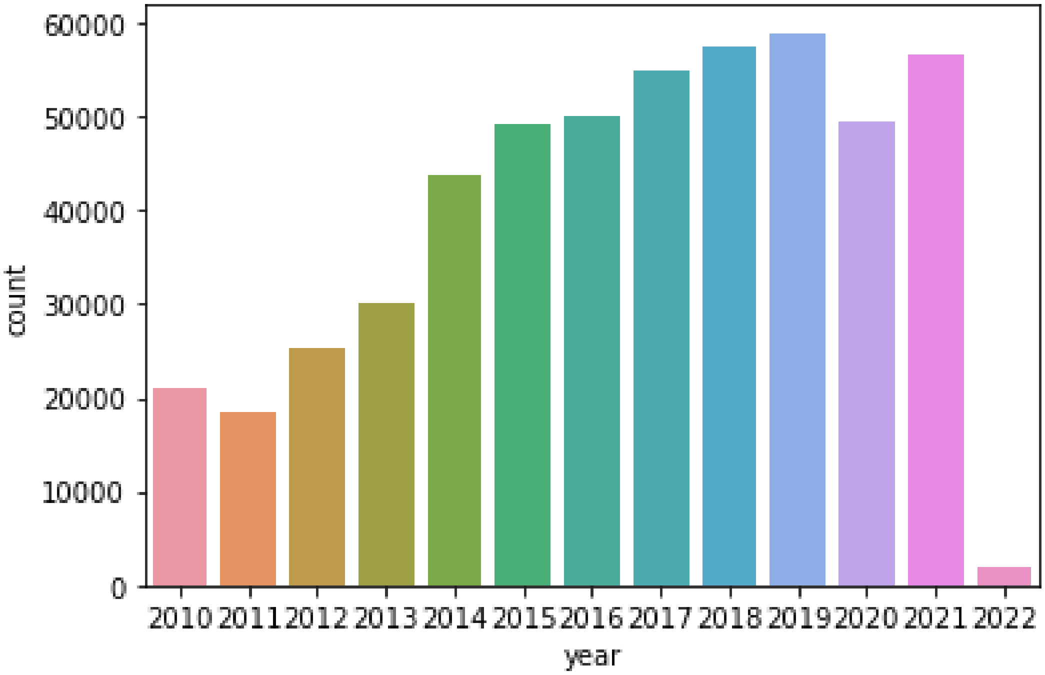
```
sns.countplot(x='location', data=df_merge_col)
plt.show()
```



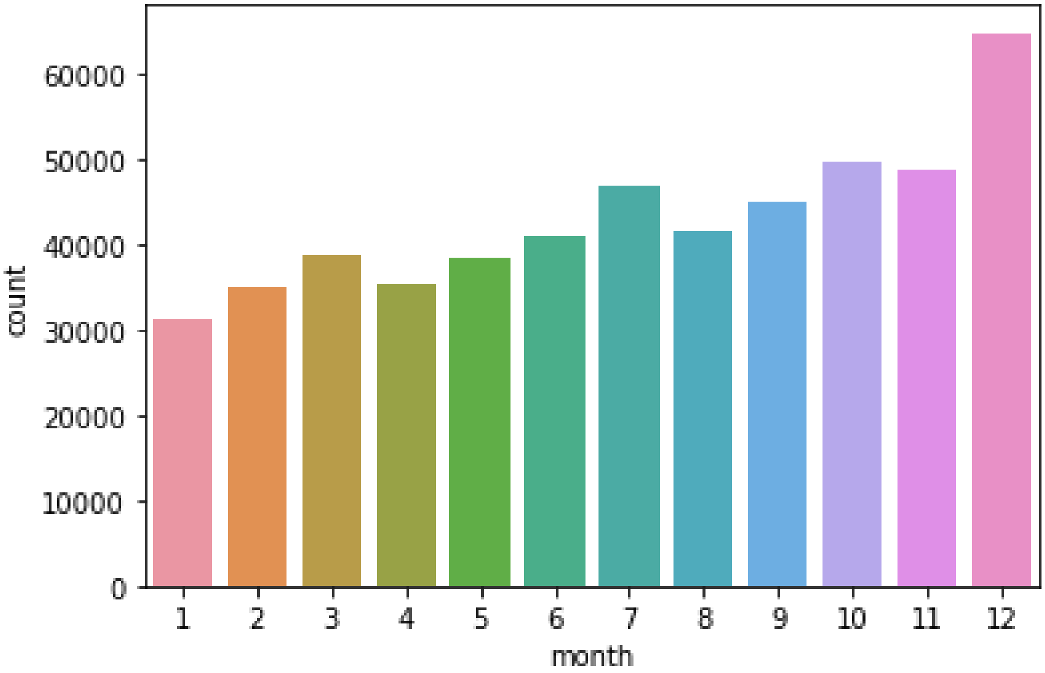
```
sns.countplot(x='county', data=df_merge_col, order =
df_merge_col['county'].value_counts().index)
locs, labels = plt.xticks()
plt.setp(labels, rotation=65)
plt.show()
```



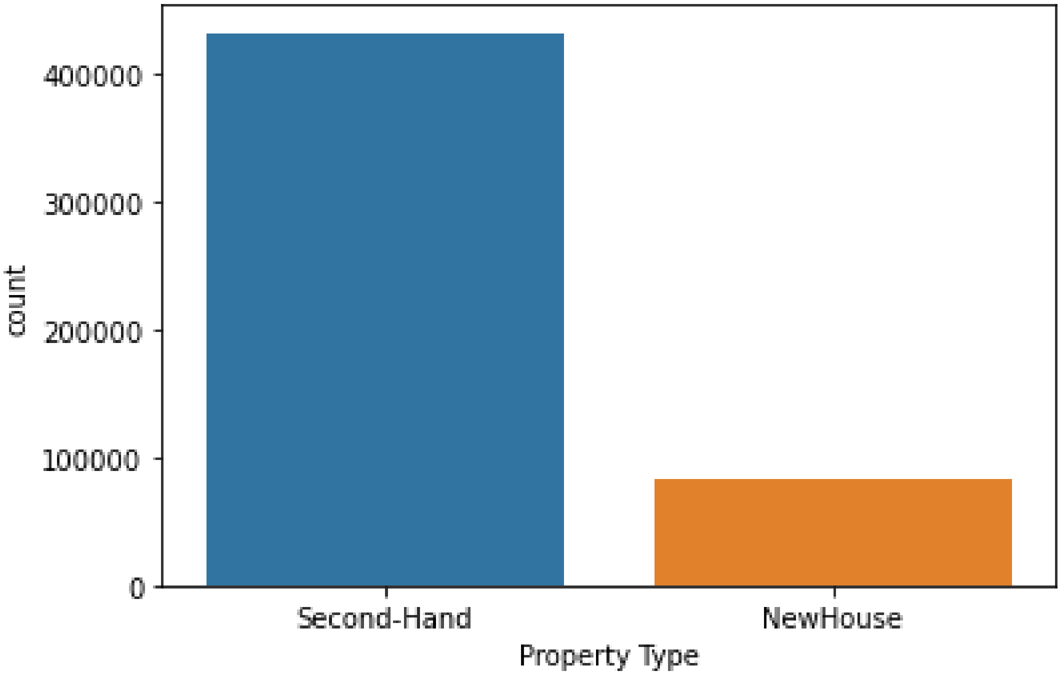
```
#sns.countplot(x='year', data=df_merge_col, order =
df_merge_col['year'].value_counts().index)
sns.countplot(x='year', data=df_merge_col)
plt.show()
```



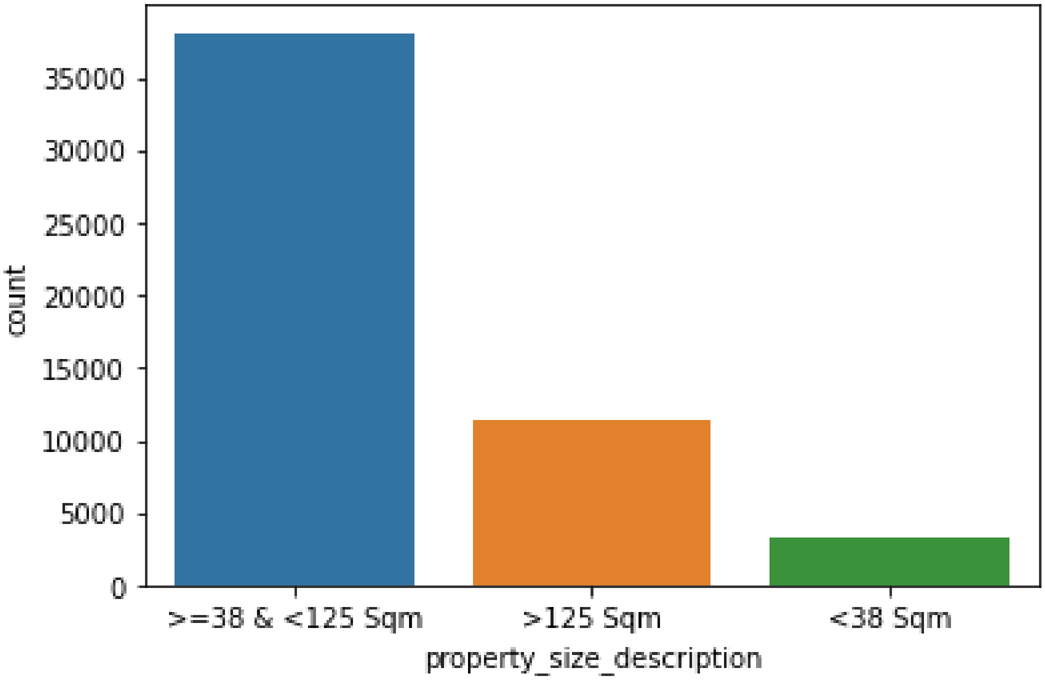
```
sns.countplot(x='month', data=df_merge_col)
plt.show()
```



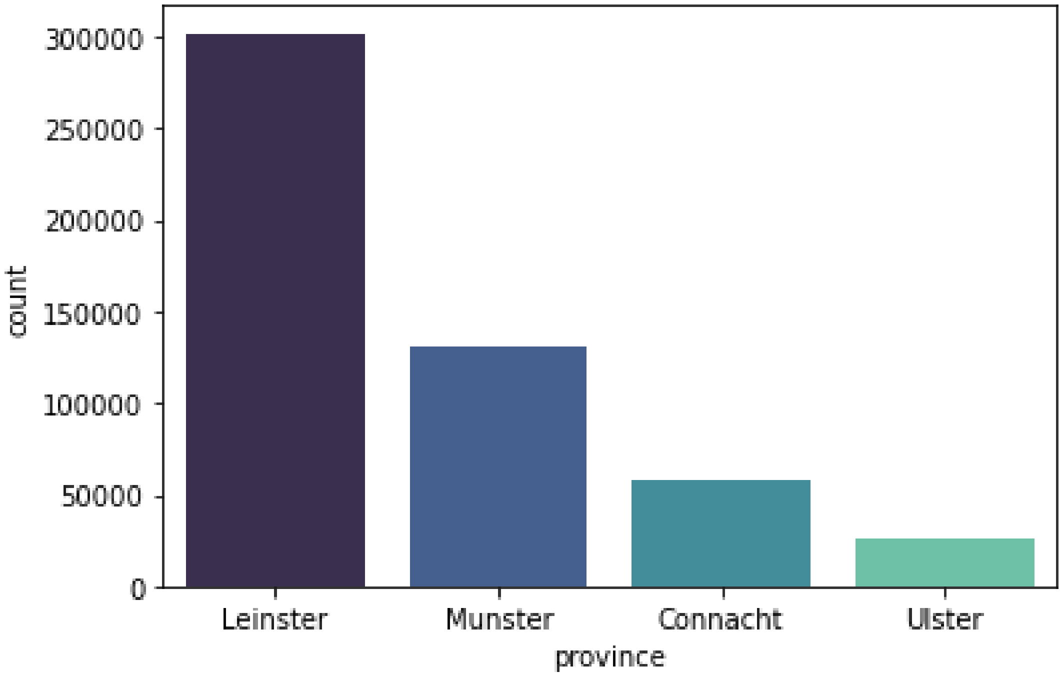
```
sns.countplot(x='property_description', data=df_merge_col)
plt.xlabel('Property Type')
plt.show()
```



```
df_merge_col['property_size_description'] =
df_merge_col['property_size_description'].replace(['greater than or
equal to 38 sq metres and less than 125 sq metres', 'less than 38 sq
metres','greater than or equal to 125 sq metres'],['>=38 & <125
Sqm','<38 Sqm','>=125 Sqm'])

sns.countplot(x='property_size_description', data=df_merge_col)
plt.show()
```

