Sheet

Настройка и подготовка среды

```
import random
from datetime import datetime
import pandas as pd
import numpy as np

import matplotlib.pyplot as plt

#Для подбора параметров модели
from scipy.optimize import curve_fit

#Настройки вывода (построения) графиков
%matplotlib inline
plt.style.use('seaborn-whitegrid')
```

Импорт датафрейма

```
input_frame = pd.read_csv("portfolio_data.csv")
input_frame
```

	Date	AMZN	DPZ	BTC	NFLX
0	5/1/2013	248.229996	51.190983	106.250000	30.415714
1	5/2/2013	252.550003	51.987320	98.099998	30.641428
2	5/3/2013	258.049988	52.446388	112.900002	30.492857
3	5/6/2013	255.720001	53.205257	109.599998	30.098572
4	5/7/2013	257.730011	54.151505	113.199997	29.464285
...	...	...	...	...	...
1515	5/8/2019	1917.770020	283.149994	6171.959961	364.369995
1516	5/9/2019	1899.869995	282.160004	6358.290039	362.750000
1517	5/10/2019	1889.979980	278.369995	7191.359863	361.040009
1518	5/13/2019	1822.680054	273.880005	7980.129883	345.260010
1519	5/14/2019	1840.119995	272.859985	8183.830078	345.609985

1520 rows × 5 columns

Разбиение датасета на тренировочный и тестовый (70/30). Вывод тренировочного сета

```
size = len(input_frame)
train_size_multiplier = 0.8
train_size = int(size * train_size_multiplier)

train = input_frame.iloc[:train_size]
test = input_frame.iloc[train_size:]

train
```

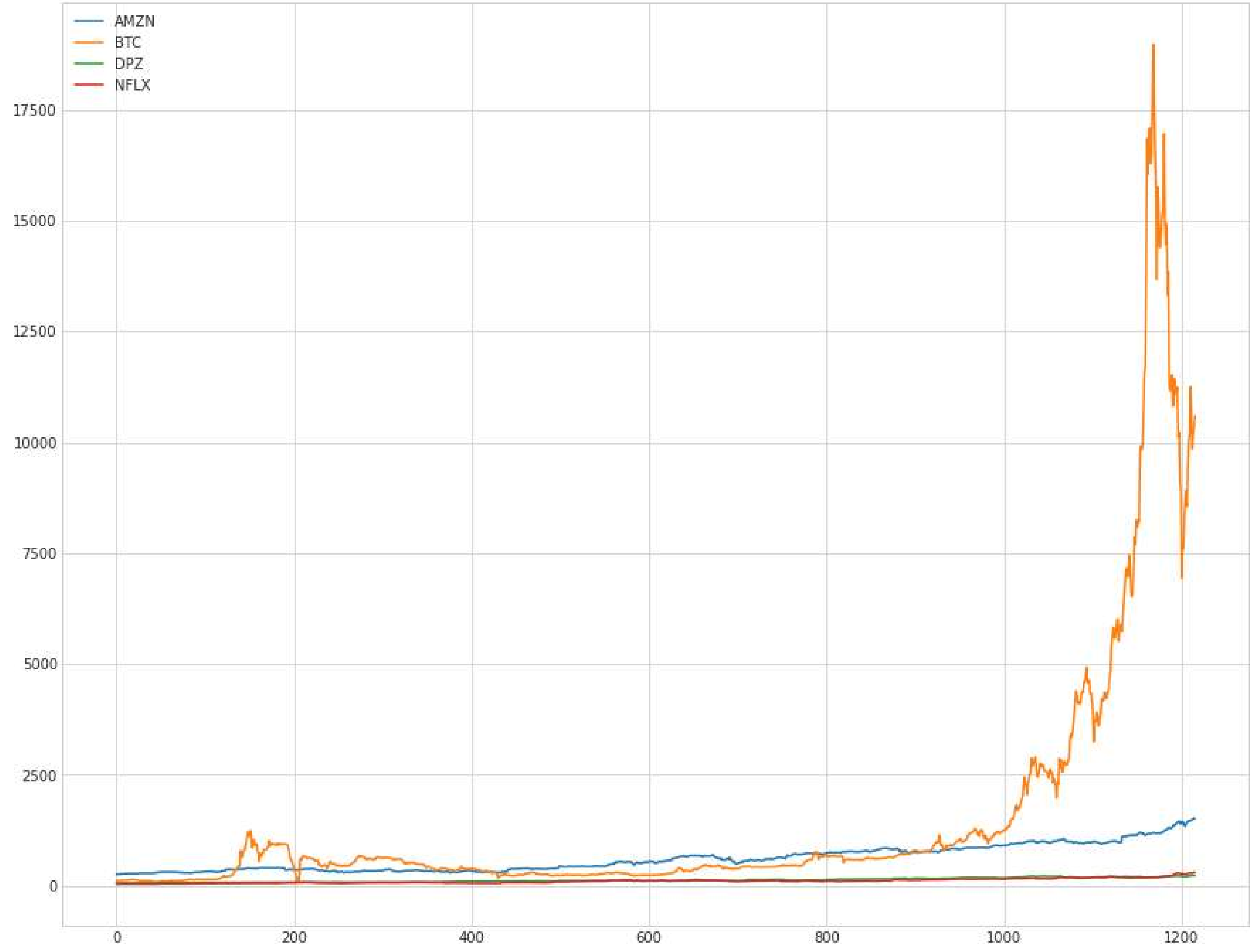
	Date	AMZN	DPZ	BTC	NFLX
0	5/1/2013	248.229996	51.190983	106.250000	30.415714
1	5/2/2013	252.550003	51.987320	98.099998	30.641428
2	5/3/2013	258.049988	52.446388	112.900002	30.492857
3	5/6/2013	255.720001	53.205257	109.599998	30.098572
4	5/7/2013	257.730011	54.151505	113.199997	29.464285
...	...	...	...	...	...
1211	2/21/2018	1482.920044	227.955032	10481.660160	281.040009
1212	2/22/2018	1485.339966	224.464478	9847.959961	278.140015
1213	2/23/2018	1500.000000	226.293793	10175.509770	285.929993
1214	2/26/2018	1521.949951	225.473083	10326.500000	294.160004
1215	2/27/2018	1511.979980	223.940399	10594.759770	290.609985

1216 rows × 5 columns

Разбиение тренировочного сета по компаниям. Построение графика стоимости акций компаний.

```
dates = pd.DataFrame(train['Date'], train.index)
amzn = pd.DataFrame(train['AMZN'], train.index)
dpz = pd.DataFrame(train['DPZ'], train.index)
btc = pd.DataFrame(train['BTC'], train.index)
nflx = pd.DataFrame(train['NFLX'], train.index)

plt.figure(figsize=(15, 12))
plt.plot(amzn, label='AMZN')
plt.plot(btc, label='BTC')
plt.plot(dpz, label='DPZ')
plt.plot(nflx, label='NFLX')
plt.legend();
```



Вывод характеристик данных стоимости различных компаний из тренировочного сета.

```
train.describe()
```

