# Task 2 Exploratory Data Analysis & Data Cleaning

This notebook is for Historical pricing data: variable and fixed pricing data etc

## Data Dictionary

## Summary

### Import Libraries

In [1]:
```
import numpy as np
import pandas as pd
import matplotlib.pyplot as plt
import seaborn as sns
import statsmodels.api as sm
import datetime
from datetime import datetime, timedelta
import scipy.stats

%matplotlib inline
#sets the default autosave frequency in seconds
%autosave 60
sns.set_style('dark')
sns.set(font_scale=1.2)

import warnings
warnings.filterwarnings('ignore')

#import feature_engine.missing_data_imputers as mdi
#from feature_engine.outlier_removers import Winsorizer
#from feature_engine import categorical_encoders as ce

pd.set_option('display.max_columns',None)
#pd.set_option('display.max_rows',None)
pd.set_option('display.width', 1000)

np.random.seed(0)
np.set_printoptions(suppress=True)
```

```
Autosaving every 60 seconds
```

In [2]:
```
df = pd.read_csv("histdata.csv",parse_dates=['price_date'], dayfirst=True)
```

In [3]:
```
df
```

Out[3]:

| | id | price_date | price_p1_var | price_p2_var | price_p3_var | price_p1_fix | price_p2_fix | price_p3_fix |
|---|---|---|---|---|---|---|---|---|
| 0 | 038af19179925da21a25619c5a24b745 | 2015-01-01 | 0.151367 | 0.000000 | 0.000000 | 44.266931 | 0.00000 | 0.000000 |
| 1 | 038af19179925da21a25619c5a24b745 | 2015-02-01 | 0.151367 | 0.000000 | 0.000000 | 44.266931 | 0.00000 | 0.000000 |
| 2 | 038af19179925da21a25619c5a24b745 | 2015-03-01 | 0.151367 | 0.000000 | 0.000000 | 44.266931 | 0.00000 | 0.000000 |
| 3 | 038af19179925da21a25619c5a24b745 | 2015-04-01 | 0.149626 | 0.000000 | 0.000000 | 44.266931 | 0.00000 | 0.000000 |
| 4 | 038af19179925da21a25619c5a24b745 | 2015-05-01 | 0.149626 | 0.000000 | 0.000000 | 44.266931 | 0.00000 | 0.000000 |
| ... | ... | ... | ... | ... | ... | ... | ... | ... |
| 192997 | 16f51cdc2baa19af0b940ee1b3dd17d5 | 2015-08-01 | 0.119916 | 0.102232 | 0.076257 | 40.728885 | 24.43733 | 16.291555 |
| 192998 | 16f51cdc2baa19af0b940ee1b3dd17d5 | 2015-09-01 | 0.119916 | 0.102232 | 0.076257 | 40.728885 | 24.43733 | 16.291555 |
| 192999 | 16f51cdc2baa19af0b940ee1b3dd17d5 | 2015-10-01 | 0.119916 | 0.102232 | 0.076257 | 40.728885 | 24.43733 | 16.291555 |
| 193000 | 16f51cdc2baa19af0b940ee1b3dd17d5 | 2015-11-01 | 0.119916 | 0.102232 | 0.076257 | 40.728885 | 24.43733 | 16.291555 |
| 193001 | 16f51cdc2baa19af0b940ee1b3dd17d5 | 2015-12-01 | 0.119916 | 0.102232 | 0.076257 | 40.728885 | 24.43733 | 16.291555 |

193002 rows × 8 columns

## Exploratory Data Analysis

In [4]:
```
df.info()
```

```
<class 'pandas.core.frame.DataFrame'>
RangeIndex: 193002 entries, 0 to 193001
Data columns (total 8 columns):
 #   Column        Non-Null Count   Dtype
---  ------        --------------   -----
 0   id            193002 non-null  object
 1   price_date    193002 non-null  datetime64[ns]
 2   price_p1_var  191643 non-null  float64
 3   price_p2_var  191643 non-null  float64
 4   price_p3_var  191643 non-null  float64
 5   price_p1_fix  191643 non-null  float64
 6   price_p2_fix  191643 non-null  float64
 7   price_p3_fix  191643 non-null  float64
dtypes: datetime64[ns](1), float64(6), object(1)
memory usage: 11.8+ MB
```