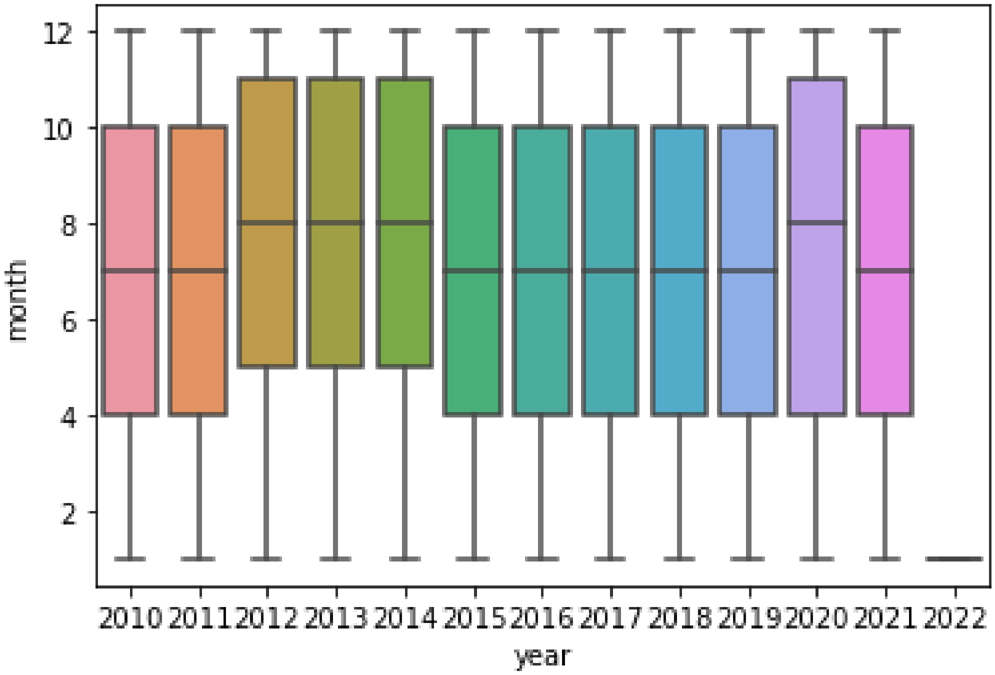


```
sns.countplot(x='province', data=df_merge_col, palette = 'mako')
#sns.color_palette("light:#5A9", as_cmap=True)
plt.show()
```

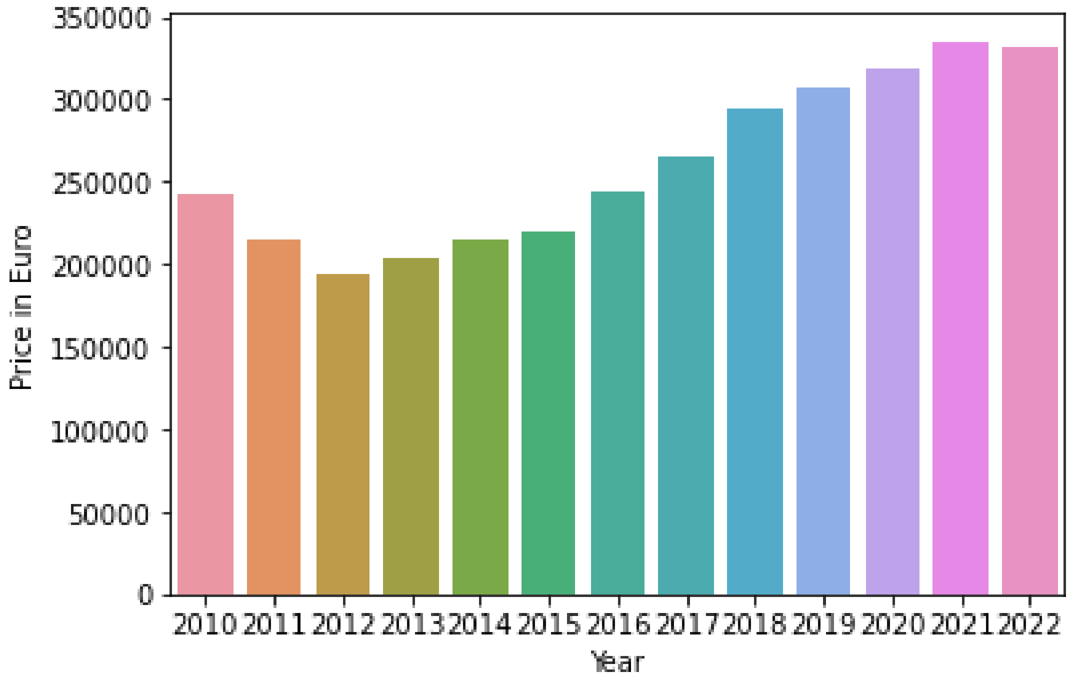


Bivariate Plots

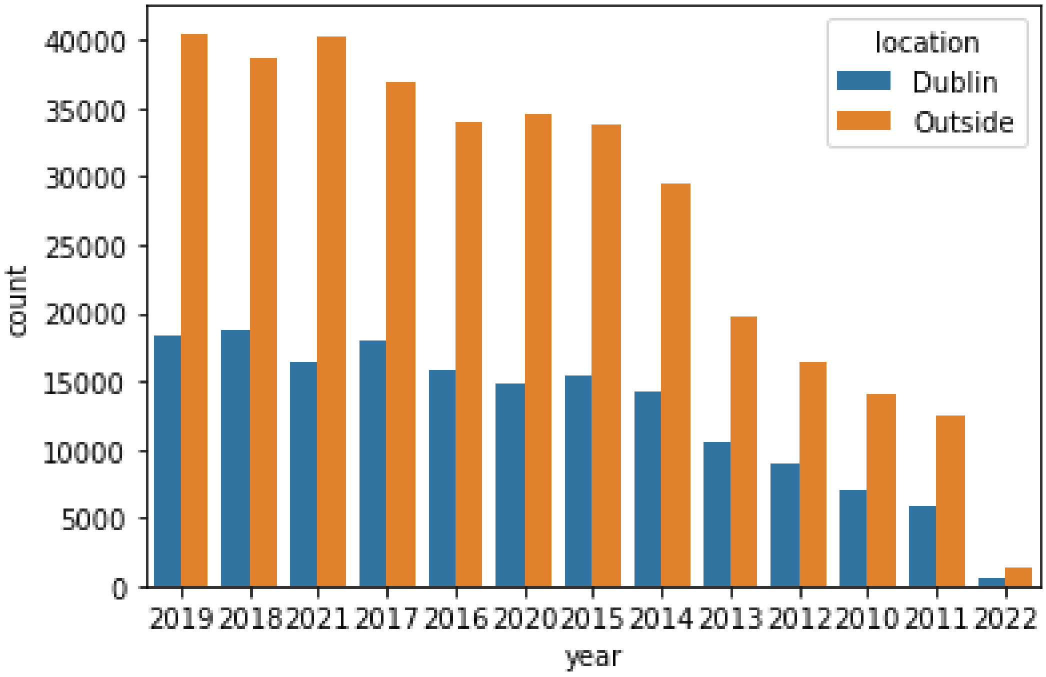
```
sns.boxplot(x='year', y='month', data=df_merge_col)
plt.show()
```



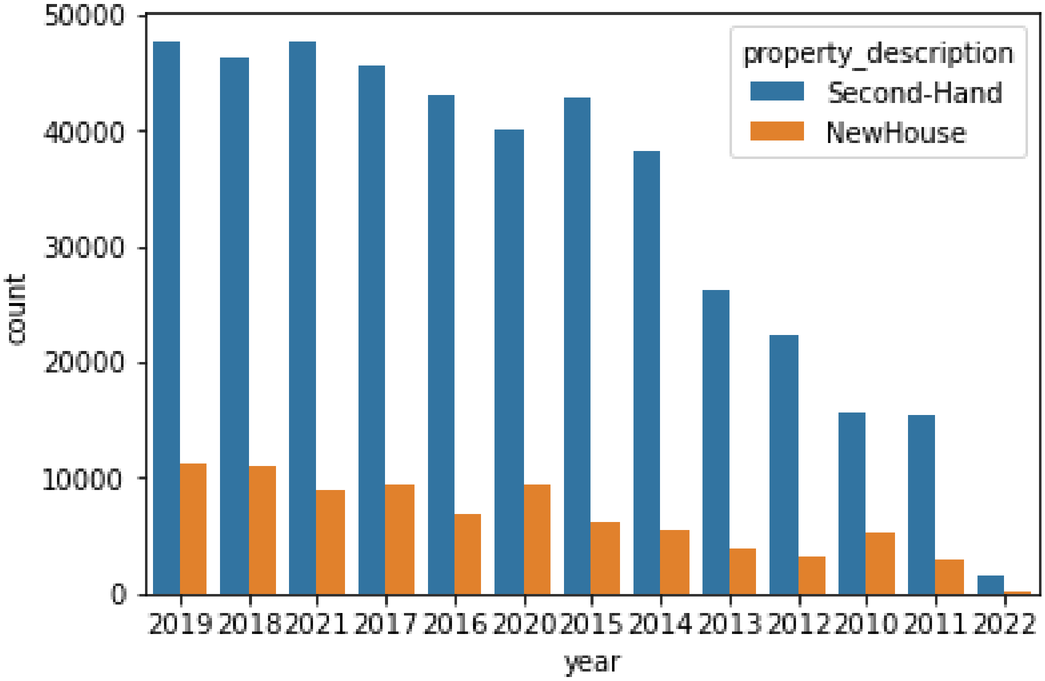
```
sns.barplot(x='year', y='price', data=df_merge_col, ci=None)
plt.xlabel('Year')
plt.ylabel('Price in Euro')
plt.show()
```



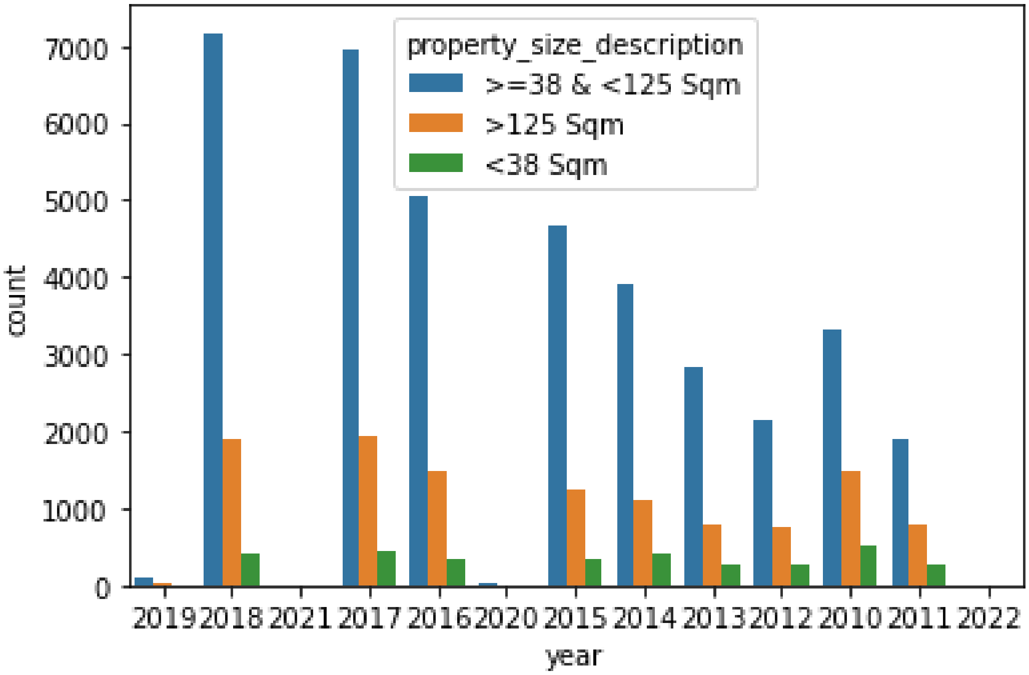
```
sns.countplot(x='year',hue='location', data=df_merge_col, order =
df_merge_col['year'].value_counts().index)
plt.show()
```



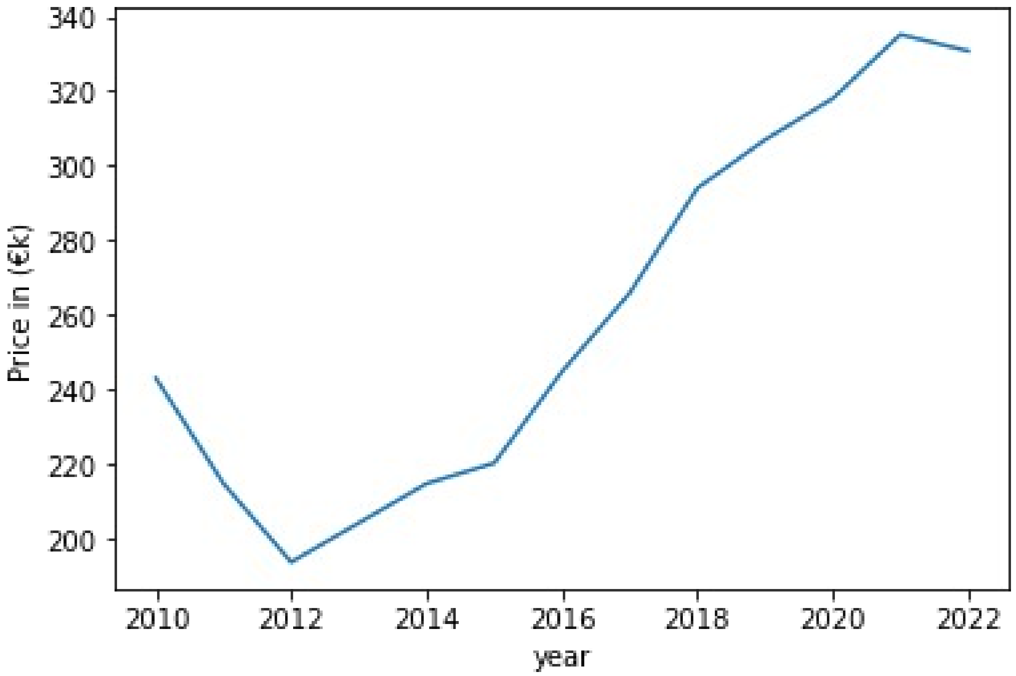
```
sns.countplot(x='year',hue='property_description', data=df_merge_col,
order = df_merge_col['year'].value_counts().index)
plt.show()
```