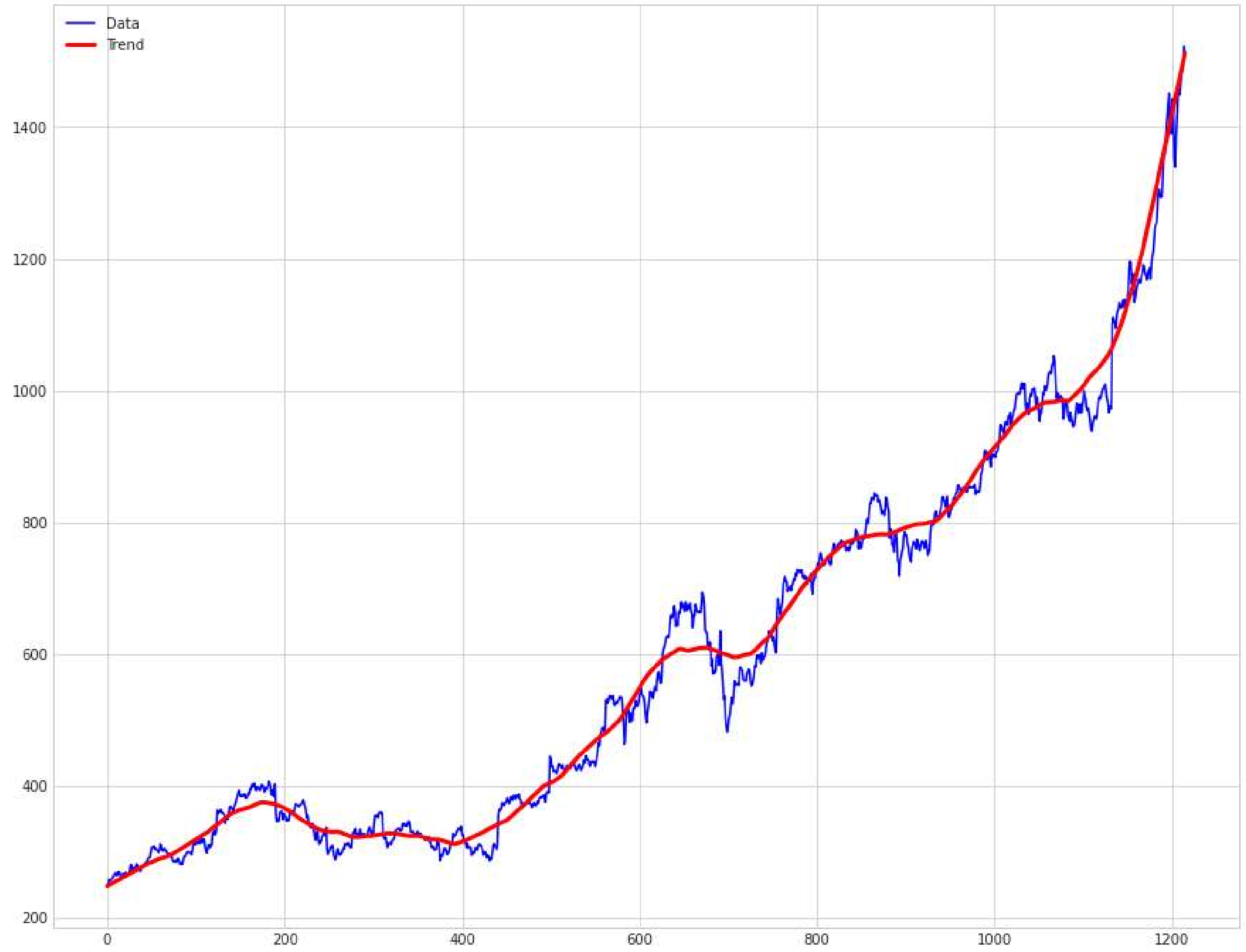
	AMZN	DPZ	BTC	NFLX
count	1216.000000	1216.000000	1216.000000	1216.000000
mean	600.592204	118.217057	1497.352800	99.970480
std	292.773934	48.320868	2928.733921	52.553209
min	248.229996	51.190983	69.660004	29.464285
25%	334.492501	71.632040	273.974991	58.082144
50%	532.729981	105.989105	478.330001	94.354999
75%	807.812516	162.477245	920.912490	125.664997
max	1521.949951	227.955032	18972.320310	294.160004

Выделение тренда в данных (удаление шумов). На примере стоимости акций компании AMZN.

```
def calc_trend(data, win_size = 100):
    left = list(np.linspace(data[0], data[:win_size].mean(), win_size // 2)) #linear aproximation
    middle = list(float(data[i - win_size // 2:i + win_size // 2].mean()) for i in range(win_size //
    right = list(np.linspace(data[len(data)-win_size-1:].mean(), data[len(data)-1], win_size // 2))
    return left + middle + right

trend_data = amzn
new_trend = calc_trend(trend_data.iloc[:, 0], win_size=100)
plt.figure(figsize=(15, 12))
plt.plot(trend_data, label='Data', color='b')
plt.plot(new_trend, label='Trend', color='r', linewidth=3)
plt.legend()
```

```
<matplotlib.legend.Legend at 0x7f49c8da36a0>
```



Методы для удобного получения коэффициента корреляции и параметров модели в легко читаемом виде.

```
def corrcoef(x, y):
    print(f'{getcorrcoef(x, y):.5f}')

def getcorrcoef(x, y):
    return np.corrcoef(x, y)[0, 1]


def pretty_params(a_, c_, popt_):
    pretty_c = 'None' if c_ is None else f'{c_:.5f}'

    print(f'a={a_:.5f}; b={popt_[0]:.5f}; c={pretty_c}; d={popt_[2]:.5f}; e={popt_[3]:.5f}; f={popt_[
```

Подготовка моделей. Определение функций. Без рандоим - для подбора параметров. С рандомом - для итоговой модели.

```
#Фиксируем сид рандома. Для воспроизводимости экспериментов.
random.seed(100)
def func(x, b, c, d, e, f):
    return e * x * np.exp(b * x) + f * np.sin(x * d)

def func_with_noise(x, b, c, d, e, f, c2):
    return e * x * np.exp(b * x) + f * np.sin(x * d) * (np.random.random(len(x)) * c2)
```

Подбор параметров для оптимизированной функции модели. На примере акций Амазона.

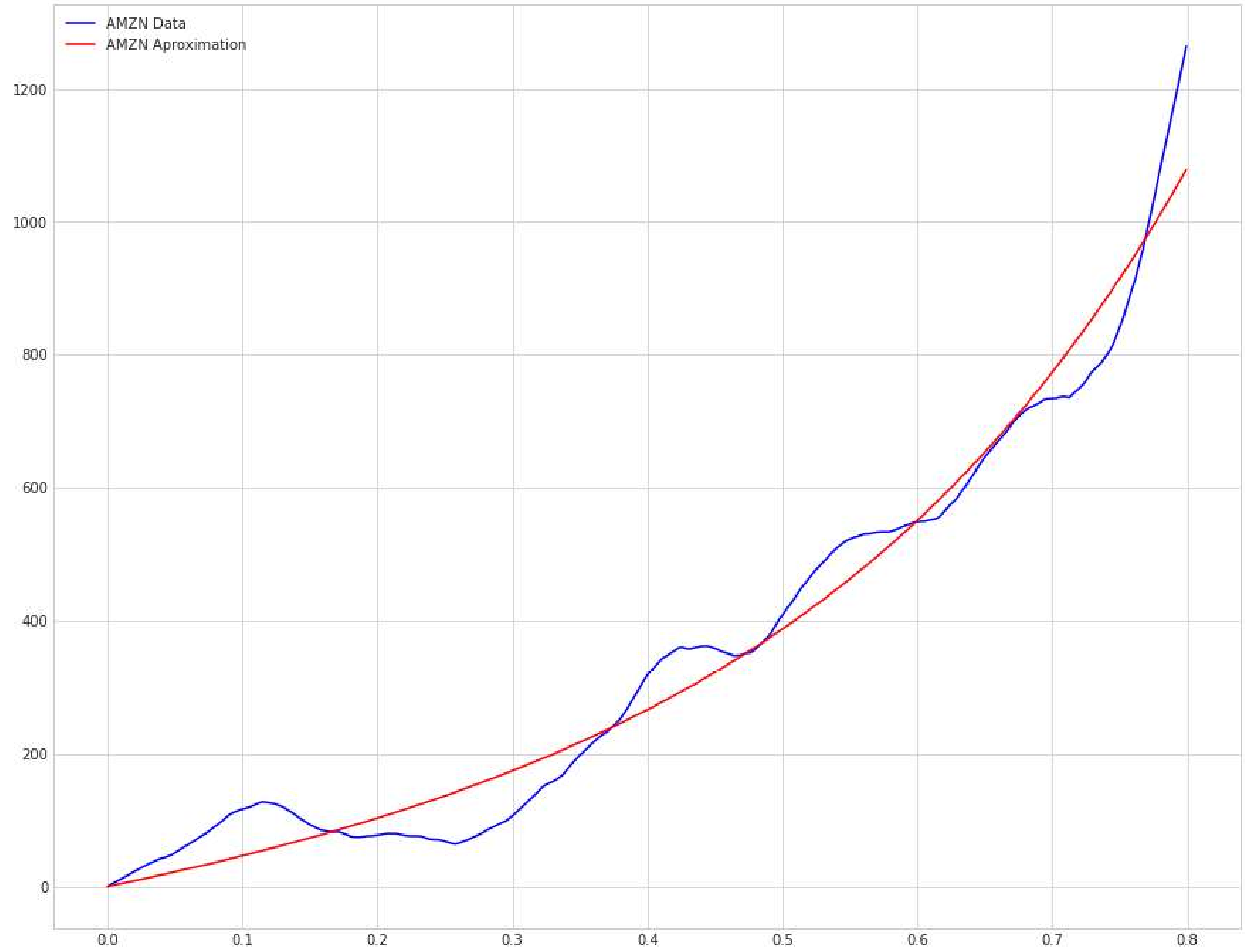
```
data_for_input = amzn
name = 'AMZN'

trend = calc_trend(data_for_input.iloc[:, 0])
a = trend[0]
ydata = np.asarray(trend) - a
xdata = np.asarray(list(range(0, len(ydata)))) / len(input_frame)
popt, pcov = curve_fit(func, xdata, ydata, method='trf')

plt.figure(figsize=(15, 12))
plt.plot(xdata, ydata, color='blue', label=f'{name} Data')
y_aprox_data = func(xdata, *popt)
plt.plot(xdata, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.legend()

print("Params values")
pretty_params(a, None, popt)
print("Correlation coeff")
trend_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

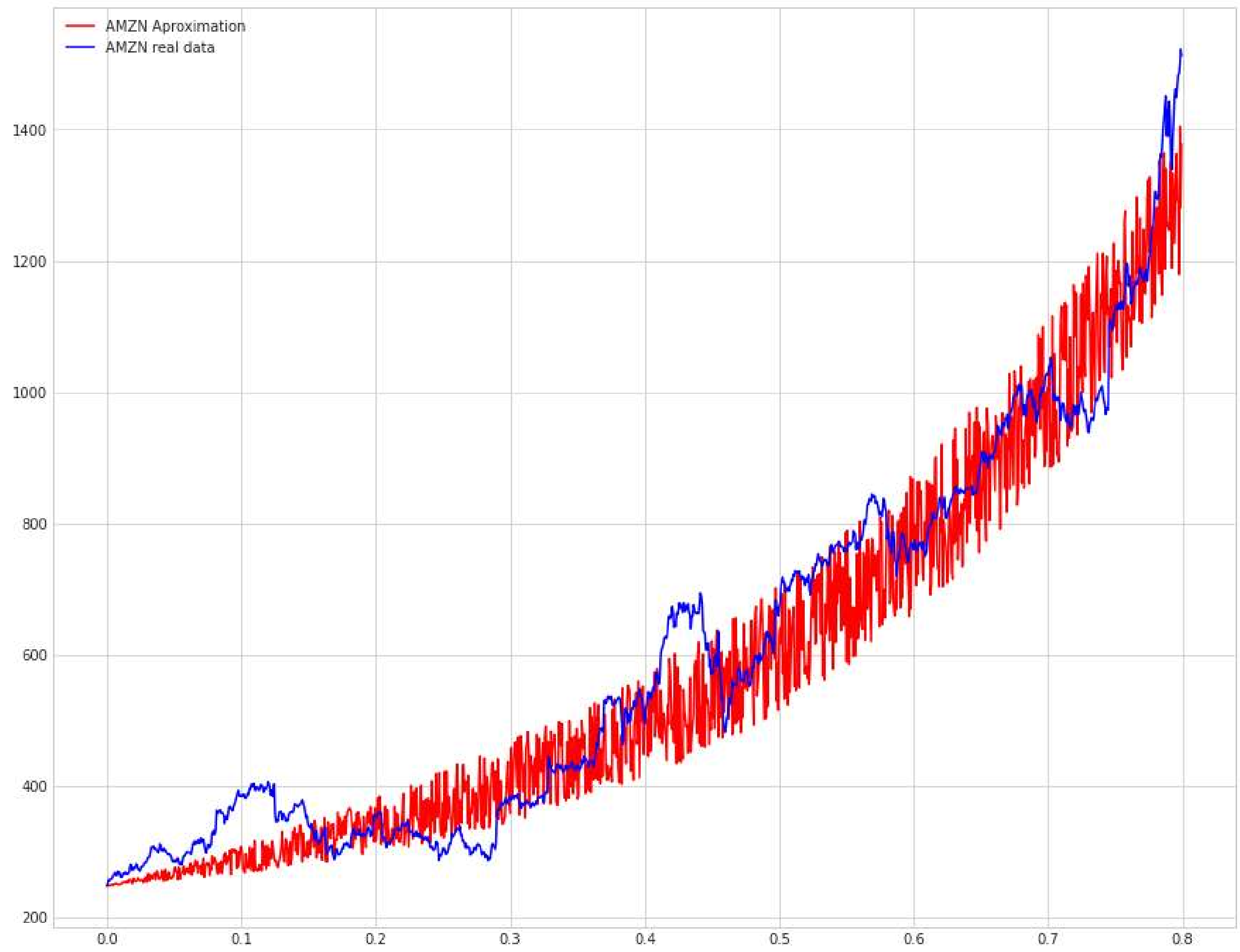
```
Params values
a=248.23000; b=2.58777; c=None; d=1.69199; e=145.32740; f=163.38877;
Correlation coeff
0.98612
```