In [5]:
```
df.describe()
```

Out[5]:

| | price_p1_var | price_p2_var | price_p3_var | price_p1_fix | price_p2_fix | price_p3_fix |
|---|---|---|---|---|---|---|
| count | 191643.000000 | 191643.000000 | 191643.000000 | 191643.000000 | 191643.000000 | 191643.000000 |
| mean | 0.140991 | 0.054412 | 0.030712 | 43.325546 | 10.698201 | 6.455436 |
| std | 0.025117 | 0.050033 | 0.036335 | 5.437952 | 12.856046 | 7.782279 |
| min | 0.000000 | 0.000000 | 0.000000 | -0.177779 | -0.097752 | -0.065172 |
| 25% | 0.125976 | 0.000000 | 0.000000 | 40.728885 | 0.000000 | 0.000000 |
| 50% | 0.146033 | 0.085483 | 0.000000 | 44.266930 | 0.000000 | 0.000000 |
| 75% | 0.151635 | 0.101780 | 0.072558 | 44.444710 | 24.339581 | 16.226389 |
| max | 0.280700 | 0.229788 | 0.114102 | 59.444710 | 36.490692 | 17.458221 |

In [6]:
```
df.columns
```

Out[6]:
```
Index(['id', 'price_date', 'price_p1_var', 'price_p2_var', 'price_p3_var', 'price_p1_fix', 'price_p2_fix',
'price_p3_fix'], dtype='object')
```

In [7]:
```
df["id"].value_counts()
```

Out[7]:
```
86d4239a622874b4803a940ae83d1b42    12
e0006d2afdacab622d44e6cd410989d7    12
4c0f9d0109b4defb54291d5101030b5c    12
23fd68a696417a48402d576d45872d2d    12
5c89a926f4606bd126f2e1b8b33b9b6c    12
                                    ..
3e459d61dc831e29f8a9a9a59f95efd2     8
83cf18b07114e495ae8b7fb235e45ee2     8
bf89f2d8c1b133a134fd93603cb4c947     7
15b36e47cf04bf151e3f4438d12672e5     7
c5dcd5c506e565aaabffa29bc1ec0a37     7
Name: id, Length: 16096, dtype: int64
```

In [8]:
```
df["price_date"].value_counts()
```

Out[8]:
```
2015-12-01    16094
2015-08-01    16094
2015-07-01    16090
2015-11-01    16087
2015-10-01    16085
2015-06-01    16085
2015-09-01    16082
2015-02-01    16082
2015-05-01    16080
2015-04-01    16079
2015-03-01    16074
2015-01-01    16070
Name: price_date, dtype: int64
```

In [9]:
```
df.groupby(["price_date"]).mean()
```

Out[9]:

| price_date | price_p1_var | price_p2_var | price_p3_var | price_p1_fix | price_p2_fix | price_p3_fix |
|---|---|---|---|---|---|---|
| 2015-01-01 | 0.142561 | 0.054884 | 0.030399 | 43.224372 | 10.716260 | 6.469952 |
| 2015-02-01 | 0.142757 | 0.054958 | 0.030462 | 43.226638 | 10.706995 | 6.469121 |
| 2015-03-01 | 0.143091 | 0.054987 | 0.030527 | 43.241339 | 10.690361 | 6.457830 |
| 2015-04-01 | 0.143213 | 0.055551 | 0.030993 | 43.269548 | 10.822268 | 6.528723 |
| 2015-05-01 | 0.143512 | 0.055089 | 0.030665 | 43.304062 | 10.697581 | 6.448145 |
| 2015-06-01 | 0.143692 | 0.054739 | 0.030413 | 43.328810 | 10.593585 | 6.388537 |
| 2015-07-01 | 0.143669 | 0.055200 | 0.030809 | 43.337050 | 10.702093 | 6.457581 |
| 2015-08-01 | 0.137905 | 0.053495 | 0.030822 | 43.362274 | 10.698239 | 6.453573 |
| 2015-09-01 | 0.137888 | 0.053355 | 0.030776 | 43.346782 | 10.661984 | 6.427358 |
| 2015-10-01 | 0.137844 | 0.053499 | 0.030848 | 43.348056 | 10.677121 | 6.439320 |
| 2015-11-01 | 0.137880 | 0.053505 | 0.030848 | 43.419709 | 10.679994 | 6.444858 |
| 2015-12-01 | 0.137945 | 0.053696 | 0.030987 | 43.497869 | 10.732132 | 6.480254 |

In [10]:
```
df.groupby(["price_date"]).median()
```

Out[10]:

| price_date | price_p1_var | price_p2_var | price_p3_var | price_p1_fix | price_p2_fix | price_p3_fix |
|---|---|---|---|---|---|---|
| 2015-01-01 | 0.148825 | 0.084991 | 0.0 | 44.266931 | 0.0 | 0.0 |
| 2015-02-01 | 0.148825 | 0.085058 | 0.0 | 44.266931 | 0.0 | 0.0 |
| 2015-03-01 | 0.148825 | 0.085058 | 0.0 | 44.266931 | 0.0 | 0.0 |
| 2015-04-01 | 0.148825 | 0.085658 | 0.0 | 44.266930 | 0.0 | 0.0 |
| 2015-05-01 | 0.148825 | 0.085658 | 0.0 | 44.266930 | 0.0 | 0.0 |
| 2015-06-01 | 0.148825 | 0.085390 | 0.0 | 44.266930 | 0.0 | 0.0 |
| 2015-07-01 | 0.148825 | 0.085658 | 0.0 | 44.266930 | 0.0 | 0.0 |
| 2015-08-01 | 0.144524 | 0.084905 | 0.0 | 44.266930 | 0.0 | 0.0 |
| 2015-09-01 | 0.144524 | 0.085165 | 0.0 | 44.266930 | 0.0 | 0.0 |
| 2015-10-01 | 0.144292 | 0.085568 | 0.0 | 44.266930 | 0.0 | 0.0 |
| 2015-11-01 | 0.144292 | 0.086087 | 0.0 | 44.266930 | 0.0 | 0.0 |
| 2015-12-01 | 0.144524 | 0.086328 | 0.0 | 44.444710 | 0.0 | 0.0 |

In [11]:
```
df.groupby(["id"]).mean()
```

Out[11]:

| id | price_p1_var | price_p2_var | price_p3_var | price_p1_fix | price_p2_fix | price_p3_fix |
|---|---|---|---|---|---|---|
| 0002203ffbb812588b632b9e628cc38d | 0.124338 | 0.103794 | 0.073160 | 40.701732 | 24.421038 | 16.280694 |
| 0004351ebdd665e6ee664792efc4fd13 | 0.146426 | 0.000000 | 0.000000 | 44.385450 | 0.000000 | 0.000000 |
| 0010bcc39e42b3c2131ed2ce55246e3c | 0.181558 | 0.000000 | 0.000000 | 45.319710 | 0.000000 | 0.000000 |
| 0010ee3855fdea87602a5b7aba8e42de | 0.118757 | 0.098292 | 0.069032 | 40.647427 | 24.388455 | 16.258971 |
| 00114d74e963e47177db89bc70108537 | 0.147926 | 0.000000 | 0.000000 | 44.266930 | 0.000000 | 0.000000 |
| ... | ... | ... | ... | ... | ... | ... |
| ffef185810e44254c3a4c6395e6b4d8a | 0.138863 | 0.115125 | 0.080780 | 40.896427 | 24.637456 | 16.507972 |
| fffac626da707b1b5ab11e8431a4d0a2 | 0.147137 | 0.000000 | 0.000000 | 44.311375 | 0.000000 | 0.000000 |
| fffc0cacd305dd51f316424bbb08d1bd | 0.153879 | 0.129497 | 0.094842 | 41.160171 | 24.895768 | 16.763569 |
| fffe4f5646aa39c7f97f95ae2679ce64 | 0.123858 | 0.103499 | 0.073735 | 40.606699 | 24.364017 | 16.242678 |
| ffff7fa066f1fb305ae285bb03bf325a | 0.125360 | 0.104895 | 0.075635 | 40.647427 | 24.388455 | 16.258971 |