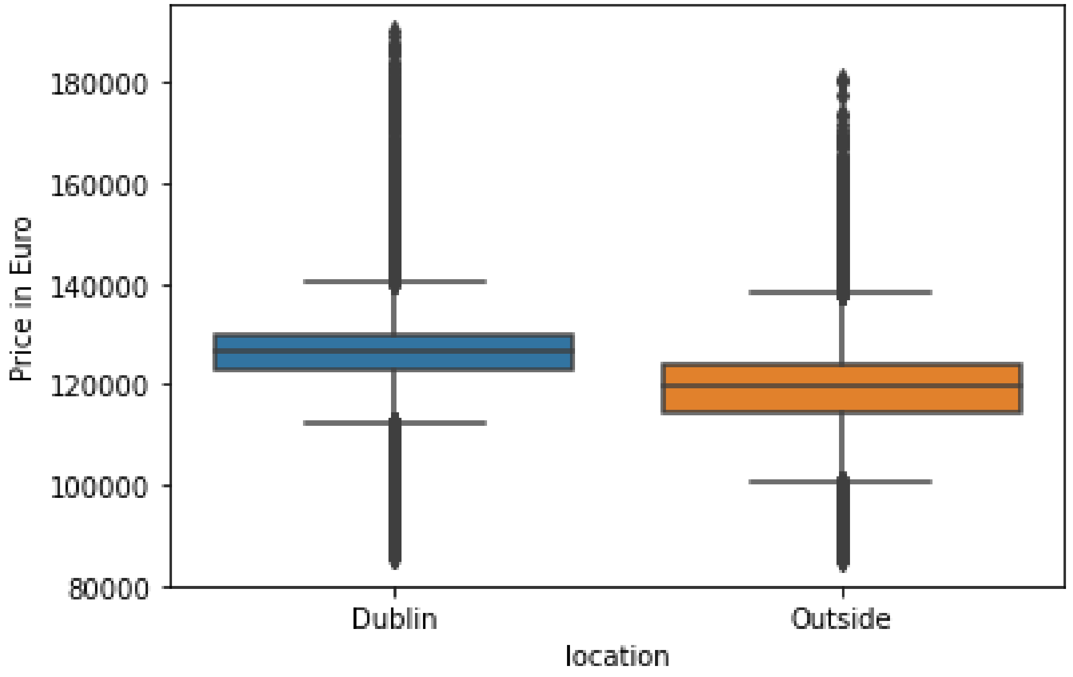
```
sns.countplot(x='year',hue='property_size_description',
data=df_merge_col, order = df_merge_col['year'].value_counts().index)
plt.show()
```



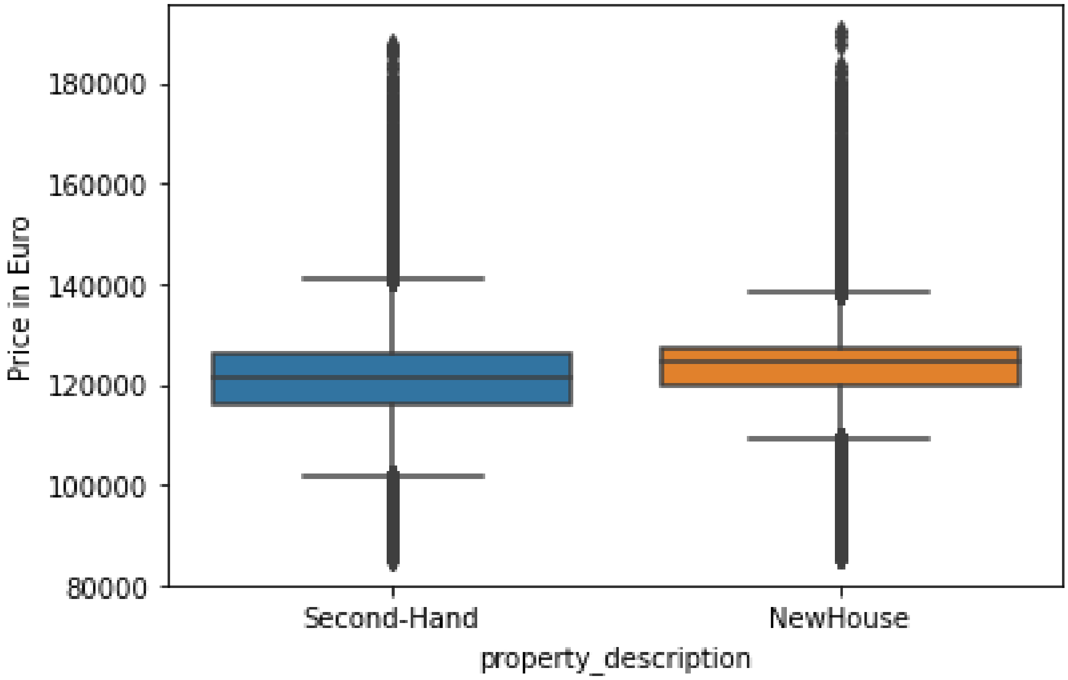
```
sns.lineplot(x='year', y=(df_merge_col['price'])/10**3,
data=df_merge_col, ci=None)
plt.ylabel('Price in (€k)')
plt.show()
```



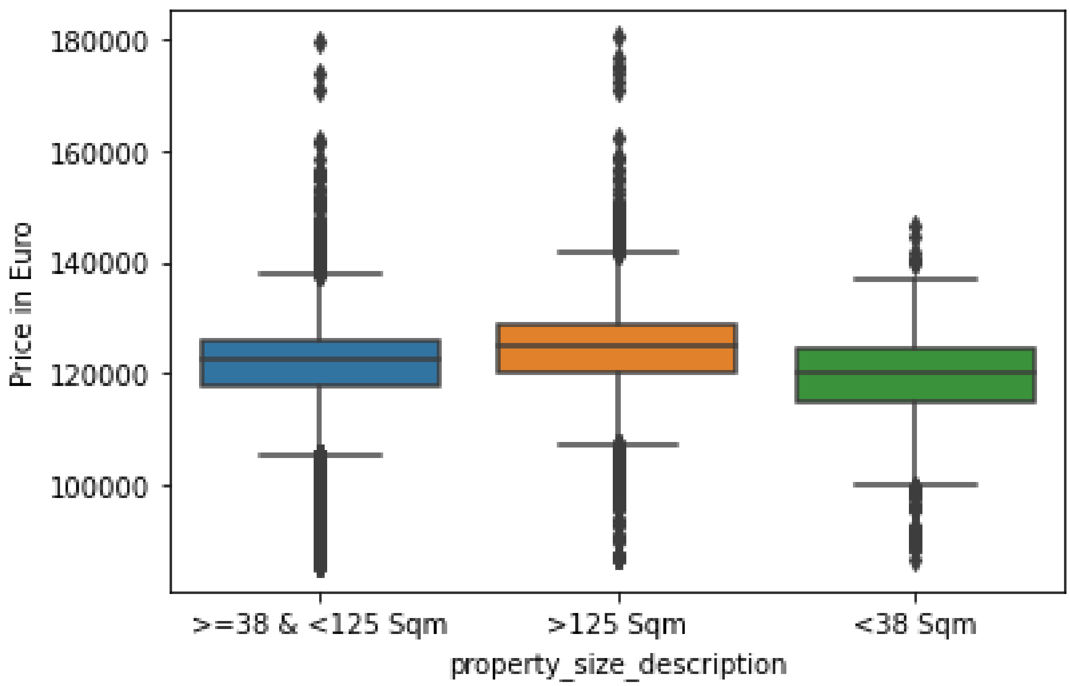
```
#  bivariate with Price
#sns.boxplot(x='location', y=np.log(df_merge_col['price']),
data=df_merge_col)
sns.boxplot(x='location', y=np.log(df_merge_col['price'])*10**4,
data=df_merge_col)
plt.ylabel('Price in Euro')
plt.show()
```



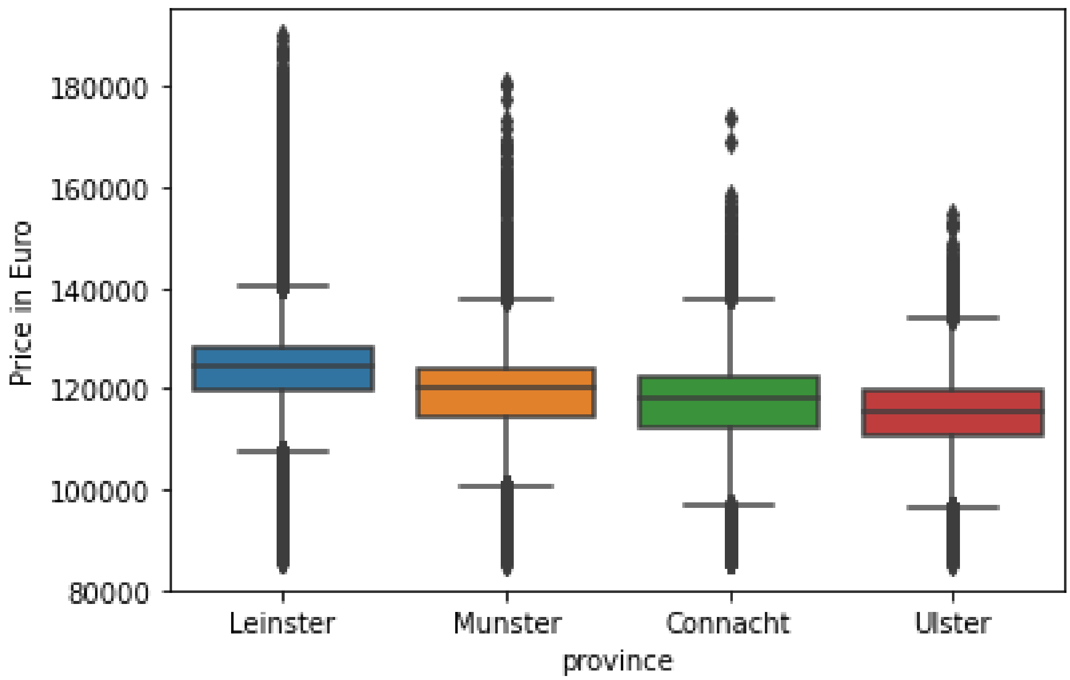
```
sns.boxplot(x='property_description',
y=np.log(df_merge_col['price'])*10**4, data=df_merge_col)
plt.ylabel('Price in Euro')
plt.show()
```



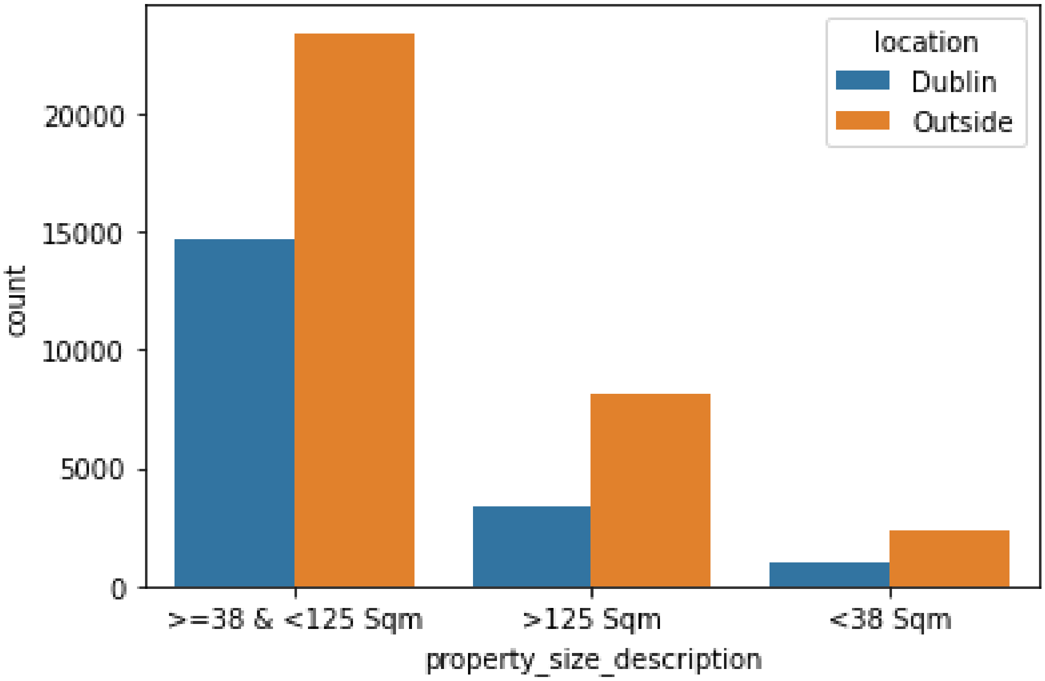
```
sns.boxplot(x='property_size_description',
y=np.log(df_merge_col['price'])*10**4, data=df_merge_col)
plt.ylabel('Price in Euro')
plt.show()
```