```
c = 1.6
ydata = data_for_input.iloc[:, 0]
plt.figure(figsize=(15, 12))
y_aprox_data = func_with_noise(xdata, *popt, c) + a
plt.plot(xdata, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.plot(xdata, ydata, color='blue', label=f'{name} real data')
plt.legend()

print("Params values")
pretty_params(a, c, popt)
print("Correlation coeff")
noise_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

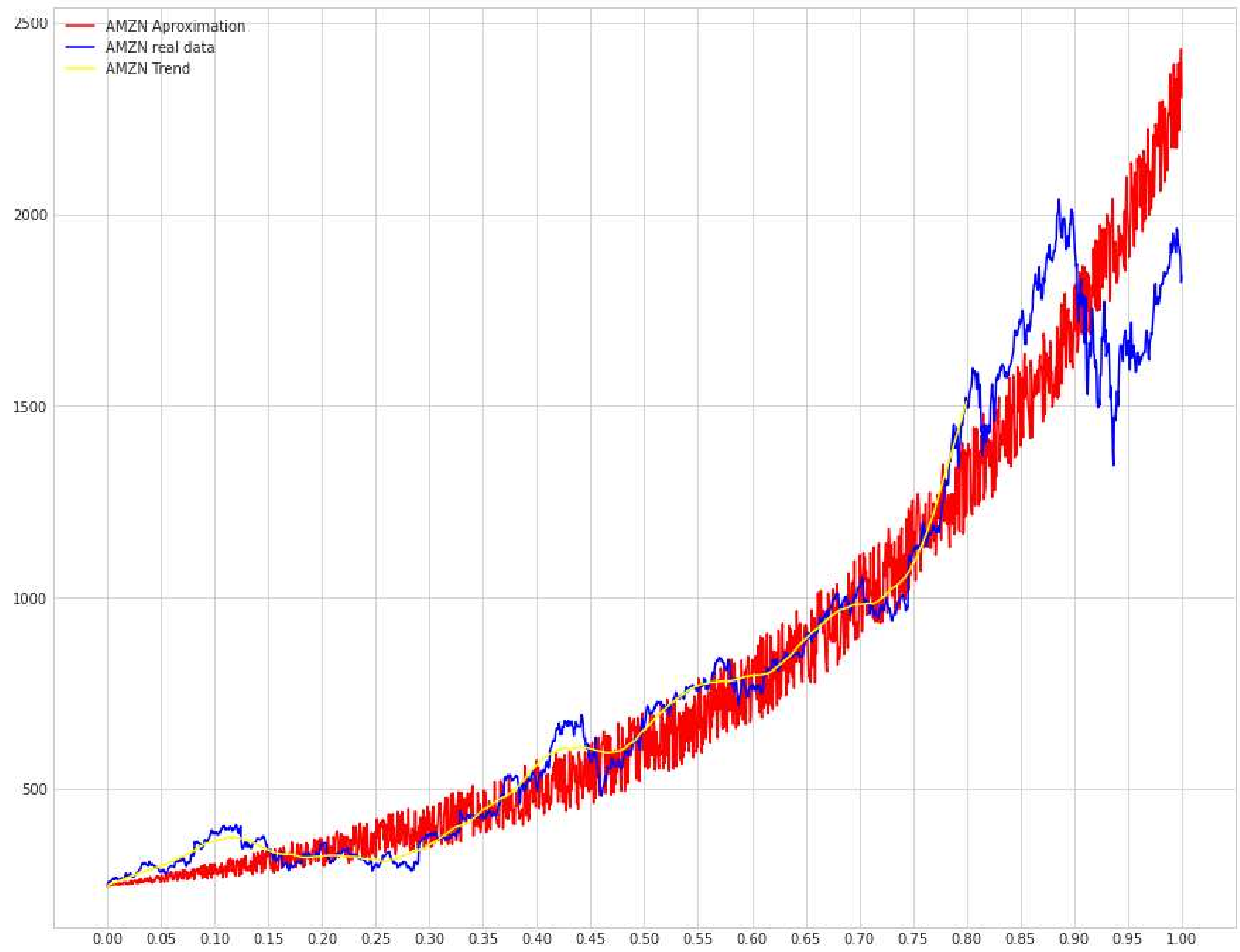
```
Params values
a=248.23000; b=2.58777; c=1.60000; d=1.69199; e=145.32740; f=163.38877;
Correlation coeff
0.96350
```



```
x_for_test = np.asarray(np.linspace(0, 1, len(input_frame)))
ydata = input_frame[name]
y_aprox_data = func_with_noise(x_for_test, *popt, c) + a
plt.figure(figsize=(15, 12))
plt.xticks([0, 0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8
plt.plot(x_for_test, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.plot(x_for_test, ydata, color='blue', label=f'{name} real data')
plt.plot(x_for_test[:len(trend)], trend, color='yellow', label=f'{name} Trend')
plt.legend()

print("Params values")
pretty_params(a, c, popt)
print("Correlation coeff")
real_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

```
Params values
a=248.23000; b=2.58777; c=1.60000; d=1.69199; e=145.32740; f=163.38877;
Correlation coeff
0.96204
```