16096 rows × 6 columns

In [12]:
```
company = pd.DataFrame(df.groupby(["id"]).mean())
```

In [13]:
```
company
```

Out[13]:

| id | price_p1_var | price_p2_var | price_p3_var | price_p1_fix | price_p2_fix | price_p3_fix |
|---|---|---|---|---|---|---|
| 0002203ffbb812588b632b9e628cc38d | 0.124338 | 0.103794 | 0.073160 | 40.701732 | 24.421038 | 16.280694 |
| 0004351ebdd665e6ee664792efc4fd13 | 0.146426 | 0.000000 | 0.000000 | 44.385450 | 0.000000 | 0.000000 |
| 0010bcc39e42b3c2131ed2ce55246e3c | 0.181558 | 0.000000 | 0.000000 | 45.319710 | 0.000000 | 0.000000 |
| 0010ee3855fdea87602a5b7aba8e42de | 0.118757 | 0.098292 | 0.069032 | 40.647427 | 24.388455 | 16.258971 |
| 00114d74e963e47177db89bc70108537 | 0.147926 | 0.000000 | 0.000000 | 44.266930 | 0.000000 | 0.000000 |
| ... | ... | ... | ... | ... | ... | ... |
| ffef185810e44254c3a4c6395e6b4d8a | 0.138863 | 0.115125 | 0.080780 | 40.896427 | 24.637456 | 16.507972 |
| fffac626da707b1b5ab11e8431a4d0a2 | 0.147137 | 0.000000 | 0.000000 | 44.311375 | 0.000000 | 0.000000 |
| fffc0cacd305dd51f316424bbb08d1bd | 0.153879 | 0.129497 | 0.094842 | 41.160171 | 24.895768 | 16.763569 |
| fffe4f5646aa39c7f97f95ae2679ce64 | 0.123858 | 0.103499 | 0.073735 | 40.606699 | 24.364017 | 16.242678 |
| ffff7fa066f1fb305ae285bb03bf325a | 0.125360 | 0.104895 | 0.075635 | 40.647427 | 24.388455 | 16.258971 |

16096 rows × 6 columns

In [14]:
```
output = pd.read_csv("output.csv", index_col="id")
```

In [15]:
```
output
```

Out[15]:

| id | churn |
|---|---|
| 48ada52261e7cf58715202705a0451c9 | 0 |
| 24011ae4ebbe3035111d65fa7c15bc57 | 1 |
| d29c2c54acc38ff3c0614d0a653813dd | 0 |
| 764c75f661154dac3a6c254cd082ea7d | 0 |
| bba03439a292a1e166f80264c16191cb | 0 |
| ... | ... |
| 18463073fb097fc0ac5d3e040f356987 | 0 |
| d0a6f71671571ed83b2645d23af6de00 | 1 |
| 10e6828ddd62cbcf687cb74928c4c2d2 | 1 |
| 1cf20fd6206d7678d5bcafd28c53b4db | 0 |
| 563dde550fd624d7352f3de77c0cdfcd | 0 |