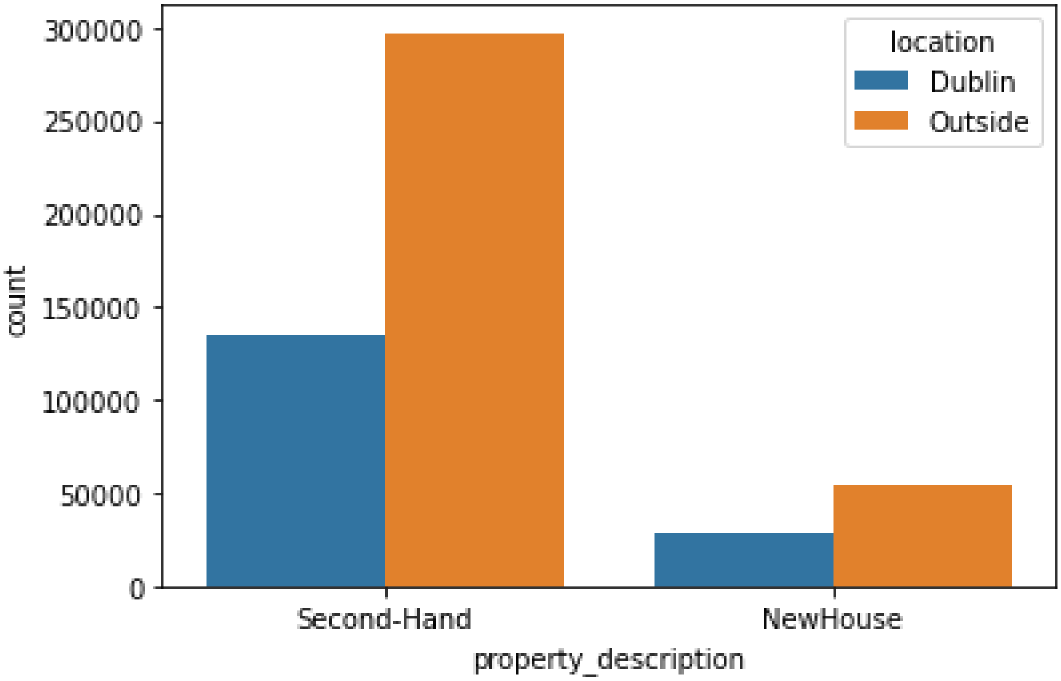
```
sns.boxplot(x='province', y=np.log(df_merge_col['price'])*10**4,
data=df_merge_col)
plt.ylabel('Price in Euro')
plt.show()
```



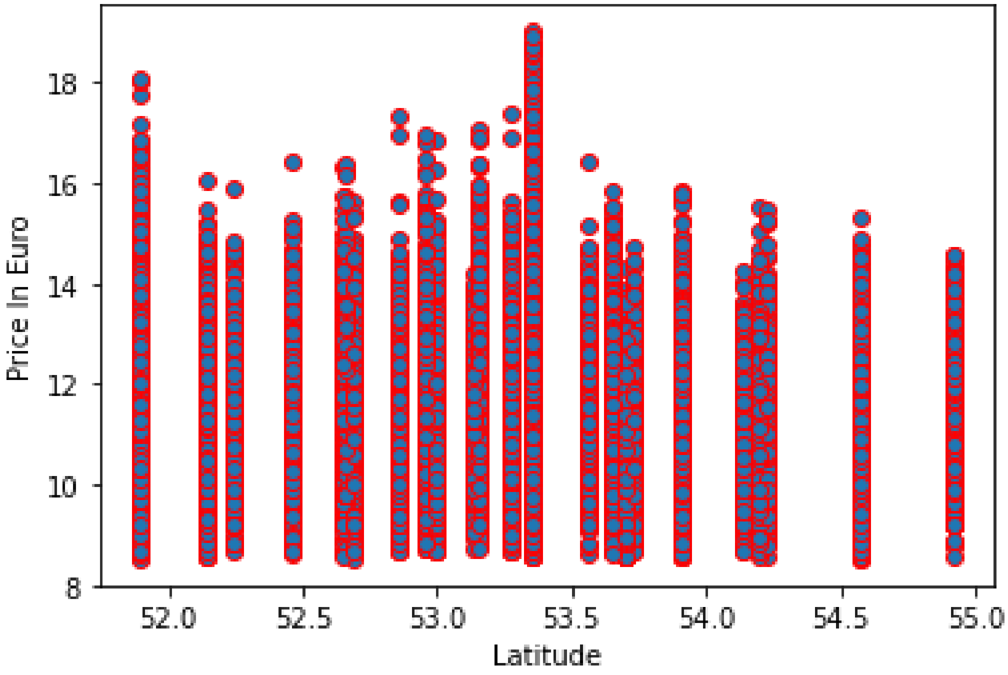
```
# with location
sns.countplot(x='property_size_description',hue='location',
data=df_merge_col, order =
df_merge_col['property_size_description'].value_counts().index)
plt.show()
```



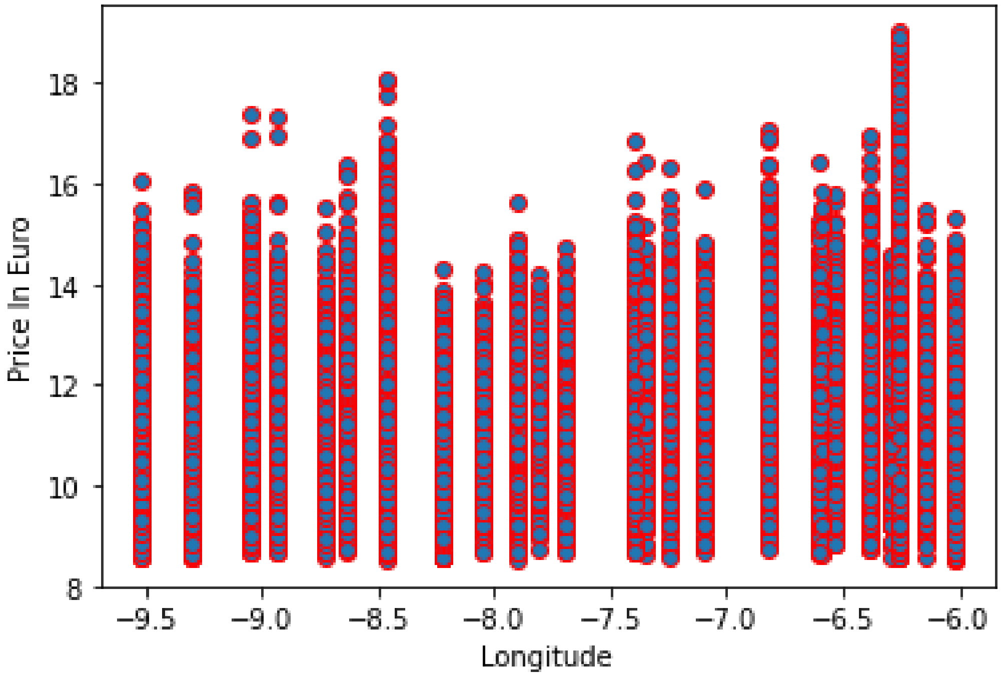
```
sns.countplot(x='property_description',hue='location',
data=df_merge_col, order =
df_merge_col['property_description'].value_counts().index)
plt.show()
```



```
# geogrpahy and price
plt.scatter(df_merge_col['lat'],np.log(df_merge_col['price']) ,edgecol
ors='r')
plt.xlabel('Latitude')
plt.ylabel('Price In Euro')
plt.show()
```



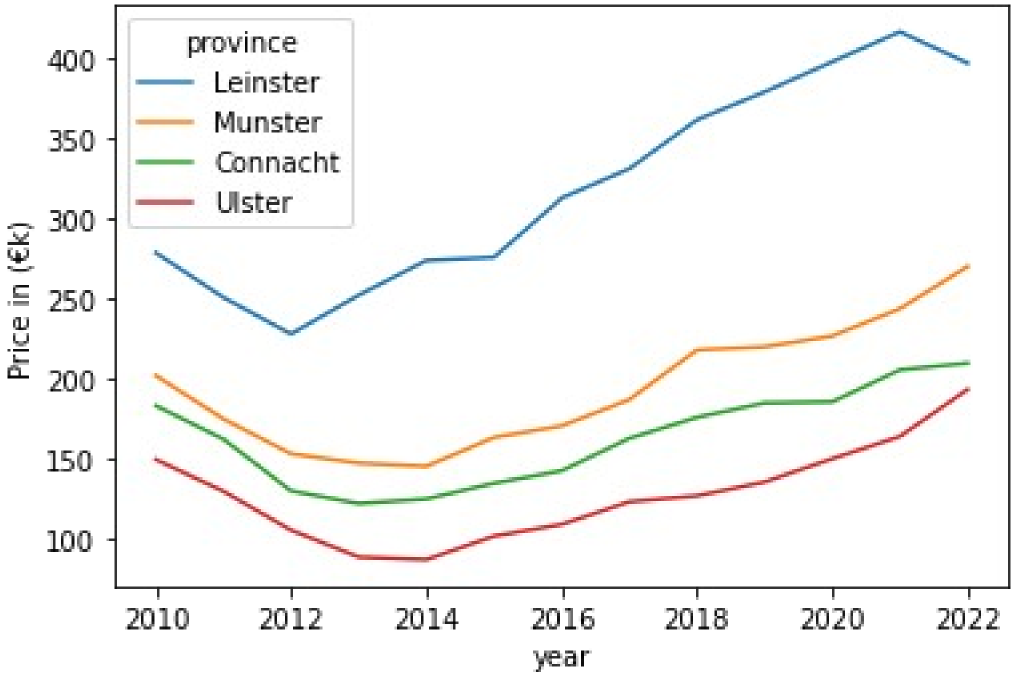
```
plt.scatter(df_merge_col['lon'],np.log(df_merge_col['price']) ,edgecol
ors='r')
plt.xlabel('Longitude')
plt.ylabel('Price In Euro')
plt.show()
```



Multivariate

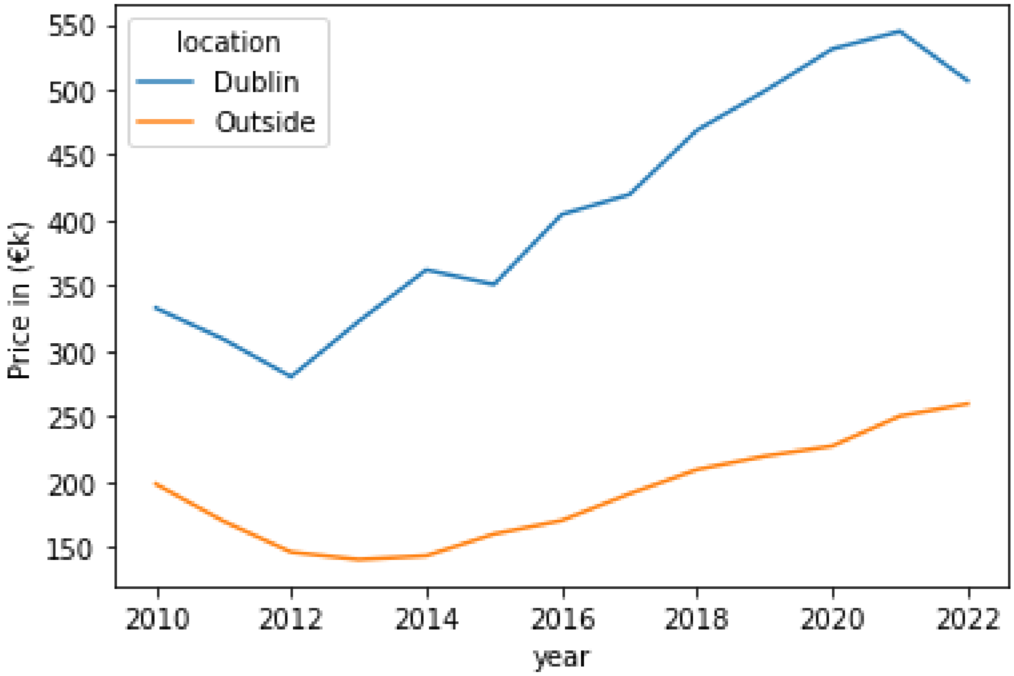
```
#multivariate
#sns.pairplot(df_merge_col)
#plt.show()

#p1 = sns.lineplot(data=df_merge_col, x="year",
y=np.log(df_merge_col['price']),hue='province', ci=None)
#p1.set_ylabel("price(log scale)")
#p1.set_yscale('log')
p1 = sns.lineplot(data=df_merge_col, x="year",
y=df_merge_col["price"]/10**3,hue='province', ci=None)
p1.set_ylabel('Price in (€k)')
```

```
Text(0, 0.5, 'Price in (€k)')
```