```
print(f'Параметры модели для стоимости акций {name}')
pretty_params(a, c, popt)
print('Correlation coeff:')
print(f'Corr coef with trend:     {trend_corrcoef:.5f}')
print(f'Corr coef with noise:     {noise_corrcoef:.5f}')
print(f'Final (real) corr coef:   {real_corrcoef:.5f}')
```

```
Параметры модели для стоимости акций AMZN
a=248.23000; b=2.58777; c=1.60000; d=1.69199; e=145.32740; f=163.38877;
Correlation coeff:
Corr coef with trend:     0.98612
Corr coef with noise:     0.96350
Final (real) corr coef:   0.96204
```

Моделирование стоимости ценных бумаг для компании BTC.

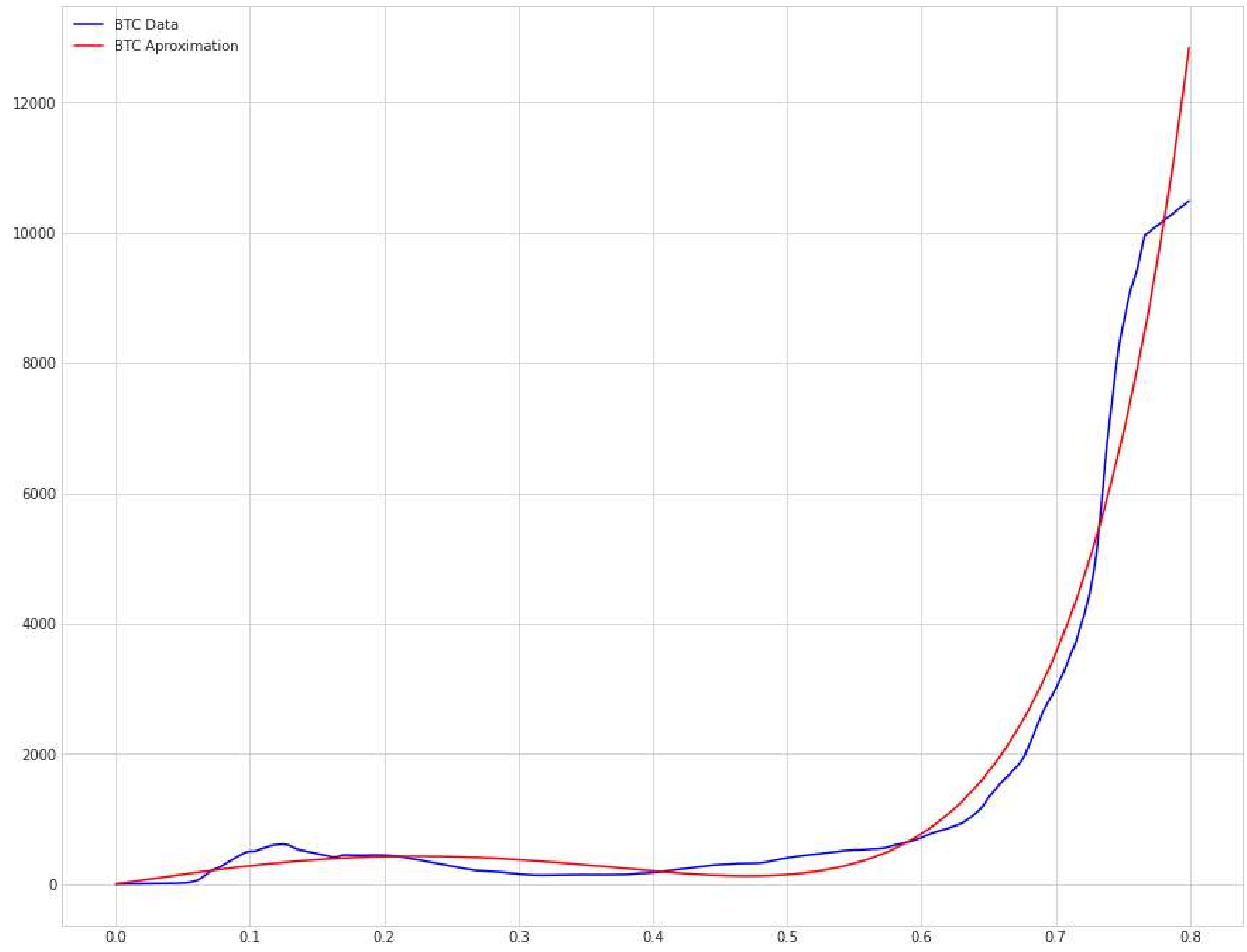
```python
data_for_input = btc
name = 'BTC'

trend = calc_trend(data_for_input.iloc[:, 0])
a = trend[0]
ydata = np.asarray(trend) - a
xdata = np.asarray(list(range(0, len(ydata)))) / len(input_frame)
popt, pcov = curve_fit(func, xdata, ydata, method='trf')

plt.figure(figsize=(15, 12))
plt.plot(xdata, ydata, color='blue', label=f'{name} Data')
y_aprox_data = func(xdata, *popt)
plt.plot(xdata, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.legend()

print("Params values")
pretty_params(a, None, popt)
print("Correlation coeff")
trend_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