16096 rows × 1 columns

In [16]:
```
df3 = pd.merge(left=company, right=output, how="inner", left_index=True, right_index=True)
```

In [17]:
```
df3
```

Out[17]:

| id | price_p1_var | price_p2_var | price_p3_var | price_p1_fix | price_p2_fix | price_p3_fix | churn |
|---|---|---|---|---|---|---|---|
| 0002203ffbb812588b632b9e628cc38d | 0.124338 | 0.103794 | 0.073160 | 40.701732 | 24.421038 | 16.280694 | 0 |
| 0004351ebdd665e6ee664792efc4fd13 | 0.146426 | 0.000000 | 0.000000 | 44.385450 | 0.000000 | 0.000000 | 0 |
| 0010bcc39e42b3c2131ed2ce55246e3c | 0.181558 | 0.000000 | 0.000000 | 45.319710 | 0.000000 | 0.000000 | 0 |
| 0010ee3855fdea87602a5b7aba8e42de | 0.118757 | 0.098292 | 0.069032 | 40.647427 | 24.388455 | 16.258971 | 0 |
| 00114d74e963e47177db89bc70108537 | 0.147926 | 0.000000 | 0.000000 | 44.266930 | 0.000000 | 0.000000 | 0 |
| ... | ... | ... | ... | ... | ... | ... | ... |
| ffef185810e44254c3a4c6395e6b4d8a | 0.138863 | 0.115125 | 0.080780 | 40.896427 | 24.637456 | 16.507972 | 0 |
| fffac626da707b1b5ab11e8431a4d0a2 | 0.147137 | 0.000000 | 0.000000 | 44.311375 | 0.000000 | 0.000000 | 0 |
| fffc0cacd305dd51f316424bbb08d1bd | 0.153879 | 0.129497 | 0.094842 | 41.160171 | 24.895768 | 16.763569 | 0 |
| fffe4f5646aa39c7f97f95ae2679ce64 | 0.123858 | 0.103499 | 0.073735 | 40.606699 | 24.364017 | 16.242678 | 0 |
| ffff7fa066f1fb305ae285bb03bf325a | 0.125360 | 0.104895 | 0.075635 | 40.647427 | 24.388455 | 16.258971 | 0 |

16096 rows × 7 columns

In [18]:
```
df3["churn"].value_counts()
```

Out[18]:
```
0    14501
1     1595
Name: churn, dtype: int64
```

In [19]:
```
print("Percentage of churn customers: {:.2f}%".format(1595/14501*100))
```

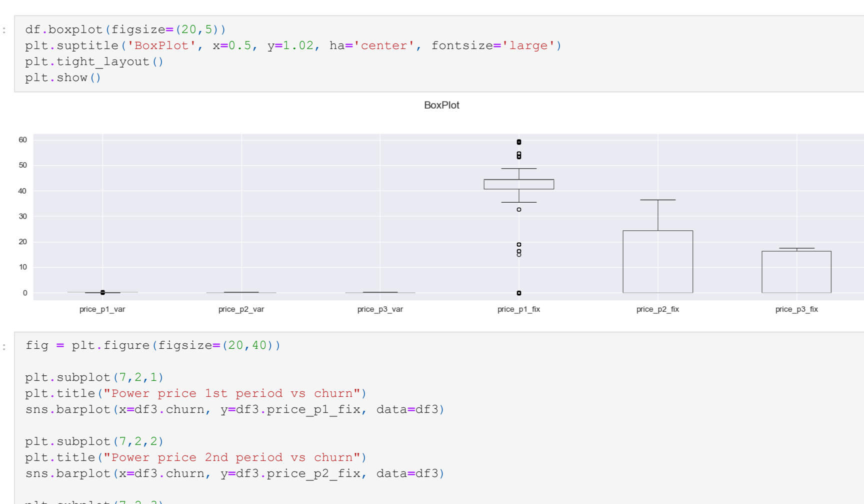
```
Percentage of churn customers: 11.00%
```