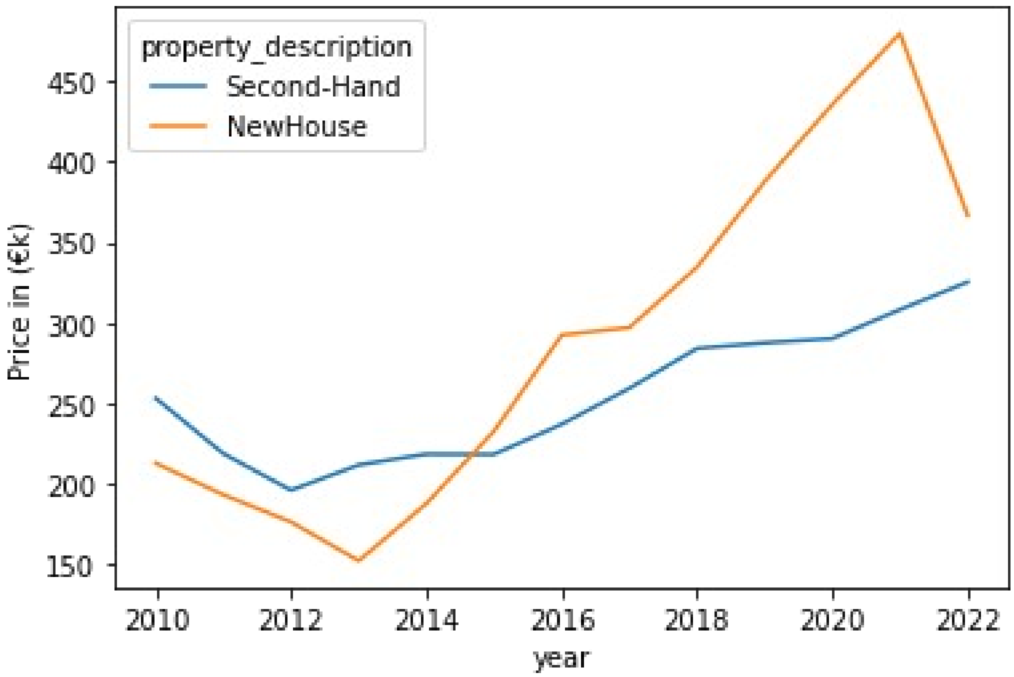
```
p1 = sns.lineplot(data=df_merge_col, x="year",
y=df_merge_col["price"]/10**3,hue='location', ci=None)
p1.set_ylabel('Price in (€k)')
```

```
Text(0, 0.5, 'Price in (€k)')
```

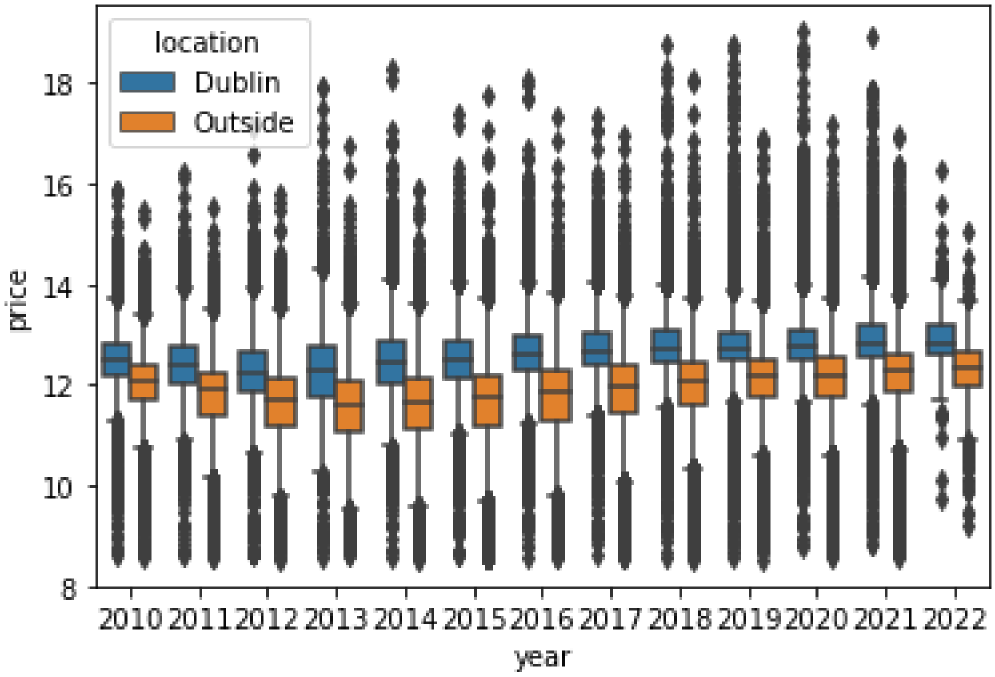


```
p1 = sns.lineplot(data=df_merge_col, x="year",
y=df_merge_col["price"]/10**3,hue='property_description',ci=None)
p1.set_ylabel('Price in (€k)')
```

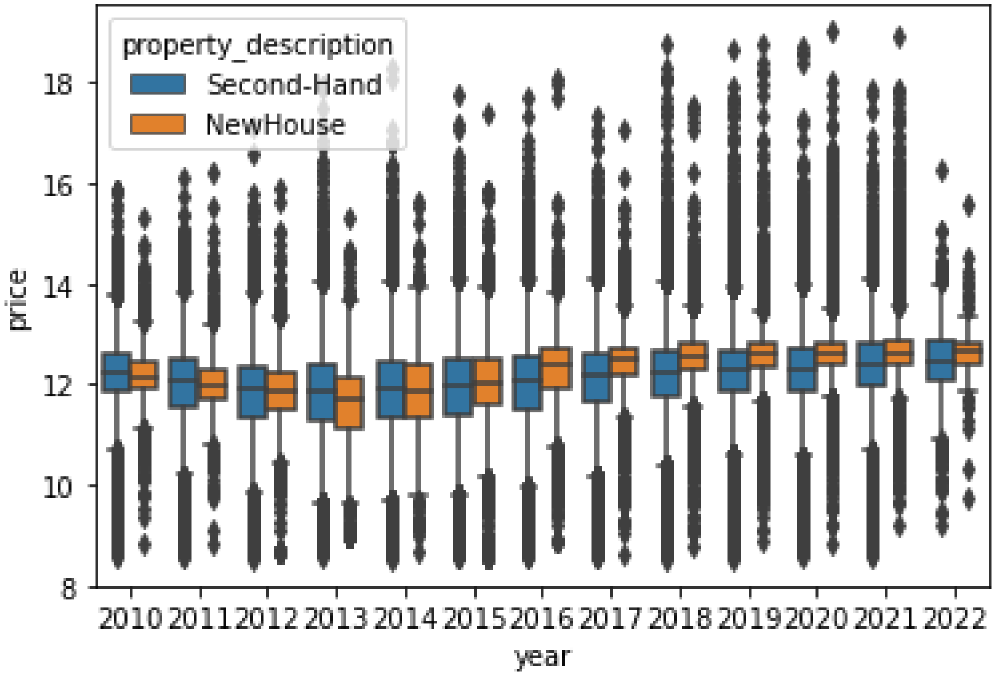
```
Text(0, 0.5, 'Price in (€k)')
```



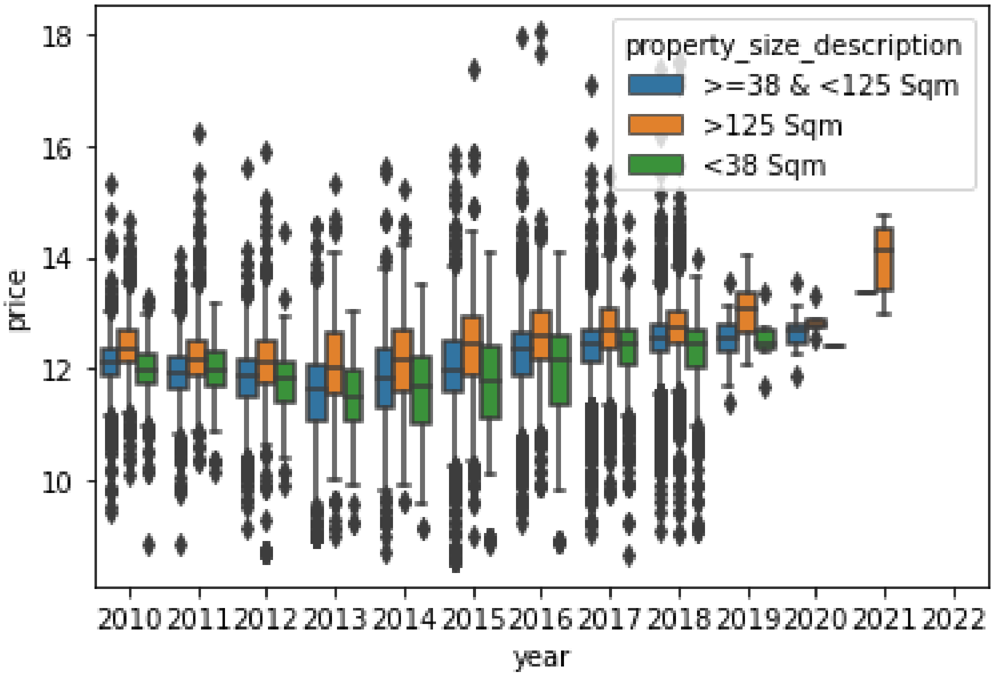
```
sns.boxplot(x='year', y=np.log(df_merge_col['price']), hue='location',
data=df_merge_col)
plt.show()
```



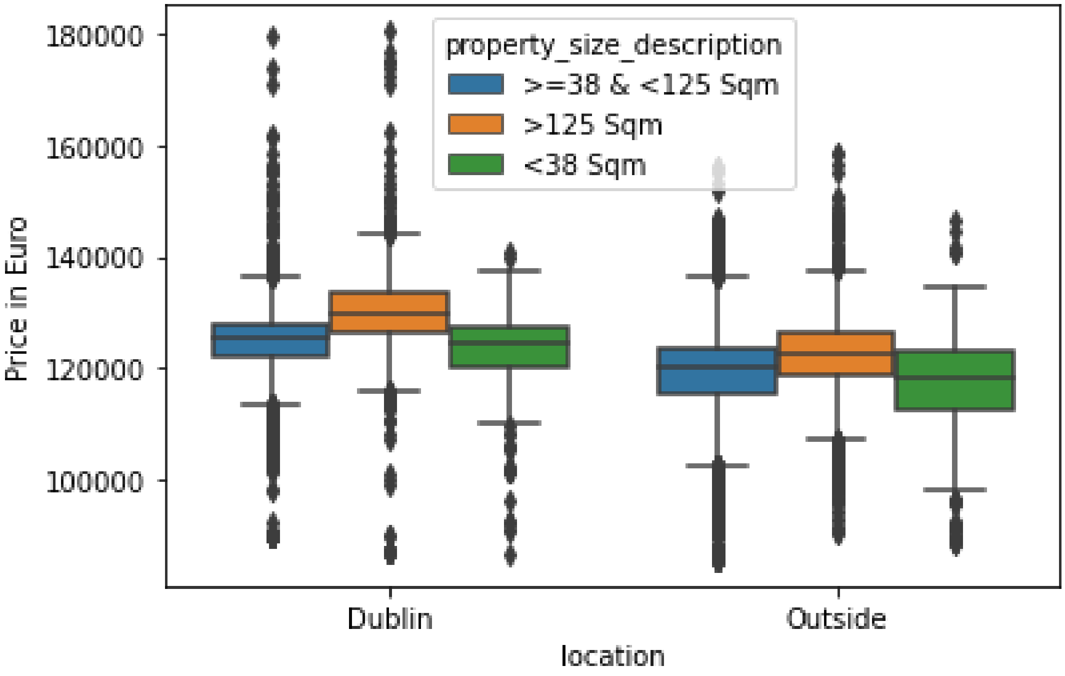
```
sns.boxplot(x='year', y=np.log(df_merge_col['price']),
hue='property_description', data=df_merge_col)
plt.show()
```



```
sns.boxplot(x='year', y=np.log(df_merge_col['price']),
hue='property_size_description', data=df_merge_col)
plt.show()
```

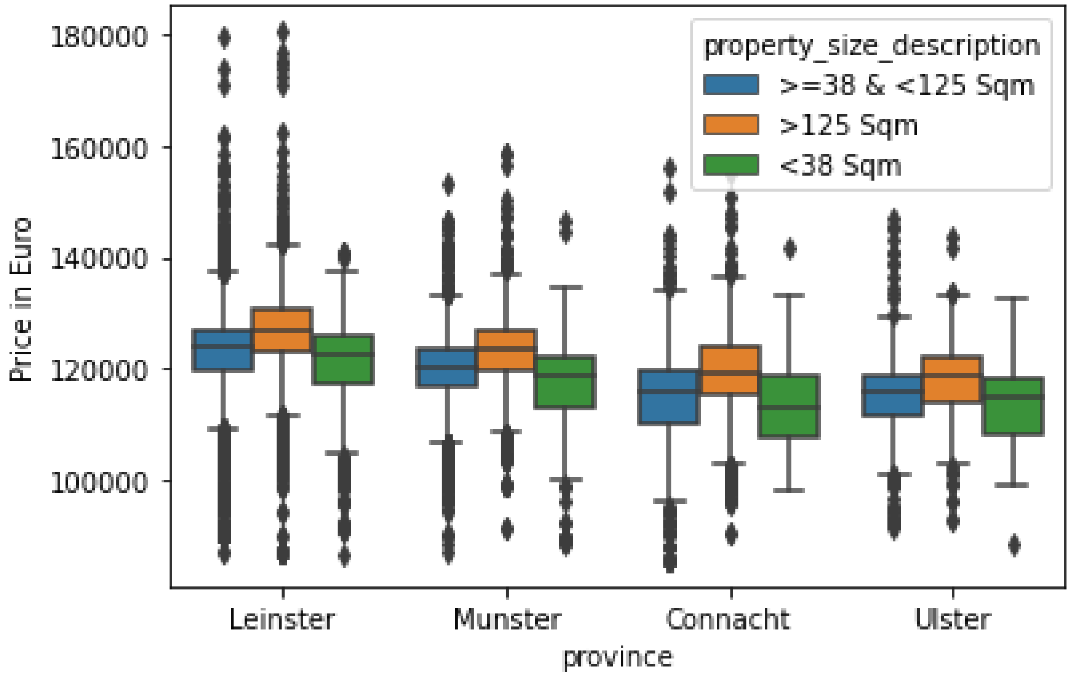


```
p1=sns.boxplot(x='location', y=np.log(df_merge_col['price'])*10**4,
hue='property_size_description', data=df_merge_col)
p1.set_ylabel('Price in Euro')
plt.show()
```