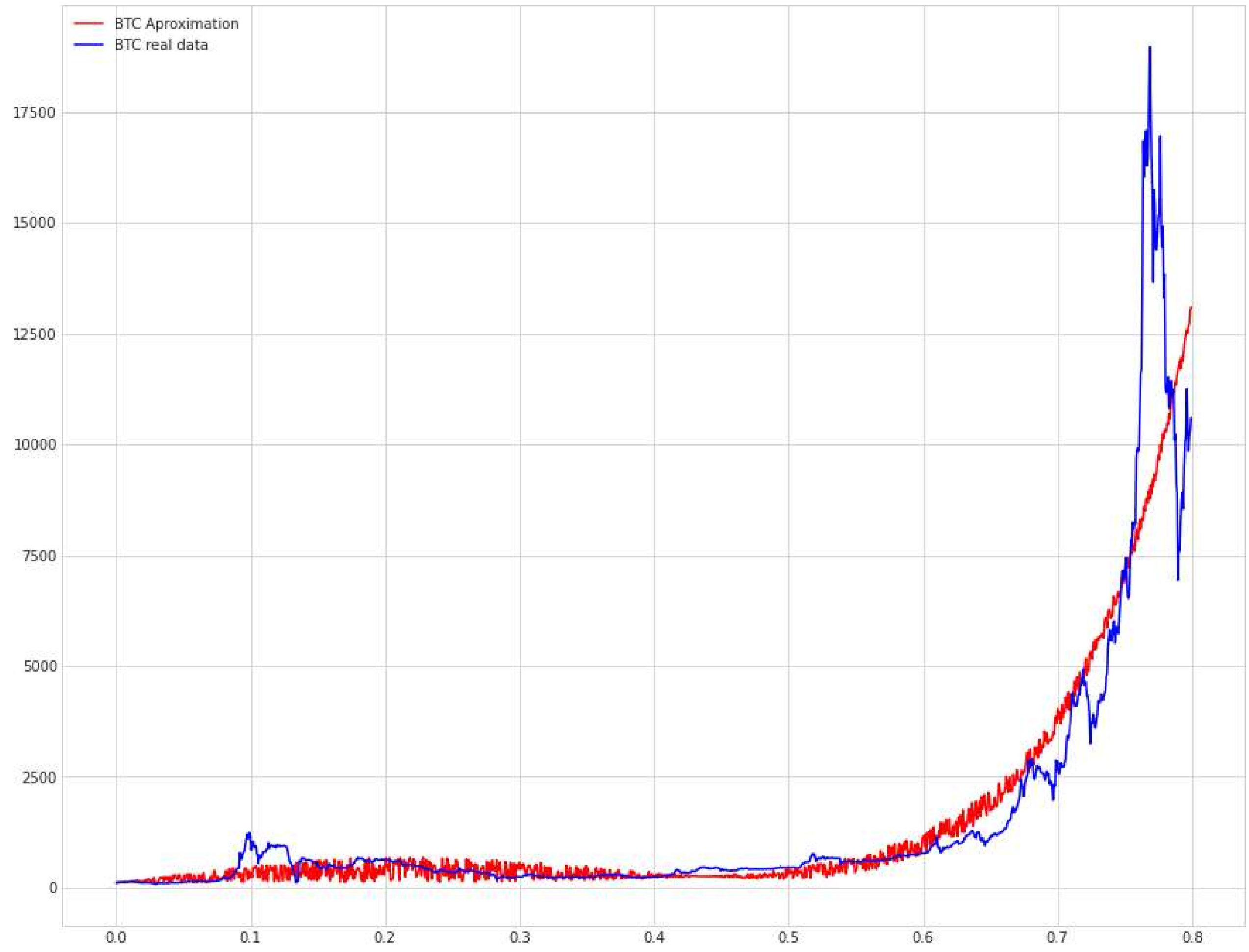
```
Params values
a=106.25000; b=10.71289; c=None; d=7.19778; e=3.11886; f=419.15801;
Correlation coeff
0.98537
```



```
c = 1.37
ydata = data_for_input.iloc[:, 0]
plt.figure(figsize=(15, 12))
y_aprox_data = func_with_noise(xdata, *popt, c) + a
plt.plot(xdata, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.plot(xdata, ydata, color='blue', label=f'{name} real data')
plt.legend()

print("Params values")
pretty_params(a, c, popt)
print("Correlation coeff")
noise_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

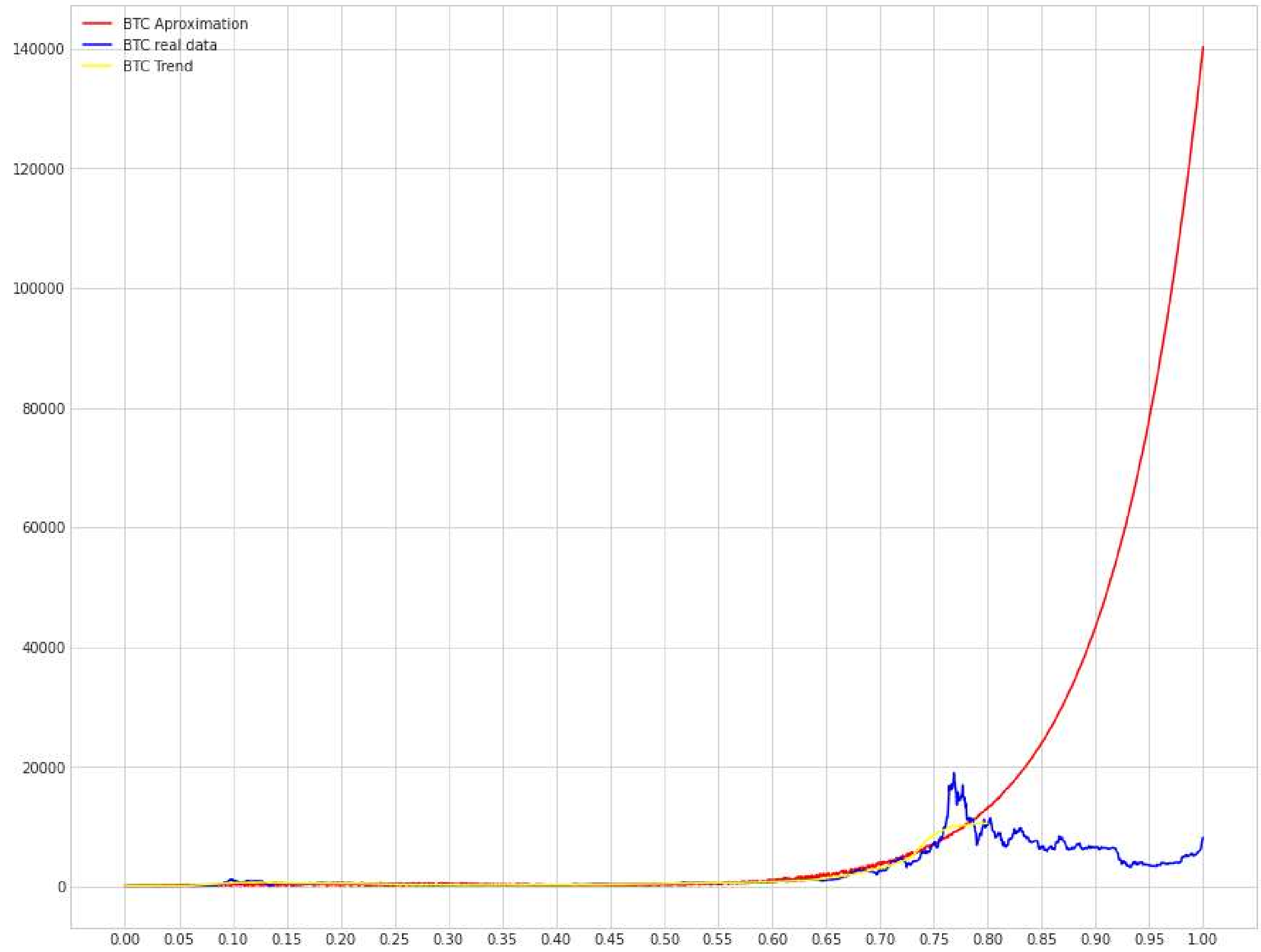
```
Params values
a=106.25000; b=10.71289; c=1.37000; d=7.19778; e=3.11886; f=419.15801;
Correlation coeff
0.92477
```



```
x_for_test = np.asarray(np.linspace(0, 1, len(input_frame)))
ydata = input_frame[name]
y_aprox_data = func_with_noise(x_for_test, *popt, c) + a
plt.figure(figsize=(15, 12))
plt.xticks([0, 0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8
plt.plot(x_for_test, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.plot(x_for_test, ydata, color='blue', label=f'{name} real data')
plt.plot(x_for_test[:len(trend)], trend, color='yellow', label=f'{name} Trend')
plt.legend()

print("Params values")
pretty_params(a, c, popt)
print("Correlation coeff")
real_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

```
Params values
a=106.25000; b=10.71289; c=1.37000; d=7.19778; e=3.11886; f=419.15801;
Correlation coeff
0.40664
```



```
print(f'Параметры модели для стоимости акций {name}')
pretty_params(a, c, popt)
print('Correlation coeff:')
print(f'Corr coef with trend:     {trend_corrcoef:.5f}')
print(f'Corr coef with noise:     {noise_corrcoef:.5f}')
print(f'Final (real) corr coef:   {real_corrcoef:.5f}')
```

```
Параметры модели для стоимости акций BTC
a=106.25000; b=10.71289; c=1.37000; d=7.19778; e=3.11886; f=419.15801;
```

```
Correlation coeff:
Corr coef with trend:     0.98537
Corr coef with noise:     0.92477
Final (real) corr coef:   0.40664
```

Моделирование стоимости ценных бумаг для компании DPZ.