In [20]:
```
#df3.to_csv("customerchurn.csv",index=False)
```

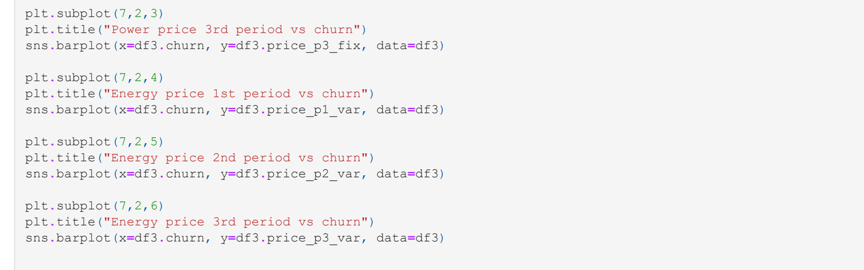
## Data Visualization

### Univariate Data Exploration

In [21]:
```
df.hist(bins=50, figsize=(20,10))
plt.suptitle('Feature Distribution', x=0.5, y=1.02, ha='center', fontsize='large')
plt.tight_layout()
plt.show()
```




In [22]:
```
df.boxplot(figsize=(20,5))
plt.suptitle('BoxPlot', x=0.5, y=1.02, ha='center', fontsize='large')
plt.tight_layout()
plt.show()
```




In [23]:
```
fig = plt.figure(figsize=(20,40))

plt.subplot(7,2,1)
plt.title("Power price 1st period vs churn")
sns.barplot(x=df3.churn, y=df3.price_p1_fix, data=df3)

plt.subplot(7,2,2)
plt.title("Power price 2nd period vs churn")
sns.barplot(x=df3.churn, y=df3.price_p2_fix, data=df3)

plt.subplot(7,2,3)
plt.title("Power price 3rd period vs churn")
sns.barplot(x=df3.churn, y=df3.price_p3_fix, data=df3)

plt.subplot(7,2,4)
plt.title("Energy price 1st period vs churn")
sns.barplot(x=df3.churn, y=df3.price_p1_var, data=df3)

plt.subplot(7,2,5)
plt.title("Energy price 2nd period vs churn")
sns.barplot(x=df3.churn, y=df3.price_p2_var, data=df3)

plt.subplot(7,2,6)
plt.title("Energy price 3rd period vs churn")
sns.barplot(x=df3.churn, y=df3.price_p3_var, data=df3)


plt.tight_layout()
plt.show()
```

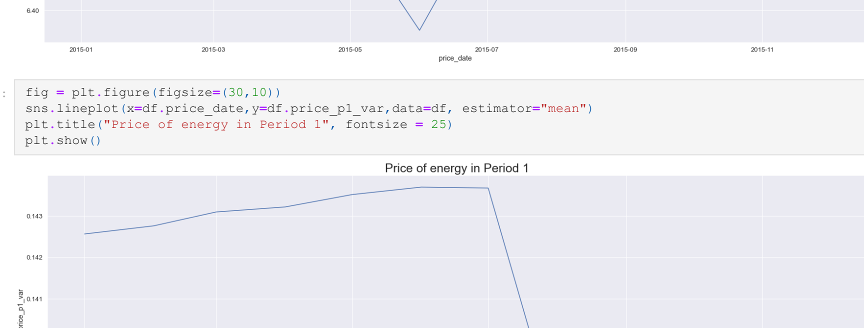

**Note: Churn happens in second and third period**

### Time-Series Analysis

In [24]:
```
fig = plt.figure(figsize=(30,10))
sns.lineplot(x=df.price_date,y=df.price_p1_fix,data=df, estimator="mean")
plt.title("Price of power in Period 1", fontsize = 25)
plt.show()
```


In [25]:
```
fig = plt.figure(figsize=(30,10))
sns.lineplot(x=df.price_date,y=df.price_p2_fix,data=df, estimator="mean")
plt.title("Price of power in Period 2", fontsize = 25)
plt.show()
```