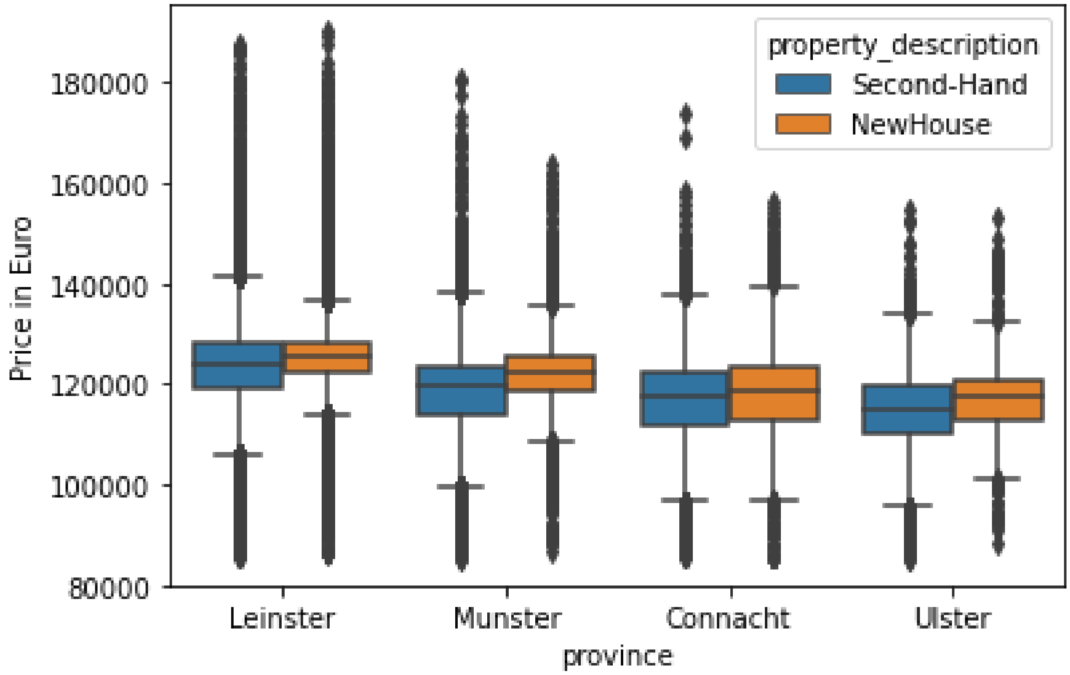


```
p1 =sns.boxplot(x='province', y=np.log(df_merge_col['price'])*10**4,
hue='property_size_description', data=df_merge_col)
```

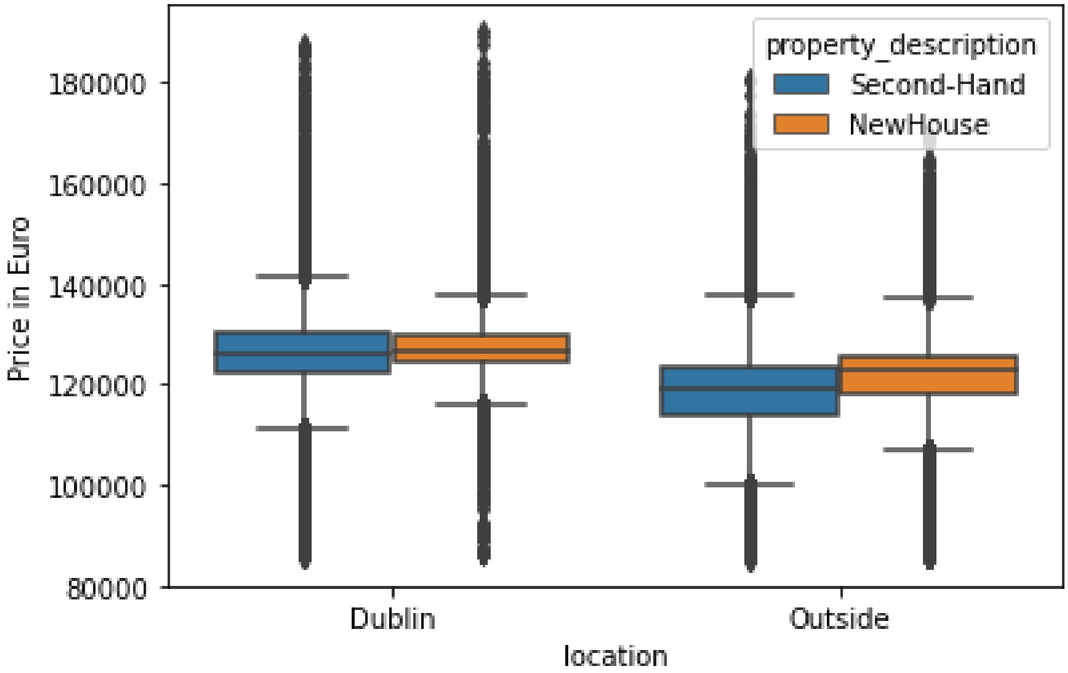
```
p1.set_ylabel('Price in Euro')
plt.show()
```



```
p1=sns.boxplot(x='province', y=np.log(df_merge_col['price'])*10**4,
hue='property_description', data=df_merge_col)
p1.set_ylabel('Price in Euro')
plt.show()
```



```
p1 =sns.boxplot(x='location', y=np.log(df_merge_col['price'])*10**4,
hue='property_description', data=df_merge_col)
p1.set_ylabel('Price in Euro')
plt.show()
```



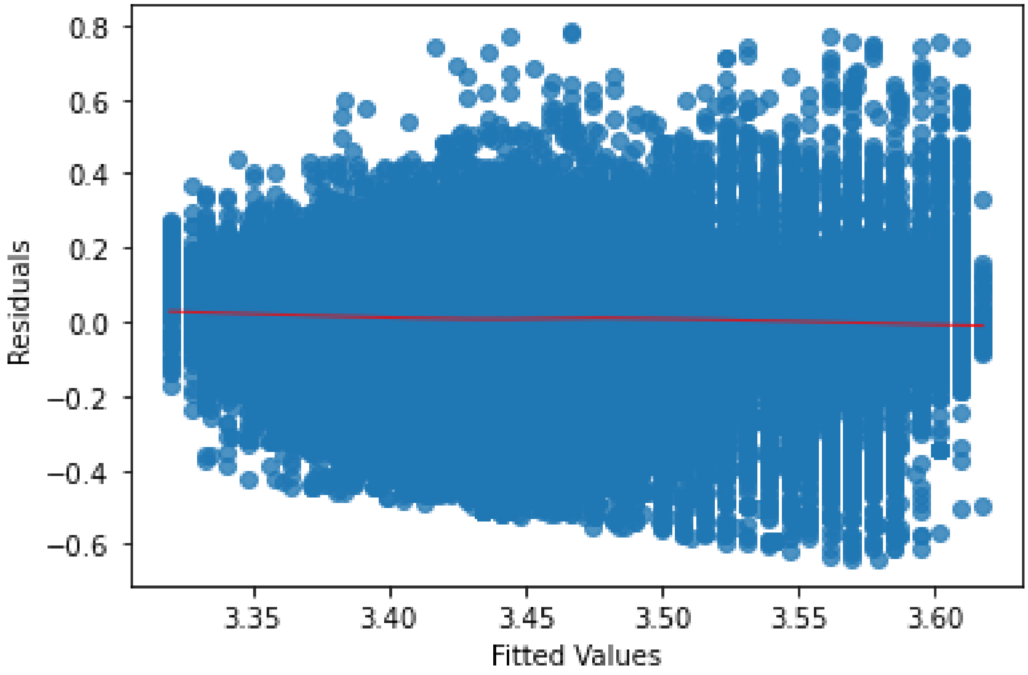
```
#df_merge_col.to_csv("PRP.csv", index=False)
```

