In [151]:

```
import importlib

import numpy as np
import matplotlib.pyplot as plt
import pandas as pd
import seaborn as sns
import datetime

from model.Portfolio import Portfolio
from model.Optimizer import Optimizer
plt.rcParams["figure.figsize"] = 10, 15
```

In [193]:

```
names = ["C38U", "ND8U", "V01", "AGS", "N2IU", "IAU", "BTC"]

p = Portfolio()

# Set risk-free investment as 2%, approximately SSB's returns
p.rf = 0.02

# Add all assets
for name in names:
    p.addAsset(f"data/{name}.csv", name)

# Convert non SGD assets to SGD
p.addExchangeRate("data/forex/SGDEUR.csv", "EUR", True)
p.addExchangeRate("data/forex/USDSGD.csv", "USD", False)
p.exchangeAdjustment(5, "USD")
p.exchangeAdjustment(6, "USD")
```

In [194]:

```
currentWeight = [20, 20, 20, 10, 10, 5, 5]

normalisedWeight = np.array(currentWeight)/np.sum(currentWeight)
normalisedWeight
```

Out[194]:

```
array([0.22222222, 0.22222222, 0.22222222, 0.11111111, 0.11111111,
       0.05555556, 0.05555556])
```

In [195]:

```
currentResult, currentBtPlot = p.backtest(normalisedWeight, rebalancePeriod=90)
```

In [196]:

```
currentResult
```

Out[196]:

```
{'dateStart': Timestamp('2011-04-27 00:00:00'),
 'dateEnd': Timestamp('2019-06-13 00:00:00'),
 'days': 2969,
 'valueStart': 100000.0,
 'valueEnd': 5328542.469088322,
 'sharpe': 0.508645594114274,
 'drawdown': 52.06914900495348,
 'drawdownPeriod': 388,
 'moneydown': 5788603.082195563,
 'maxDrawdown': 80.94370215110318,
 'maxDrawdownPeriod': 802,
 'maxMoneydown': 8998629.182735845,
 'averageReturns': 1.5755901477791217,
 'standardDeviation': 3.0582986774670413,
 'positiveYears': 7,
 'negativeYears': 2,
 'noChangeYears': 0,
 'bestYearReturns': 9.807584609195118,
 'worstYearReturns': -0.7139077350069437}
```

In [197]:

```
currentBtPlot()
```

Out[197]:

```
[[<Figure size 720x1080 with 10 Axes>]]
```

In [198]:

```
o = Optimizer(p)
optimisedWeight, tests = o.kfoldTs(10)
```

In [199]:

```
optimisedWeight
```

Out[199]:

```
[0.04913283588910955,
 0.14084001408867974,
 0.3883892050792337,
 0.12118859623866907,
 0.1684877235741769,
 0.11579203872854357,
 0.016169586401587378]
```

In [200]:

```
tests
```

Out[200]:

```
{'sharpeRaw': [53.0379340737709,
  0.9830758390494339,
  20.97435870640965,
  18.830920821394884,
  -1.0409228063224225,
  10.199086467506493,
  -4.704931359468397,
  52.99191374228981,
  7.550605816235641,
  43.68294786393664],
 'sharpeAvg': 20.25049891648026,
 'sharpeStd': 20.995916021659212,
 'weightsRaw': [array([0.        , 0.02087681, 0.43747243, 0.15155395,
0.180777  ,
        0.20034043, 0.00897937]),
  array([0.05850365, 0.14853474, 0.3213288 , 0.09826185, 0.23767833,
        0.12456956, 0.01112307]),
  array([0.04883034, 0.19275923, 0.38231289, 0.13664947, 0.13934355,
        0.07849736, 0.02160715]),
  array([0.04980762, 0.15536926, 0.43726837, 0.11614092, 0.14286036,
        0.08457151, 0.01398196]),
  array([0.05420867, 0.17470143, 0.37409811, 0.1207953 , 0.17176305,
        0.09188087, 0.01255256]),
  array([0.05304417, 0.15356596, 0.38454215, 0.13179709, 0.15849123,
        0.10475135, 0.01380803]),
  array([0.06617274, 0.1253762 , 0.36445551, 0.14056073, 0.16262034,
        0.123814  , 0.01700049]),
  array([0.04530765, 0.14032937, 0.39435632, 0.11613011, 0.16717606,
        0.11715922, 0.01954126]),
  array([0.05893602, 0.15320141, 0.3795245 , 0.10254824, 0.16474858,
        0.11776296, 0.0232783 ]),
  array([0.0565175 , 0.14368571, 0.40853297, 0.09744831, 0.15941873,
        0.11457311, 0.01982367])],
 'weightsStd': 0    0.017318
 1    0.043665
 2    0.032625
 3    0.017711
 4    0.025860
 5    0.032181
 6    0.004540
 dtype: float64}
```

In [201]:

```
optimisedResult, optimisedBtPlot = p.backtest(optimisedWeight, rebalancePeriod=90)
```

In [202]:

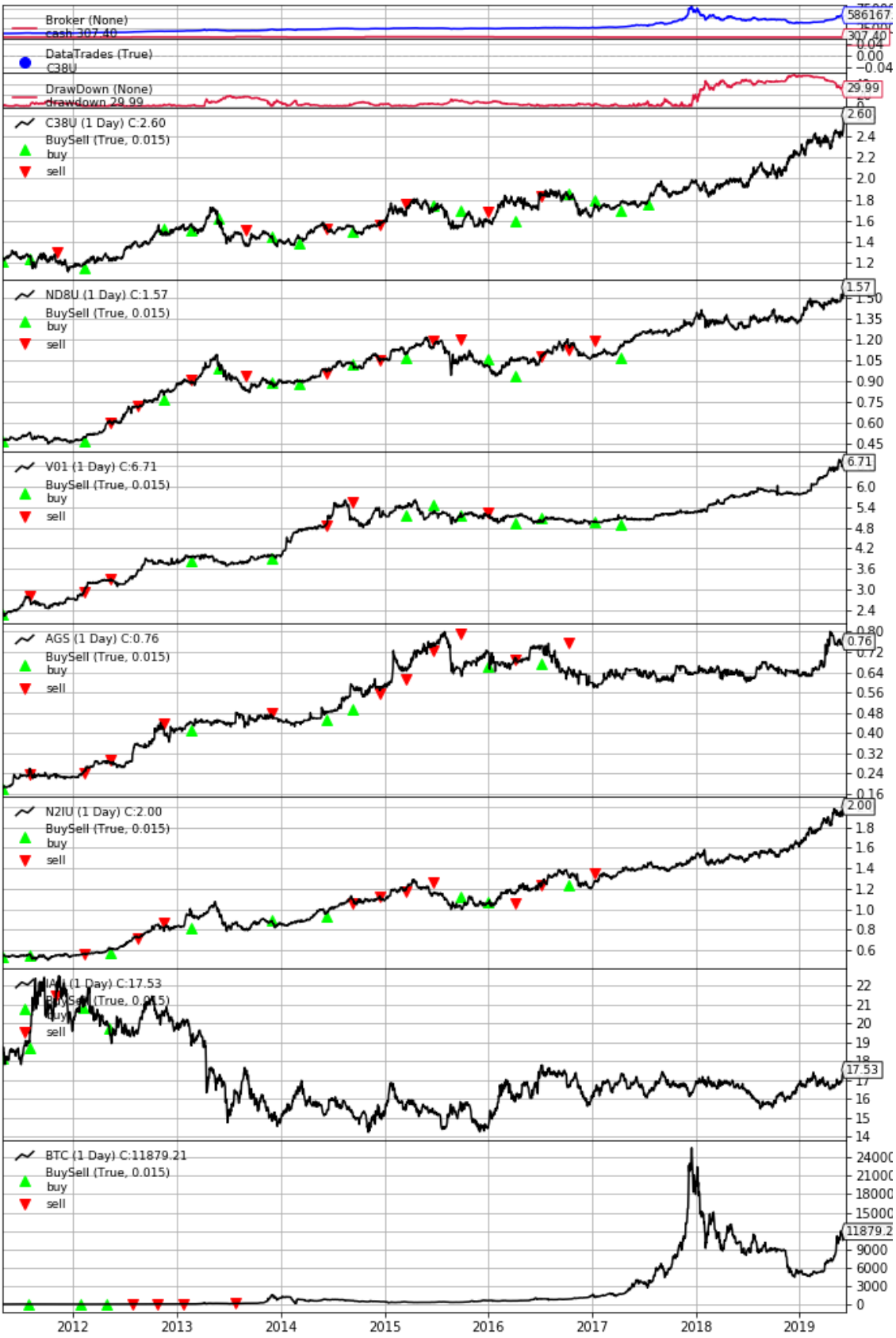
```
optimisedResult
```

Out[202]:

```
{'dateStart': Timestamp('2011-04-27 00:00:00'),
 'dateEnd': Timestamp('2019-06-13 00:00:00'),
 'days': 2969,
 'valueStart': 100000.0,
 'valueEnd': 586167.140641525,
 'sharpe': 0.5293873624691495,
 'drawdown': 29.992508054352747,
 'drawdownPeriod': 388,
 'moneydown': 251124.87532816036,
 'maxDrawdown': 55.97153246583289,
 'maxDrawdownPeriod': 388,
 'maxMoneydown': 468645.1725522991,
 'averageReturns': 0.3193528389515772,
 'standardDeviation': 0.5654703156406047,
 'positiveYears': 8,
 'negativeYears': 1,
 'noChangeYears': 0,
 'bestYearReturns': 1.7277711623147582,
 'worstYearReturns': -0.4478037542329313}
```

In [203]:

```
optimisedBtPlot()
```



Out[203]:

```
[[<Figure size 720x1080 with 10 Axes>]]
```

In [204]:

```
dict(zip(names, np.array(optimisedWeight)*100))
```

Out[204]:

```
{'C38U': 4.913283588910955,
 'ND8U': 14.084001408867975,
 'V01': 38.83892050792337,
 'AGS': 12.118859623866907,
 'N2IU': 16.84877235741769,
 'IAU': 11.579203872854357,
 'BTC': 1.6169586401587377}
```

In [ ]:

```

```