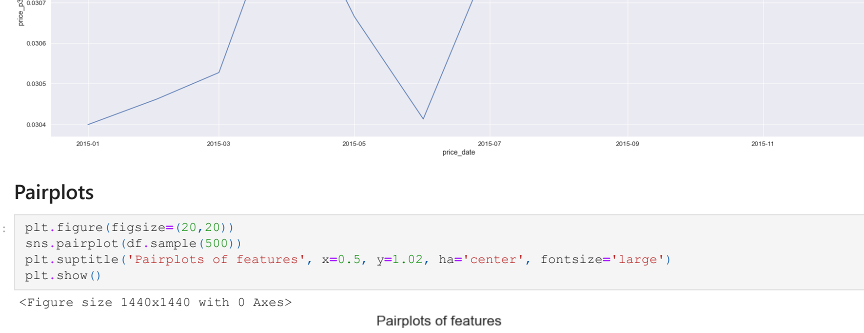

In [26]:
```
fig = plt.figure(figsize=(30,10))
sns.lineplot(x=df.price_date,y=df.price_p3_fix,data=df, estimator="mean")
plt.title("Price of power in Period 3", fontsize = 25)
plt.show()
```




In [27]:
```
fig = plt.figure(figsize=(30,10))
sns.lineplot(x=df.price_date,y=df.price_p1_var,data=df, estimator="mean")
plt.title("Price of energy in Period 1", fontsize = 25)
plt.show()
```


In [28]:
```
fig = plt.figure(figsize=(30,10))
sns.lineplot(x=df.price_date,y=df.price_p2_var,data=df, estimator="mean")
plt.title("Price of energy in Period 2", fontsize = 25)
plt.show()
```