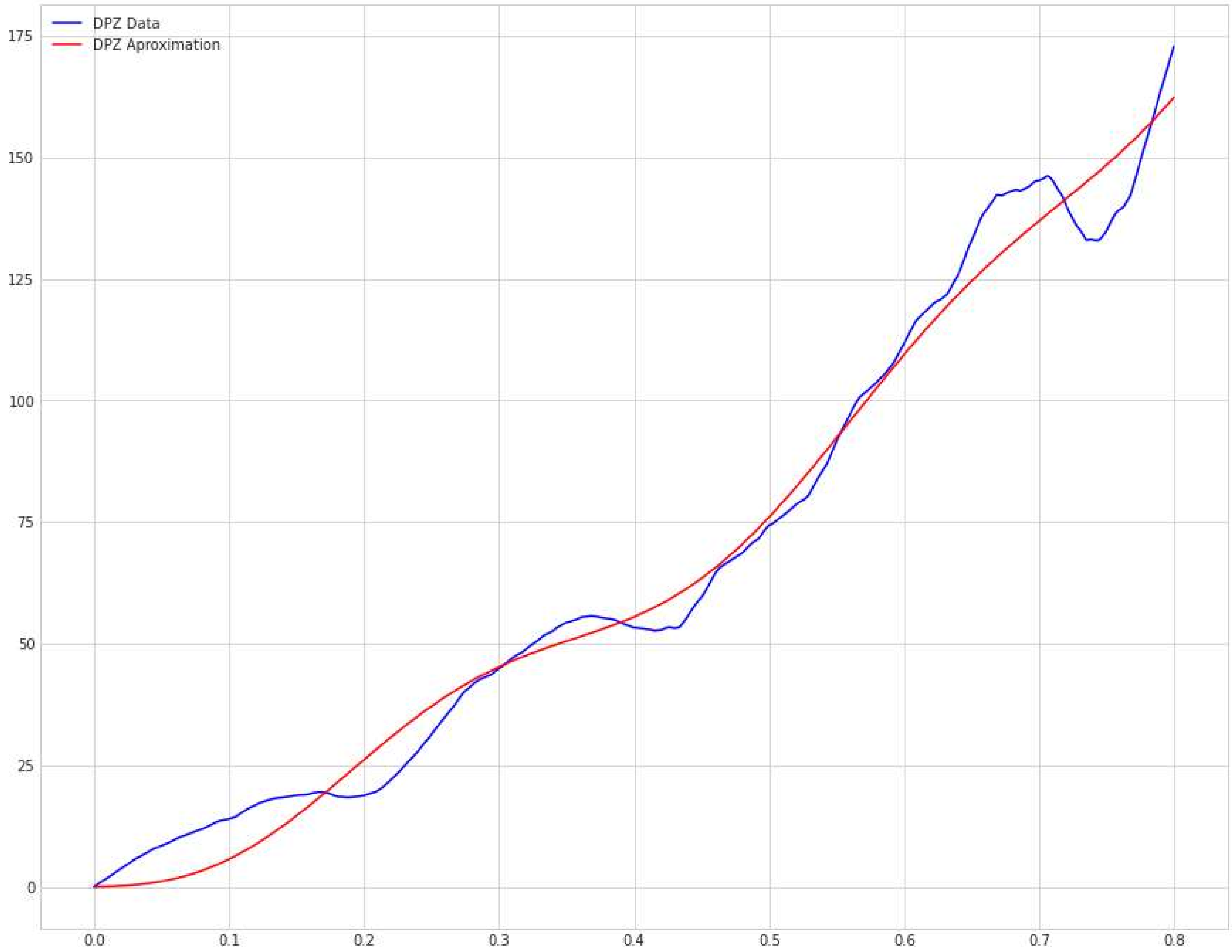
```python
# data_for_input = input_frame['DPZ'].iloc[:int(size * 0.8)]
data_for_input = dpz
name = 'DPZ'

trend = calc_trend(data_for_input.iloc[:, 0])
a = trend[0]
ydata = np.asarray(trend) - a
xdata = np.asarray(list(range(0, len(ydata)))) / len(input_frame)
popt, pcov = curve_fit(func, xdata, ydata, method='dogbox')

plt.figure(figsize=(15, 12))
plt.plot(xdata, ydata, color='blue', label=f'{name} Data')
y_aprox_data = func(xdata, *popt)
plt.plot(xdata, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.legend()

print("Params values")
pretty_params(a, None, popt)
print("Correlation coeff")
trend_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

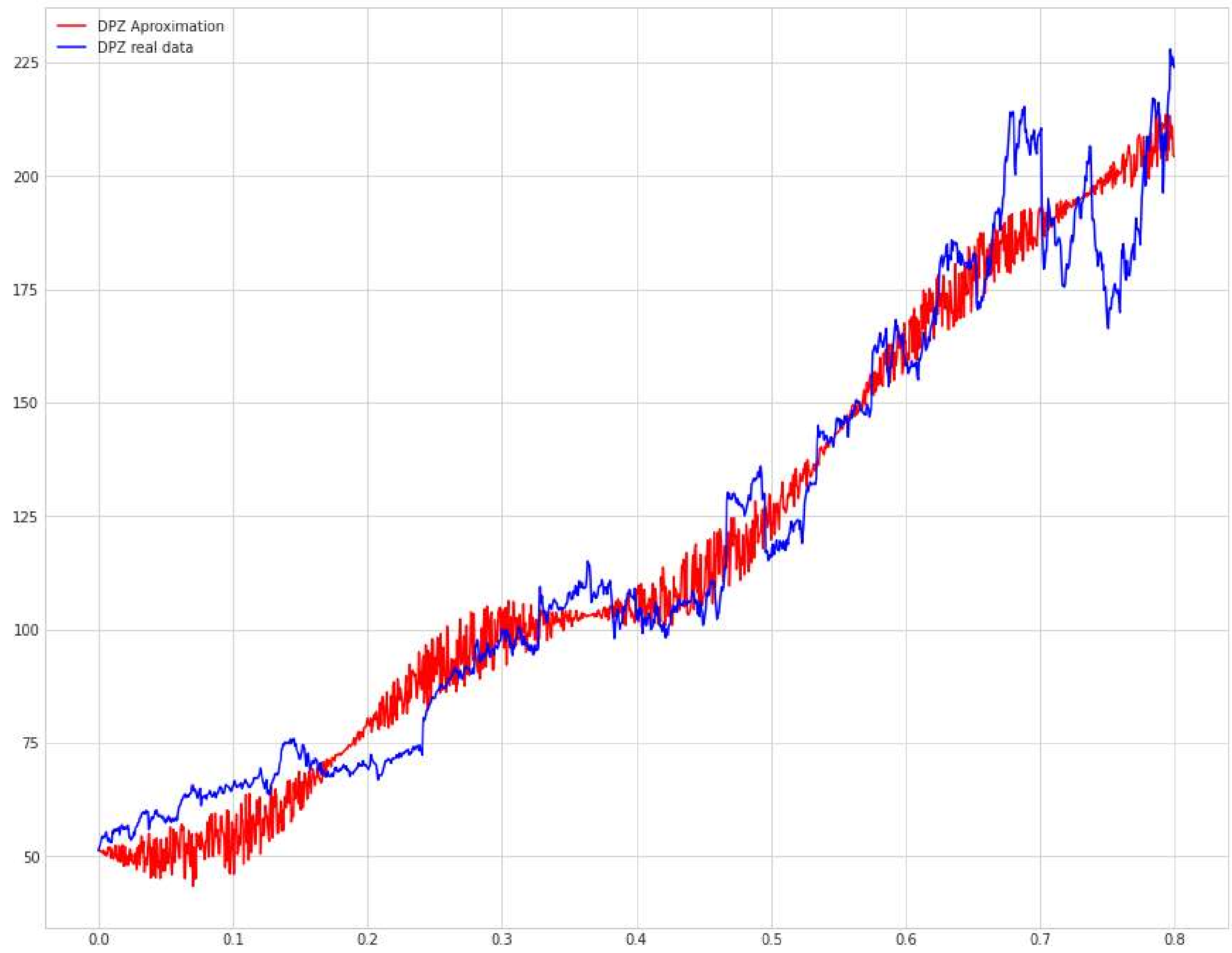
```
Params values
a=51.19098; b=0.89254; c=None; d=17.19434; e=102.60744; f=-5.56481;
Correlation coeff
0.99255
```



```
c = 3
ydata = data_for_input.iloc[:, 0]
plt.figure(figsize=(15, 12))
y_aprox_data = func_with_noise(xdata, *popt, c) + a
plt.plot(xdata, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.plot(xdata, ydata, color='blue', label=f'{name} real data')
plt.legend()

print("Params values")
pretty_params(a, c, popt)
print("Correlation coeff")
noise_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

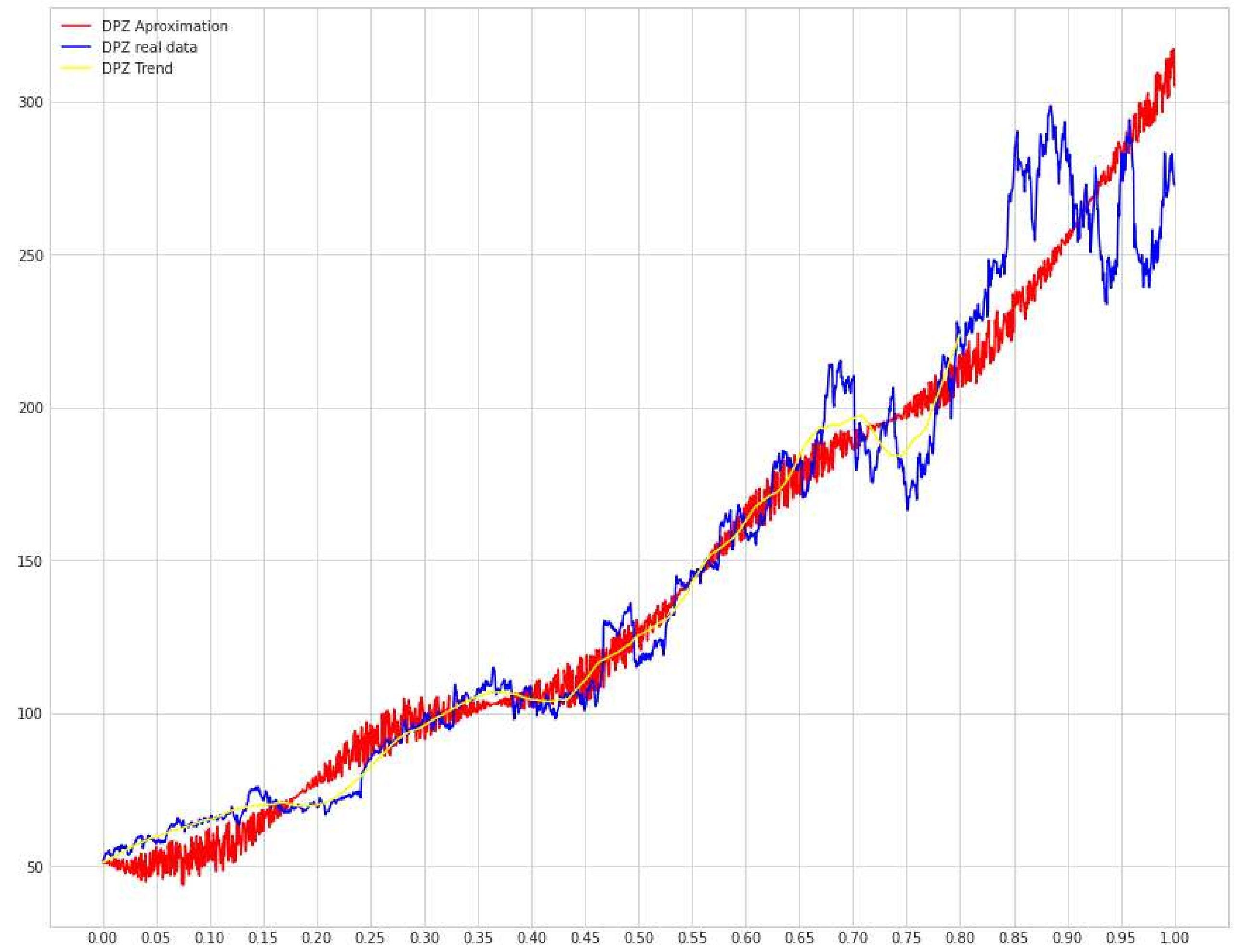
```
Params values
a=51.19098; b=0.89254; c=3.00000; d=17.19434; e=102.60744; f=-5.56481;
Correlation coeff
0.97898
```



```
x_for_test = np.asarray(np.linspace(0, 1, len(input_frame)))
ydata = input_frame[name]
y_aprox_data = func_with_noise(x_for_test, *popt, c) + a
plt.figure(figsize=(15, 12))
plt.xticks([0, 0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8
plt.plot(x_for_test, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.plot(x_for_test, ydata, color='blue', label=f'{name} real data')
plt.plot(x_for_test[:len(trend)], trend, color='yellow', label=f'{name} Trend')
plt.legend()

print("Params values")
pretty_params(a, c, popt)
print("Correlation coeff")
real_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