Initail Analyses

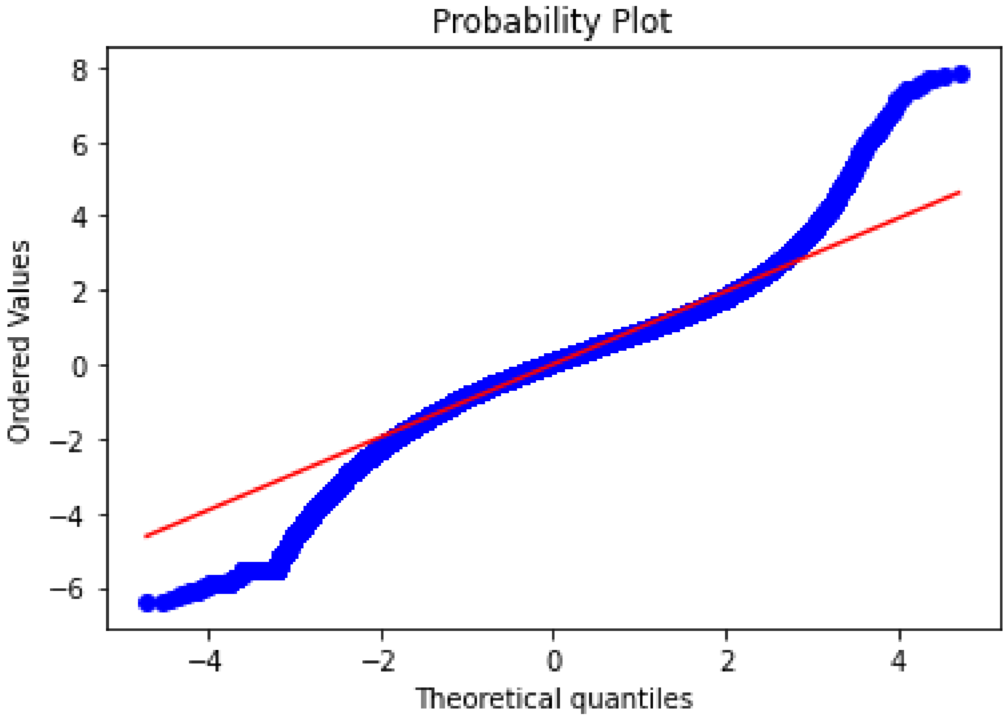
MLR

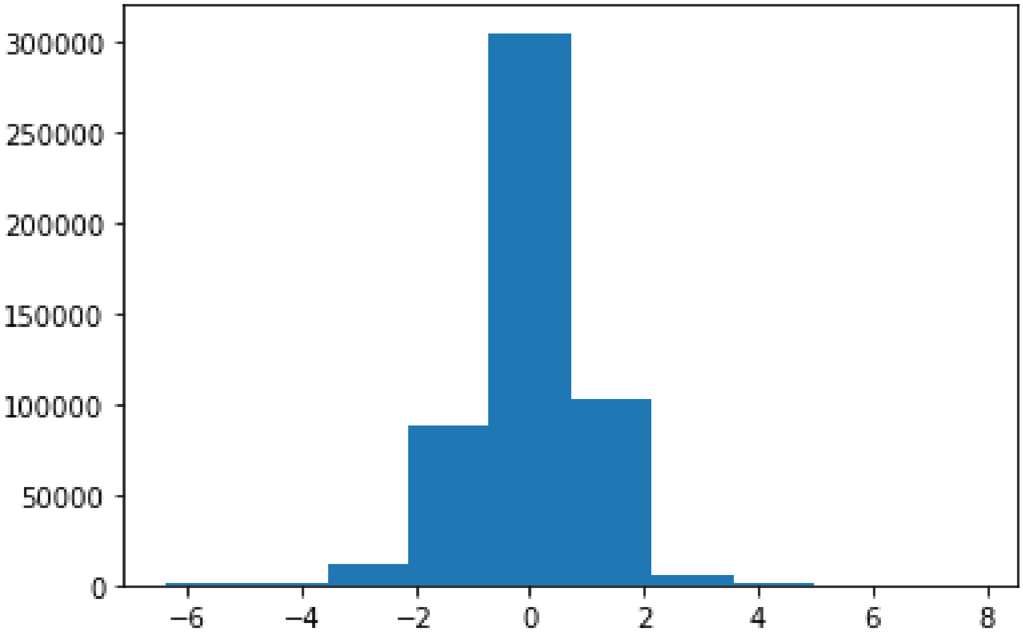
```
rppr1 = df_merge_col.copy()
rppr1.drop(columns
=['month_year','date_of_sale','address','VAT_exclusive','FMP','postal_
code','county'], inplace=True)

#pd.get_dummies(rppr1["location"])
rppr1["location_Dublin"]=pd.get_dummies(rppr1["location"])["Dublin"]

#pd.get_dummies(rppr1["property_description"])
rppr1["property_new"]=pd.get_dummies(rppr1["property_description"])
["NewHouse"]

#pd.get_dummies(rppr1["province"])
#rppr1["provinces_Leinster"]=pd.get_dummies(rppr["province"])
["Leinster"]
rppr1["provinces_connacht"]=pd.get_dummies(rppr1["province"])
["Connacht"]
rppr1["provinces_Ulster"]=pd.get_dummies(rppr1["province"])["Ulster"]
rppr1["provinces_munster"]=pd.get_dummies(rppr1["province"])
["Munster"]
```

```
from numpy import sqrt
log_price = np.log(rppr1['price'])
transform  = sqrt(log_price)

X = rppr1[["location_Dublin","property_new","provinces_connacht",
"provinces_Ulster", "provinces_munster","year", "lat","lon"]]
X = sm.add_constant(X)
y = transform
#X.head(20)

model_full_mlr = sm.OLS(y, X).fit()


#fitted values
model_fitted_vals = model_full_mlr.fittedvalues
#model residuals
model_residuals = model_full_mlr.resid
#standardised residuals
model_norm_residuals =
model_full_mlr.get_influence().resid_studentized_internal

sns.regplot(x=model_fitted_vals,y=model_residuals,
 ci=False,lowess=True,
 line_kws={'color': 'red', 'lw': 1, 'alpha': 0.8})
plt.xlabel("Fitted Values")
plt.ylabel("Residuals")
plt.show()
```



```
stats.probplot(model_norm_residuals, plot=sns.mpl.pyplot)
plt.show()
plt.hist(model_norm_residuals)
plt.show()
```





```
from statsmodels.formula.api import ols
model_full_mlr1 = ols('log_price ~ C(year)+C(province)
+C(property_description)+lat+lon', data=rppr1).fit()
model_full_mlr1.summary()
```

```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results                            

======================================================================
========
Dep. Variable:              log_price   R-squared:                       
0.228
Model:                            OLS   Adj. R-squared:                  
0.228
Method:                 Least Squares   F-statistic:                     
8472.
Date:                Mon, 05 Sep 2022   Prob (F-statistic):              
0.00
Time:                        15:14:06   Log-Likelihood:            -
5.5626e+05
No. Observations:              516586   AIC:                             
1.113e+06
Df Residuals:                  516567   BIC:                             
1.113e+06
Df Model:                          18                                         

Covariance Type:            nonrobust                                         

======================================================================
====================================
                                             coef    std err          
t      P>|t|      [0.025      0.975]
----------------------------------------------------------------------
------------------------------------
Intercept                                 21.1564      0.164    
128.865      0.000      20.835      21.478
C(year)[T.2011]                           -0.1552      0.007    -
21.638      0.000      -0.169      -0.141
C(year)[T.2012]                           -0.3209      0.007    -
48.358      0.000      -0.334      -0.308
C(year)[T.2013]                           -0.3800      0.006    -
59.456      0.000      -0.393      -0.368
C(year)[T.2014]                           -0.2768      0.006    -
46.307      0.000      -0.288      -0.265
C(year)[T.2015]                           -0.2015      0.006    -
34.342      0.000      -0.213      -0.190
C(year)[T.2016]                           -0.1019      0.006    -
17.407      0.000      -0.113      -0.090
C(year)[T.2017]                            0.0032      0.006      
0.560      0.576      -0.008       0.015
C(year)[T.2018]                            0.0755      0.006     
13.171      0.000       0.064       0.087
C(year)[T.2019]                            0.1213      0.006     
21.244      0.000       0.110       0.133
```

```
C(year)[T.2020]                            0.1523      0.006     
26.007      0.000       0.141       0.164
C(year)[T.2021]                            0.2444      0.006     
42.535      0.000       0.233       0.256
C(year)[T.2022]                            0.3149      0.017     
18.347      0.000       0.281       0.349
C(province)[T.Leinster]                   -0.1093      0.006    -
17.434      0.000      -0.122      -0.097
C(province)[T.Munster]                    -0.1061      0.006    -
18.707      0.000      -0.117      -0.095
C(province)[T.Ulster]                     -0.9669      0.008   -
118.106      0.000      -0.983      -0.951
C(property_description)[T.Second-Hand]    -0.1311      0.003    -
48.631      0.000      -0.136      -0.126
lat                                       -0.1225      0.003    -
40.968      0.000      -0.128      -0.117
lon                                        0.3081      0.002     
141.366      0.000       0.304       0.312
======================================================================
========
Omnibus:                    34379.354   Durbin-Watson:                 
1.872
Prob(Omnibus):                  0.000   Jarque-Bera (JB):          
133193.650
Skew:                          -0.239   Prob(JB):                      
0.00
Kurtosis:                       5.441   Cond. No.                  
8.92e+03
======================================================================
========

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is
correctly specified.
[2] The condition number is large, 8.92e+03. This might indicate that
there are
strong multicollinearity or other numerical problems.
"""
```

```
#model_full_mlr.summary()
```

A random sample of 9423 obsevrations is seleceted from the whole data for statistical analyses.

```
# 9423 random sample
rppr_sub = df_merge_col.sample(n=9423, random_state=3)
rppr_sub
```

```
       date_of_sale                                            address  
\
91109    10/12/2013                 Tainchel, Ashtown Lower, Roundwood
```

```
423771   08/05/2020                  Greenogue, Kilsallaghan, Co Meath

442477   16/10/2020              6 The Gallops, Coolcots Lane, Wexford

343689   04/12/2018                            5 Eden Rd, Birr, Offaly

421939   16/04/2020  69 Castleland Park Way, Balbriggan, County Dublin

...             ...                                                ...

404354   11/12/2019   72 St Patricks Rd, Walkinstown Dublin 12, Dublin

218218   05/09/2016                 33 Drury Mills, Saggart, Co Dublin

463833   17/02/2021                     12 Grand Canal Wood, Allenwood

161348   02/07/2015               The Gables, Kilwogan Lane, Celbridge

499038   30/09/2021                      Ardnabourkey, Whitegate, Cork


       postal_code   county   price  FMP VAT_exclusive
property_description  \
91109          NaN  Wicklow  297500   No           No
Second-Hand
423771         NaN    Meath  315000   No           No
Second-Hand
442477         NaN  Wexford  131000   No           No
Second-Hand
343689         NaN   Offaly   80000   No           No
Second-Hand
421939         NaN   Dublin  268722   No          Yes
NewHouse
...            ...      ...     ...  ...           ...
...
404354   Dublin 12   Dublin   53750  Yes           No
Second-Hand
218218         NaN   Dublin  229075   No          Yes
NewHouse
463833         NaN  Kildare  267000   No          Yes
NewHouse
161348         NaN  Kildare  470000   No           No
Second-Hand
499038         NaN     Cork  350000   No           No
Second-Hand

       property_size_description  province        lat       lon
month_year  \
91109                        NaN  Leinster  52.958147 -6.381971
2013-10
423771                       NaN  Leinster  53.649784 -6.588529
2020-08
442477                       NaN  Leinster  52.460187 -6.606516
2020-10
343689                       NaN  Leinster  53.136172 -7.810341
2018-04
421939                       NaN  Leinster  53.349764 -6.260273
2020-04
...                          ...       ...        ...       ...
...
404354                       NaN  Leinster  53.349764 -6.260273
2019-11
218218           >=38 & <125 Sqm  Leinster  53.349764 -6.260273
2016-05
463833                       NaN  Leinster  53.154364 -6.818418
2021-02
161348                       NaN  Leinster  53.154364 -6.818418
2015-02
499038                       NaN   Munster  51.897077 -8.465467
2021-09

        year  month location
91109   2013     12  Outside
423771  2020      5  Outside
442477  2020     10  Outside
343689  2018     12  Outside
421939  2020      4   Dublin
...      ...    ...      ...
404354  2019     12   Dublin
218218  2016      9   Dublin
463833  2021      2  Outside
161348  2015      7  Outside
499038  2021      9  Outside

[9423 rows x 16 columns]
```

Dropping the address, latitude and longitude and date column since it is not using in following analysis.

ANOVA

A random sample of 9423 obsevrations is seleceted from the whole data for statistical analyses.

```
rppr = rppr_sub.copy()
rppr.drop(columns =['month_year',
'lat','lon','date_of_sale','address','VAT_exclusive','FMP','postal_cod
e','county'], inplace=True)
```

```
rppr
```

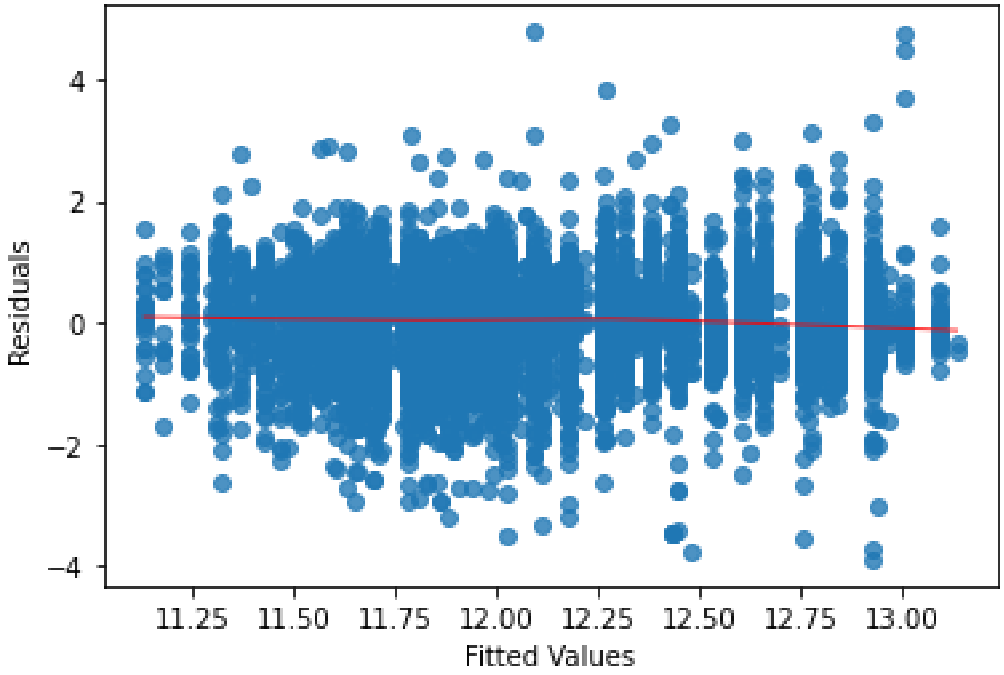
```
         price property_description property_size_description
province  year  \
91109   297500          Second-Hand                       NaN
Leinster  2013
423771  315000          Second-Hand                       NaN
Leinster  2020
442477  131000          Second-Hand                       NaN
Leinster  2020
343689   80000          Second-Hand                       NaN
Leinster  2018
421939  268722             NewHouse                       NaN
Leinster  2020
...        ...                  ...                       ...        ..
.   ...
404354   53750          Second-Hand                       NaN
Leinster  2019
218218  229075             NewHouse           >=38 & <125 Sqm
Leinster  2016
463833  267000             NewHouse                       NaN
Leinster  2021
161348  470000          Second-Hand                       NaN
Leinster  2015
499038  350000          Second-Hand                       NaN
Munster  2021

        month location
91109      12  Outside
423771      5  Outside
442477     10  Outside
343689     12  Outside
421939      4   Dublin
...       ...      ...
404354     12   Dublin
218218      9   Dublin
463833      2  Outside
161348      7  Outside
499038      9  Outside

[9423 rows x 7 columns]
```

```
pd.get_dummies(rppr["location"])
rppr["location_Dublin"]=pd.get_dummies(rppr["location"])["Dublin"]
```

