In [221]:

```python
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 [222]:

```python
names = ["C38U", "ND8U", "V01", "AGS", "N2IU", "IAU", "BTC", "A35"]

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 [223]:

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

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

Out[223]:

```
array([0.2 , 0.2 , 0.2 , 0.1 , 0.1 , 0.05, 0.05, 0.1 ])
```

In [224]:

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

```
currentResult
```

```
{'dateStart': Timestamp('2011-04-27 00:00:00'),
 'dateEnd': Timestamp('2019-06-13 00:00:00'),
 'days': 2969,
 'valueStart': 100000.0,
 'valueEnd': 655104.8081984483,
 'sharpe': 1.1302343651977251,
 'drawdown': 0.0,
 'drawdownPeriod': 0,
 'moneydown': 0.0,
 'maxDrawdown': 27.759208611705823,
 'maxDrawdownPeriod': 306,
 'maxMoneydown': 87277.91906870212,
 'averageReturns': 0.2480279715931821,
 'standardDeviation': 0.20175282102070086,
 'positiveYears': 8,
 'negativeYears': 1,
 'noChangeYears': 0,
 'bestYearReturns': 0.5963548719574734,
 'worstYearReturns': -0.02436810875592965}
```

```
currentBtPlot()
```

```
[[<Figure size 720x1080 with 11 Axes>]]
```

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

```
optimisedWeight
```

```
[0.03229938216876693,
 0.12282924644682544,
 0.34218633917837993,
 0.10510093960782259,
 0.14188498756528023,
 0.08965439661428236,
 0.014908057602555114,
 0.15113665081608763]
```

```
tests
```

```
{'sharpeRaw': [61.76749973134336,
  0.36822863932437244,
  21.387006687595612,
  21.732511183293187,
  -1.5530154462094843,
  12.929368743917701,
  -5.578683882402733,
  61.15017417229357,
  6.469040553498492,
  52.45559747340932],
 'sharpeAvg': 23.112772785606342,
 'sharpeStd': 24.77205521271505,
 'weightsRaw': [array([0.        , 0.02388098, 0.39287268, 0.12994712,
0.14491774,
         0.17523615, 0.00880224, 0.12434309]),
  array([0.03751442, 0.13676257, 0.29360114, 0.08743978, 0.20971652,
         0.10455942, 0.01060879, 0.11979737]),
  array([0.02732566, 0.1774386 , 0.33828209, 0.11906984, 0.11407497,
         0.05713222, 0.02059818, 0.14607845]),
  array([0.03079986, 0.13864504, 0.39371775, 0.10238009, 0.12186994,
         0.06367346, 0.01299722, 0.13591665]),
  array([0.03239606, 0.15232703, 0.33109818, 0.10579403, 0.14795578,
         0.06815715, 0.01157768, 0.15069409]),
  array([0.03630024, 0.13354872, 0.34156716, 0.1165741 , 0.13451522,
         0.08047984, 0.01276965, 0.14424508]),
  array([0.04798276, 0.10428872, 0.316434  , 0.1220828 , 0.13676109,
         0.09380137, 0.01540622, 0.16324304]),
  array([0.02957686, 0.11611967, 0.34017424, 0.09892872, 0.14005015,
         0.08598073, 0.01760672, 0.17156292]),
  array([0.04135629, 0.12716976, 0.32475284, 0.08654019, 0.13687528,
         0.08547802, 0.02088907, 0.17693856]),
  array([0.03974167, 0.11811138, 0.34936333, 0.08225275, 0.1321132 ,
         0.08204561, 0.0178248 , 0.17854727])],
 'weightsStd': 0    0.012265
 1    0.038252
 2    0.029574
 3    0.015675
 4    0.024547
 5    0.031514
 6    0.003991
 7    0.019965
 dtype: float64}
```