```
Params values
a=51.19098; b=0.89254; c=3.00000; d=17.19434; e=102.60744; f=-5.56481;
Correlation coeff
0.97342
```



```
print(f'Параметры модели для стоимости акций {name}')
pretty_params(a, c, popt)
print('Correlation coeff:')
print(f'Corr coef with trend:     {trend_corrcoef:.5f}')
print(f'Corr coef with noise:     {noise_corrcoef:.5f}')
print(f'Final (real) corr coef:   {real_corrcoef:.5f}')
```

```
Параметры модели для стоимости акций DPZ
a=51.19098; b=0.89254; c=3.00000; d=17.19434; e=102.60744; f=-5.56481;
Correlation coeff:
Corr coef with trend:     0.99255
Corr coef with noise:     0.97898
Final (real) corr coef:   0.97342
```

Моделирование стоимости ценных бумаг для компании NFLX.

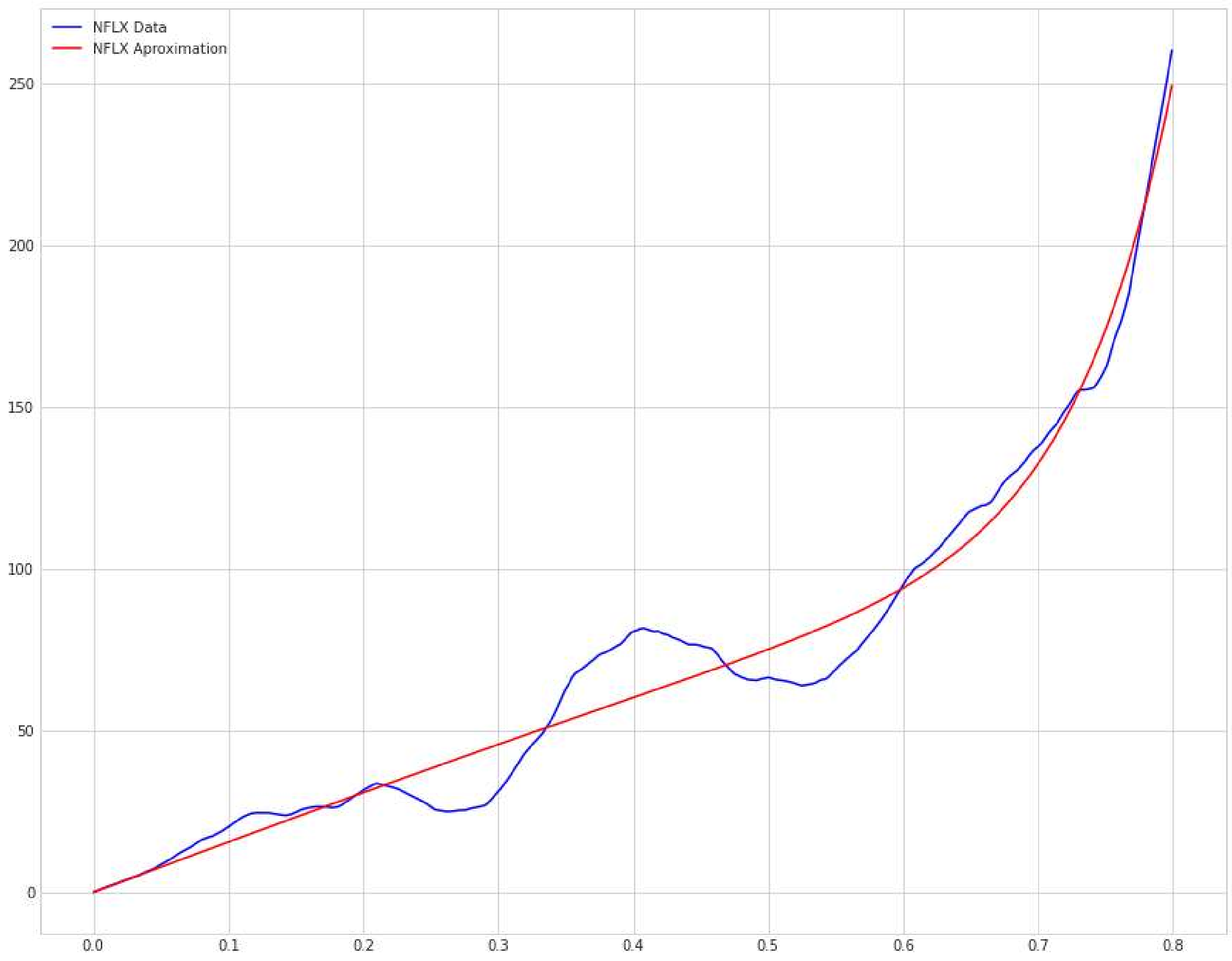
```
data_for_input = nflx
name = 'NFLX'

trend = calc_trend(data_for_input.iloc[:, 0])
a = trend[0]
ydata = np.asarray(trend) - a
xdata = np.asarray(list(range(0, len(ydata)))) / len(input_frame)
popt, pcov = curve_fit(func, xdata, ydata, method='trf')

plt.figure(figsize=(15, 12))
plt.plot(xdata, ydata, color='blue', label=f'{name} Data')
y_aprox_data = func(xdata, *popt)
plt.plot(xdata, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.legend()

print("Params values")
pretty_params(a, None, popt)
print("Correlation coeff")
trend_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