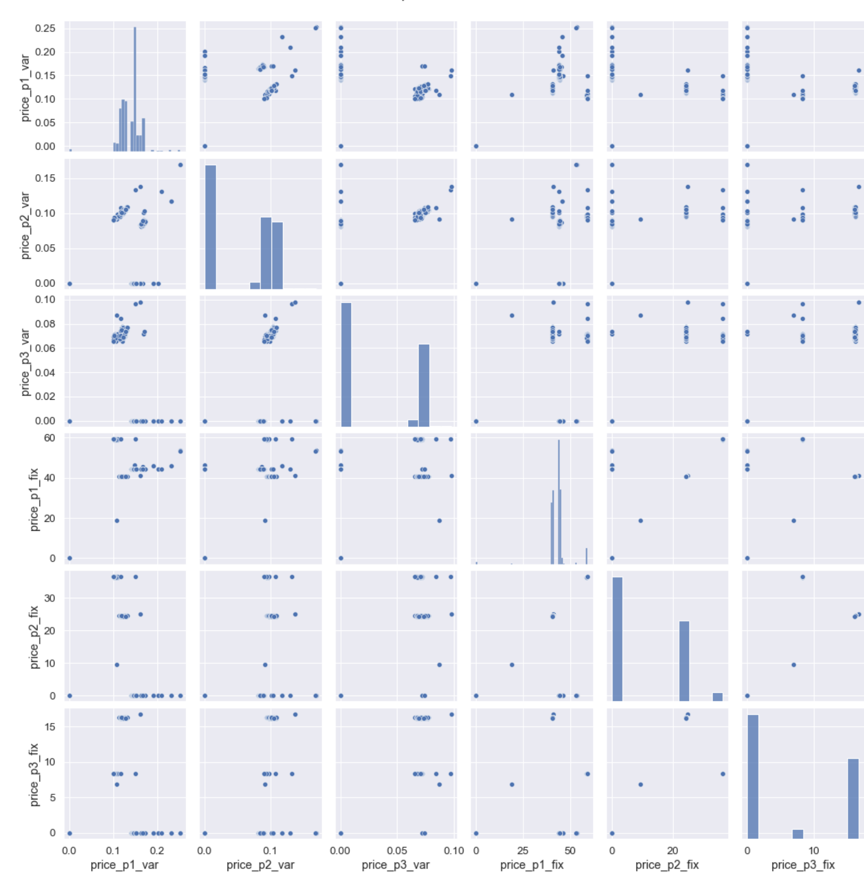

In [29]:
```
fig = plt.figure(figsize=(30,10))
sns.lineplot(x=df.price_date,y=df.price_p3_var,data=df, estimator="mean")
plt.title("Price of energy in Period 3", fontsize = 25)
plt.show()
```




### Pairplots

In [30]:
```
plt.figure(figsize=(20,20))
sns.pairplot(df.sample(500))
plt.suptitle('Pairplots of features', x=0.5, y=1.02, ha='center', fontsize='large')
plt.show()
```

```
<Figure size 1440x1440 with 0 Axes>
```



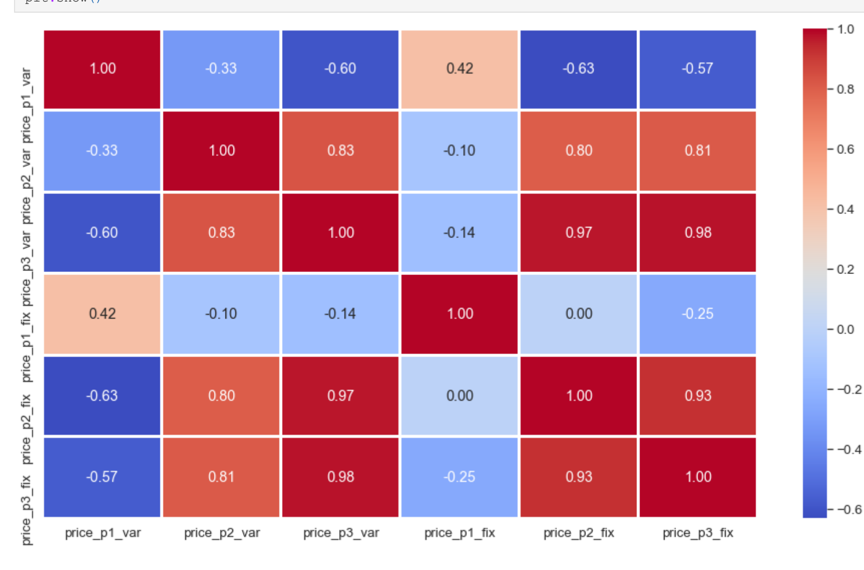

### Correlation

In [31]:
```
df.corr()
```

Out[31]:

| | price_p1_var | price_p2_var | price_p3_var | price_p1_fix | price_p2_fix | price_p3_fix |
|---|---|---|---|---|---|---|
| price_p1_var | 1.000000 | -0.329950 | -0.595257 | 0.416443 | -0.630465 | -0.572522 |
| price_p2_var | -0.329950 | 1.000000 | 0.828230 | -0.099764 | 0.802757 | 0.814439 |
| price_p3_var | -0.595257 | 0.828230 | 1.000000 | -0.137346 | 0.973831 | 0.979617 |
| price_p1_fix | 0.416443 | -0.099764 | -0.137346 | 1.000000 | 0.000941 | -0.251511 |
| price_p2_fix | -0.630465 | 0.802757 | 0.973831 | 0.000941 | 1.000000 | 0.926955 |
| price_p3_fix | -0.572522 | 0.814439 | 0.979617 | -0.251511 | 0.926955 | 1.000000 |

In [32]:
```
plt.figure(figsize=(16,9))
sns.heatmap(df.corr(),cmap="coolwarm",annot=True,fmt='.2f',linewidths=2)
plt.show()
```




**Note: price p2 and p3 are highly correlated to each other**