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

```
optimisedResult
```

```
{'dateStart': Timestamp('2011-04-27 00:00:00'),
 'dateEnd': Timestamp('2019-06-13 00:00:00'),
 'days': 2969,
 'valueStart': 100000.0,
 'valueEnd': 371028.36729039403,
 'sharpe': 1.1199069413518503,
 'drawdown': 0.0,
 'drawdownPeriod': 0,
 'moneydown': 0.0,
 'maxDrawdown': 14.651265371477681,
 'maxDrawdownPeriod': 316,
 'maxMoneydown': 29765.31310769997,
 'averageReturns': 0.16363080702977204,
 'standardDeviation': 0.1282524482403814,
 'positiveYears': 9,
 'negativeYears': 0,
 'noChangeYears': 0,
 'bestYearReturns': 0.42856221843835907,
 'worstYearReturns': 0.0013691479496369396}
```

```
optimisedBtPlot()
```

```
[[<Figure size 720x1080 with 11 Axes>]]
```

```
In [233]:
```
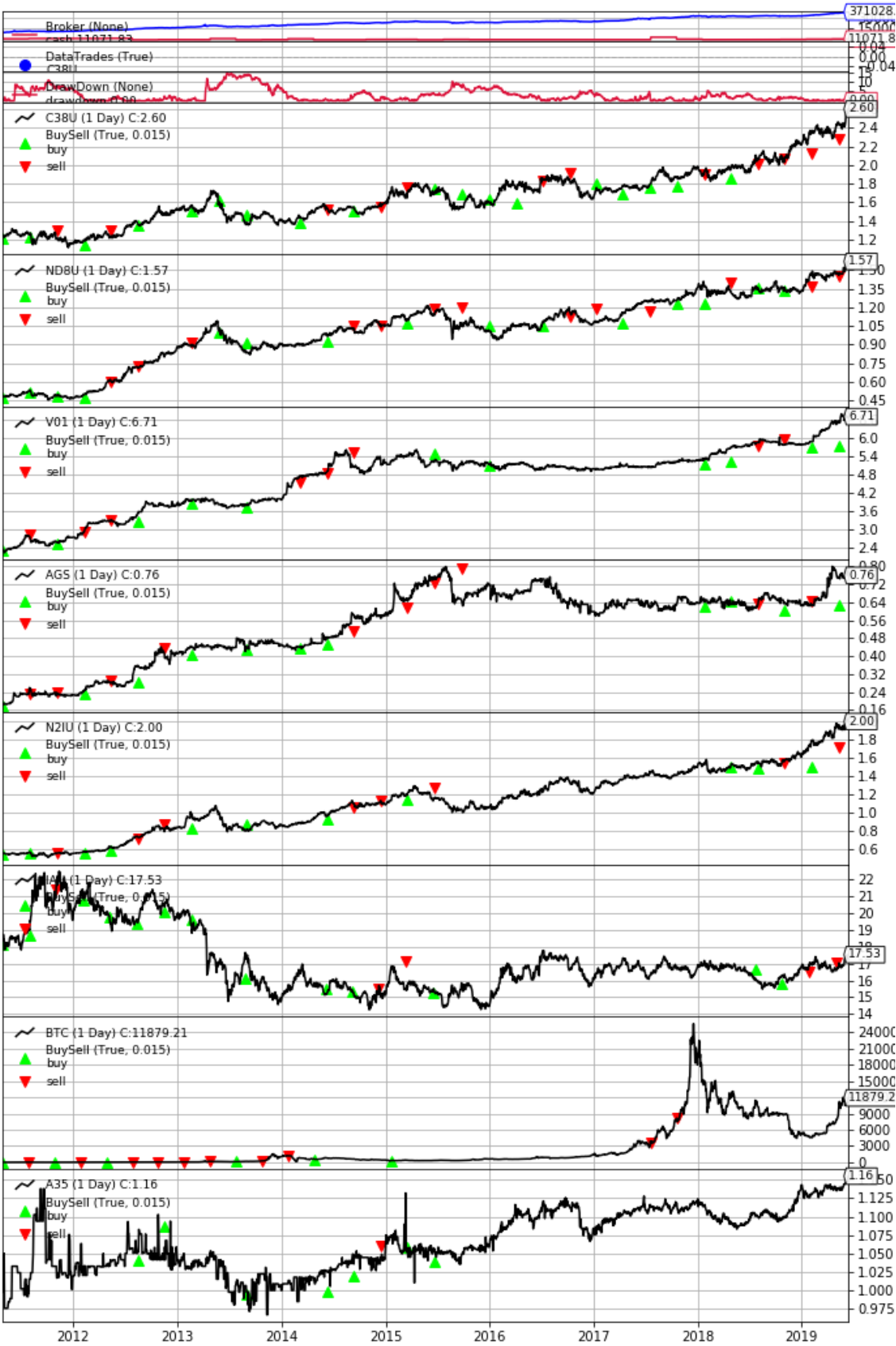
```python
dict(zip(names, np.array(optimisedWeight)*100))
```

```
Out[233]:
```

```
{'C38U': 3.2299382168766932,
 'ND8U': 12.282924644682543,
 'V01': 34.21863391783799,
 'AGS': 10.510093960782259,
 'N2IU': 14.188498756528023,
 'IAU': 8.965439661428237,
 'BTC': 1.4908057602555114,
 'A35': 15.113665081608762}
```

```
In [ ]:
```