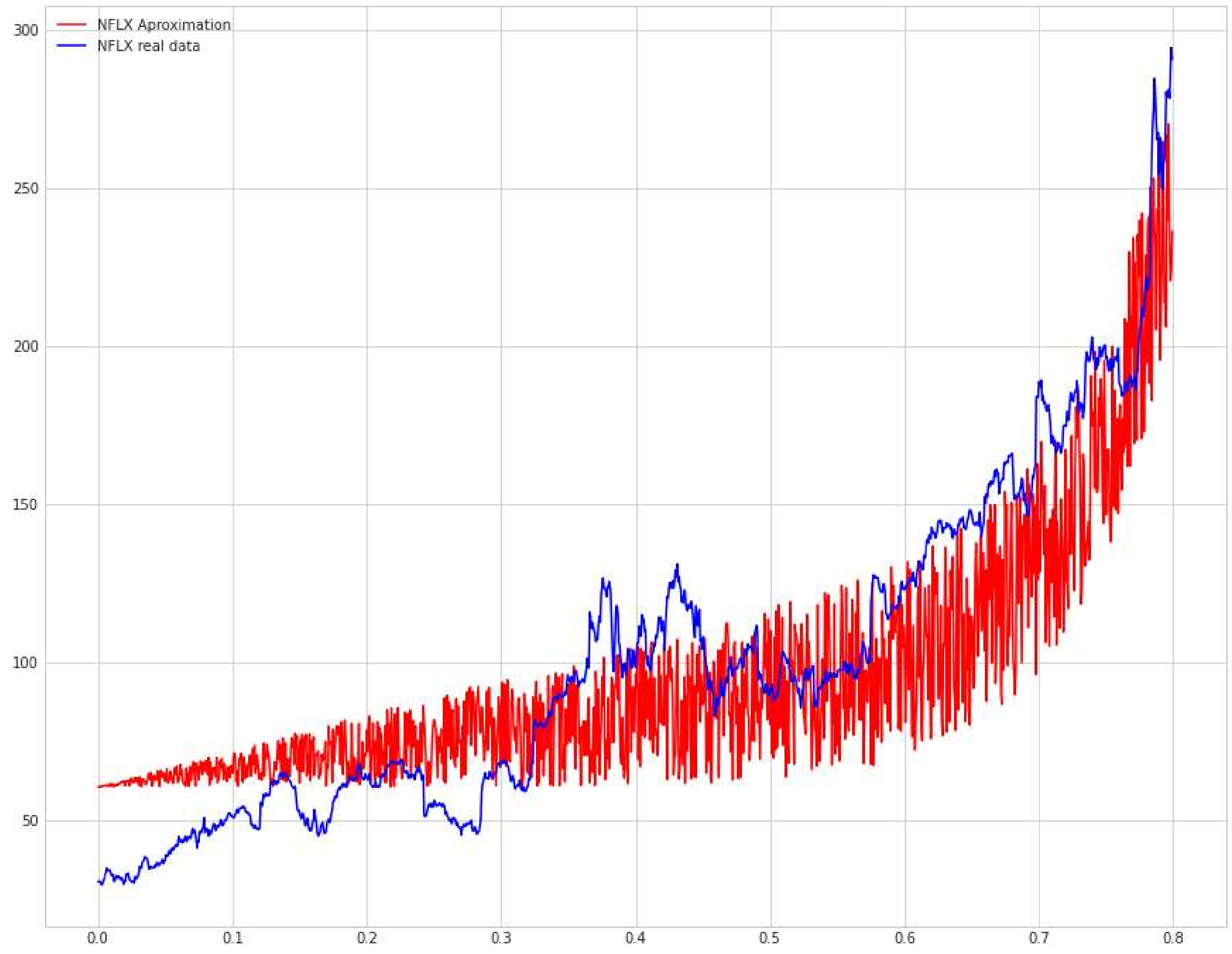
```
Params values
a=30.41571; b=12.48018; c=None; d=1.21745; e=0.00838; f=127.41417;
Correlation coeff
0.98478
```



```
c = 0.75
a = trend[0] + 30
ydata = data_for_input.iloc[:, 0]
plt.figure(figsize=(15, 12))
y_aprox_data = func_with_noise(xdata, *popt, c) + a
plt.plot(xdata, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.plot(xdata, ydata, color='blue', label=f'{name} real data')
plt.legend()

print("Params values")
pretty_params(a, c, popt)
print("Correlation coeff")
noise_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

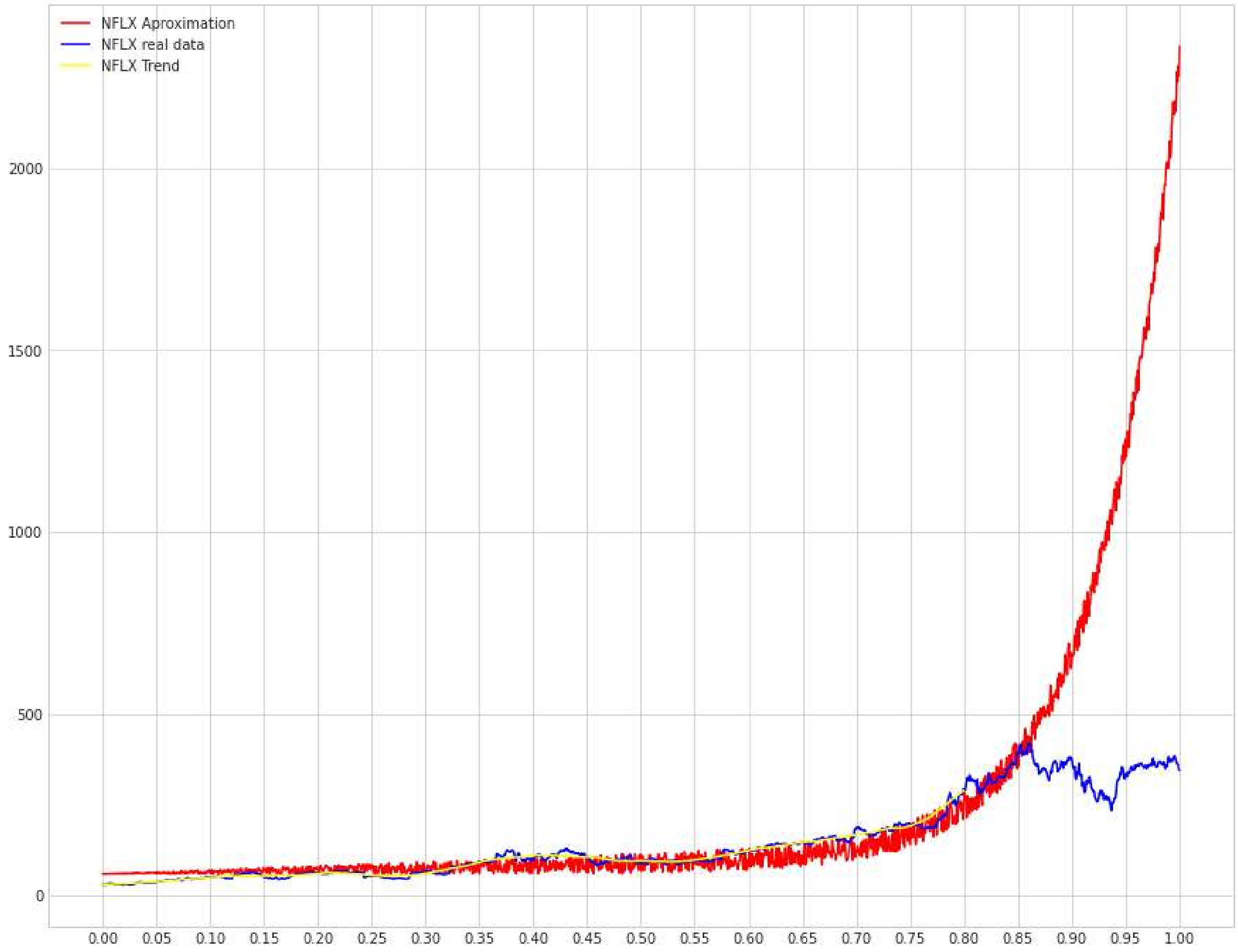
```
Params values
a=60.41571; b=12.48018; c=0.75000; d=1.21745; e=0.00838; f=127.41417;
Correlation coeff
0.87173
```



```
x_for_test = np.asarray(np.linspace(0, 1, len(input_frame)))
ydata = input_frame[name]
y_aprox_data = func_with_noise(x_for_test, *popt, c) + a
plt.figure(figsize=(15, 12))
plt.xticks([0, 0.05, 0.1, 0.15, 0.2, 0.25, 0.3, 0.35, 0.4, 0.45, 0.5, 0.55, 0.6, 0.65, 0.7, 0.75, 0.8
plt.plot(x_for_test, y_aprox_data, color='red', label=f'{name} Aproximation')
plt.plot(x_for_test, ydata, color='blue', label=f'{name} real data')
plt.plot(x_for_test[:len(trend)], trend, color='yellow', label=f'{name} Trend')
plt.legend()

print("Params values")
pretty_params(a, c, popt)
print("Correlation coeff")
real_corrcoef = getcorrcoef(y_aprox_data, ydata)
corrcoef(y_aprox_data, ydata)
```

```
Params values
a=60.41571; b=12.48018; c=0.75000; d=1.21745; e=0.00838; f=127.41417;
Correlation coeff
0.73088
```



```
print(f'Параметры модели для стоимости акций {name}')
pretty_params(a, c, popt)
print('Correlation coeff:')
print(f'Corr coef with trend:     {trend_corrcoef:.5f}')
print(f'Corr coef with noise:     {noise_corrcoef:.5f}')
print(f'Final (real) corr coef:   {real_corrcoef:.5f}')
```

```
Параметры модели для стоимости акций NFLX
a=60.41571; b=12.48018; c=0.75000; d=1.21745; e=0.00838; f=127.41417;
```

```
Correlation coeff:
Corr coef with trend:     0.98478
Corr coef with noise:     0.87173
Final (real) corr coef:   0.73088
```

Часть с вычислением дат, для анализа эффективности аппроксимации

```
last_training_date = datetime.strptime(str(dates.iloc[-1, 0]), '%m/%d/%Y')
last_date = datetime.strptime(str(input_frame.iloc[-1, 0]), '%m/%d/%Y')
first_date = datetime.strptime(str(input_frame.iloc[0, 0]), '%m/%d/%Y')

print(f'Last training date: {last_training_date.date()}\nLast date: {last_date.date()}\nDifference: {
print(f'Days in 0.05 parts: {(last_date - last_training_date) / 4}')
```

```
Last training date: 2018-02-27
Last date: 2019-05-14
Difference: 441 days, 0:00:00
Days in 0.05 parts: 110 days, 6:00:00
```