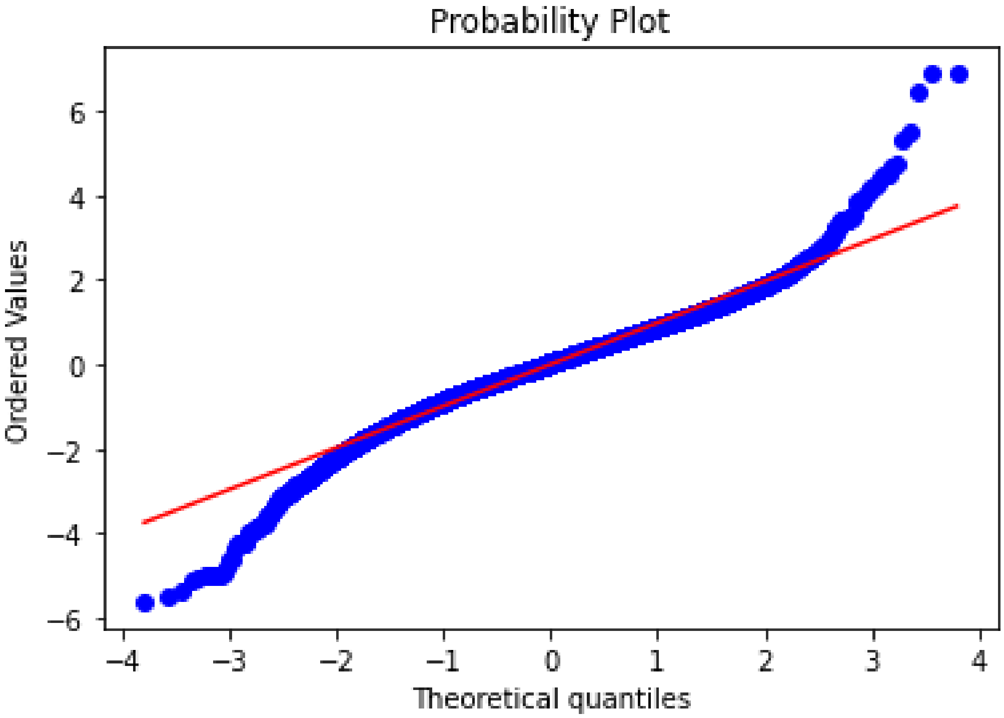
```
pd.get_dummies(rppr["property_description"])
rppr["property_new"]=pd.get_dummies(rppr["property_description"])
["NewHouse"]
```

```
#rpp = rppr[['price','year']]
from numpy import sqrt
```

```
log_price = np.log(rppr['price'])
transform = series = sqrt(log_price)

log_price = np.log(rppr['price'])

d1= pd.crosstab(index=rppr['location'], columns=rppr["year"],
margins=True)
d1

year      2010  2011  2012  2013  2014  2015  2016  2017  2018  2019
2020  \
location

Dublin     121   100   165   195   222   271   268   326   369   328
277
Outside    243   197   314   374   489   645   577   753   753   764
611
All        364   297   479   569   711   916   845  1079  1122  1092
888

year      2021  2022   All
location
Dublin     290    15  2947
Outside    729    27  6476
All       1019    42  9423

## property_size_description variable has lots of NaN values and hence
it is not considered.


#perform two-way ANOVA without interaction
model2t = ols('log_price~ C(year) + C(location) +
C(property_description) + C(province)', data=rppr_sub).fit()
#fitted values
model_fitted_vals2 = model2t.fittedvalues
#model residuals
model_residuals2 = model2t.resid
#standardised residuals
model_norm_residuals2t =
model2t.get_influence().resid_studentized_internal


sns.regplot(x=model_fitted_vals2,y=model_residuals2,
ci=False,lowess=True,
line_kws={'color': 'red', 'lw': 1, 'alpha': 0.8})
plt.xlabel("Fitted Values")
plt.ylabel("Residuals")
plt.show()
```



```
stats.probplot(model_norm_residuals2t, plot=sns.mpl.pyplot)
plt.show()
```



```
sm.stats.anova_lm(model2t, typ=2)
```

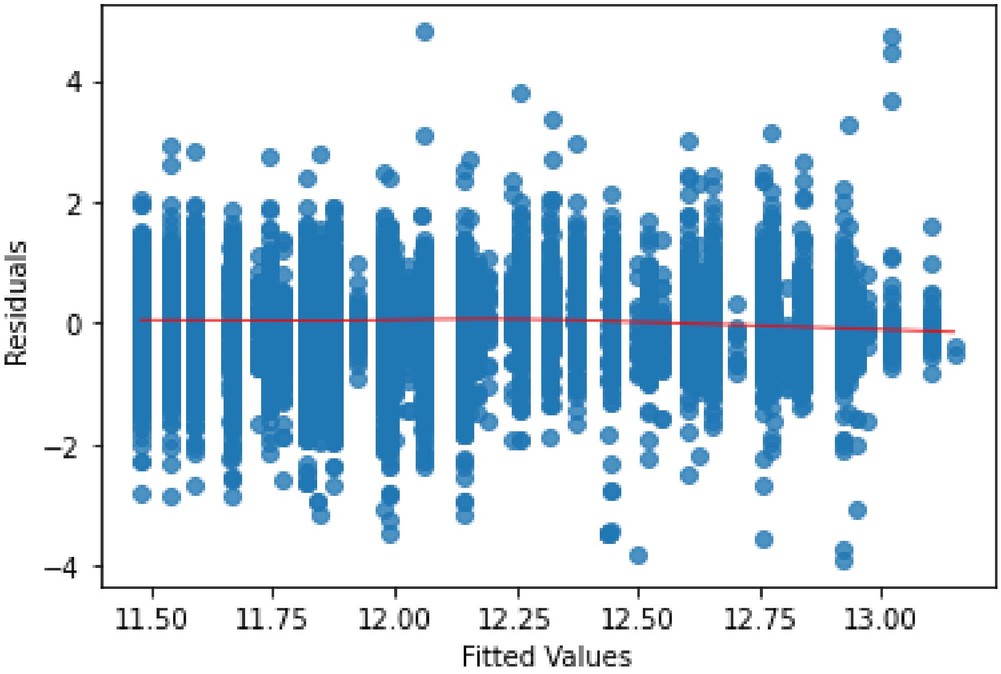
```
                              sum_sq      df           F    
PR(>F)
C(year)                   374.184533    12.0   64.743305  4.008145e-
152
C(location)               592.285002     1.0  1229.761838  2.604806e-
253
C(property_description)    35.376031     1.0   73.451281   1.194297e-
17
C(province)               131.985320     3.0   91.347076   2.880052e-
58
Residual                 4529.690442  9405.0         NaN            
NaN
```

```
model2t.summary()
```

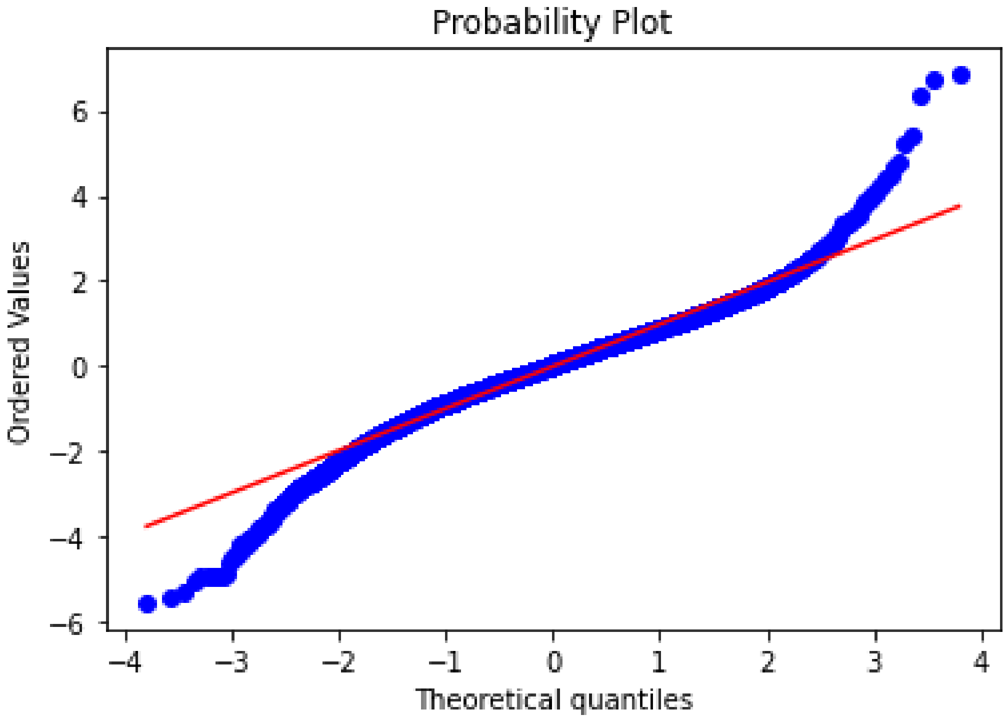
```
<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results                            
                                                                              
======================================================================
========
Dep. Variable:              log_price   R-squared:                       
0.282
Model:                            OLS   Adj. R-squared:                  
0.281
Method:                 Least Squares   F-statistic:                     
217.6
Date:                Mon, 05 Sep 2022   Prob (F-statistic):              
0.00
Time:                        12:22:54   Log-Likelihood:                  
-9919.5
No. Observations:                9423   AIC:                         
1.987e+04
Df Residuals:                    9405   BIC:                         
2.000e+04
Df Model:                          17                                     
                                                                              
Covariance Type:            nonrobust                                     
                                                                              
======================================================================
====================================
                                             coef    std err          
t      P>|t|      [0.025      0.975]
----------------------------------------------------------------------
------------------------------------
Intercept                                 12.5072      0.048    
261.978      0.000      12.414      12.601
C(year)[T.2011]                           -0.0936      0.054     -
1.723      0.085      -0.200       0.013
```

```
C(year)[T.2012]                           -0.3105      0.048     -
6.424      0.000      -0.405      -0.216
C(year)[T.2013]                           -0.3587      0.047     -
7.686      0.000      -0.450      -0.267
C(year)[T.2014]                           -0.2492      0.045     -
5.561      0.000      -0.337      -0.161
C(year)[T.2015]                           -0.1809      0.043     -
4.200      0.000      -0.265      -0.096
C(year)[T.2016]                           -0.0222      0.044     -
0.509      0.611      -0.108       0.063
C(year)[T.2017]                            0.0294      0.042
0.699      0.485      -0.053       0.112
C(year)[T.2018]                            0.1305      0.042
3.116      0.002       0.048       0.213
C(year)[T.2019]                            0.1475      0.042
3.509      0.000       0.065       0.230
C(year)[T.2020]                            0.2143      0.043
4.956      0.000       0.130       0.299
C(year)[T.2021]                            0.2978      0.042
7.012      0.000       0.215       0.381
C(year)[T.2022]                            0.3406      0.113
3.011      0.003       0.119       0.562
C(location)[T.Outside]                    -0.6631      0.019    -
35.068      0.000      -0.700      -0.626
C(property_description)[T.Second-Hand]    -0.1662      0.019     -
8.570      0.000      -0.204      -0.128
C(province)[T.Leinster]                    0.2848      0.025
11.415      0.000       0.236       0.334
C(province)[T.Munster]                     0.1999      0.025
7.949      0.000       0.151       0.249
C(province)[T.Ulster]                     -0.1873      0.037     -
5.046      0.000      -0.260      -0.115
======================================================================
========
Omnibus:                     746.293   Durbin-Watson:
1.968
Prob(Omnibus):                 0.000   Jarque-Bera (JB):
3395.607
Skew:                         -0.257   Prob(JB):
0.00
Kurtosis:                      5.896   Cond. No.
32.4
======================================================================
========

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

```
#perform two-way ANOVA without interaction
model3 = ols('log_price~ C(year) + C(location) +
C(property_description)',
 data=rppr_sub).fit()
#fitted values
model_fitted_vals3 = model3.fittedvalues
#model residuals
model_residuals3 = model3.resid
#standardised residuals
model_norm_residuals3 =
model3.get_influence().resid_studentized_internal

sns.regplot(x=model_fitted_vals3,y=model_residuals3,
ci=False,lowess=True,
line_kws={'color': 'red', 'lw': 1, 'alpha': 0.8})
plt.xlabel("Fitted Values")
plt.ylabel("Residuals")
plt.show()
```



```
stats.probplot(model_norm_residuals3, plot=sns.mpl.pyplot)
plt.show()
```



```
model3.summary()

<class 'statsmodels.iolib.summary.Summary'>
"""
                            OLS Regression Results                            
                                                                              
======================================================================
========
Dep. Variable:              log_price   R-squared:                       
0.261
Model:                            OLS   Adj. R-squared:                  
0.260
Method:                 Least Squares   F-statistic:                     
237.8
Date:                Mon, 05 Sep 2022   Prob (F-statistic):              
0.00
Time:                        12:22:55   Log-Likelihood:                  
-10055.
No. Observations:                9423   AIC:                             
2.014e+04
Df Residuals:                    9408   BIC:                             
2.025e+04
Df Model:                          14                                         

Covariance Type:            nonrobust                                         

======================================================================
====================================
                                             coef    std err
t      P>|t|      [0.025      0.975]
----------------------------------------------------------------------
------------------------------------
Intercept                                 12.8049      0.041
313.873      0.000      12.725      12.885
C(year)[T.2011]                           -0.1028      0.055     -
1.867      0.062      -0.211       0.005
C(year)[T.2012]                           -0.3060      0.049     -
6.242      0.000      -0.402      -0.210
C(year)[T.2013]                           -0.3663      0.047     -
7.738      0.000      -0.459      -0.273
C(year)[T.2014]                           -0.2551      0.045     -
5.612      0.000      -0.344      -0.166
C(year)[T.2015]                           -0.1826      0.044     -
4.179      0.000      -0.268      -0.097
C(year)[T.2016]                           -0.0244      0.044     -
0.552      0.581      -0.111       0.062
C(year)[T.2017]                            0.0271      0.043
0.635      0.526      -0.057       0.111
C(year)[T.2018]                            0.1294      0.042
3.047      0.002       0.046       0.213
C(year)[T.2019]                            0.1446      0.043
3.392      0.001       0.061       0.228
C(year)[T.2020]                            0.2137      0.044
4.872      0.000       0.128       0.300
C(year)[T.2021]                            0.2957      0.043
6.867      0.000       0.211       0.380
C(year)[T.2022]                            0.3439      0.115
2.997      0.003       0.119       0.569
C(location)[T.Outside]                    -0.7802      0.016    -
49.819      0.000      -0.811      -0.749
C(property_description)[T.Second-Hand]    -0.1791      0.020     -
9.127      0.000      -0.218      -0.141
======================================================================
========
Omnibus:                      725.608   Durbin-Watson:
1.971
Prob(Omnibus):                  0.000   Jarque-Bera (JB):
3022.455
Skew:                          -0.280   Prob(JB):
0.00
Kurtosis:                       5.717   Cond. No.
30.1
======================================================================
========

Notes:
[1] Standard Errors assume that the covariance matrix of the errors is
```

```
correctly specified.
"""
```