SA-CCR Euler allocation of an exemplary equity portfolio

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We set up a collateral agreement with no thresholds or MTA and add two equity options to it. A big put option on Adidas and a smaller call option on Adidas. Both options are struck at the current market price $S(0)$.

We consider three cases of margining

1. No margining
2. VM only
3. VM and bilateral IM

[2]:
```
ca = CollateralAgreement(threshold=0,
                         threshold_vm=0,
                         mta=0,
                         margining=Margining.UNMARGINED,
                         initialMargining=InitialMargining.NO_IM)
ca.link_sa_ccr_instance(SA_CCR(ca))

ca_vm = CollateralAgreement(threshold=0,
                            threshold_vm=0,
                            mta=0,
                            margining=Margining.MARGINED,
                            initialMargining=InitialMargining.NO_IM)
ca_vm.link_sa_ccr_instance(SA_CCR(ca_vm))

ca_im = CollateralAgreement(threshold=0,
                            threshold_vm=0,
                            mta=0,
                            margining=Margining.MARGINED,
                            initialMargining=InitialMargining.SIMM)
ca_im.link_sa_ccr_instance(SA_CCR(ca_im))
```

[3]:
```
eq_opt_ads_call = EquityOption(underlying=Stock.ADS,
                               maturity=ql.Period(1, ql.Years),
                               notional=2000000,
                               tradeType=TradeType.CALL,
                               tradeDirection=TradeDirection.LONG)
```

```
eq_opt_ads_put = EquityOption(underlying=Stock.ADS,
                              maturity=ql.Period(1, ql.Years),
                              notional=3000000,
                              tradeType=TradeType.PUT,
                              tradeDirection=TradeDirection.LONG)
```

The current value of these trades is 6,601,467 EUR for the call option and 10,378,881 EUR for the put option.

When putting these two trades in the portfolio and performing an Euler allocation,

[5]:
```
ca.add_trades([eq_opt_ads_call, eq_opt_ads_put])
ca_vm.add_trades([eq_opt_ads_call, eq_opt_ads_put])
ca_im.add_trades([eq_opt_ads_call,eq_opt_ads_put])
```

[6]:
```
eulerAllocator1 = EulerAllocator(ca)
eulerAllocator2 = EulerAllocator(ca_vm)
eulerAllocator3 = EulerAllocator(ca_im)
allocation_no_margin = eulerAllocator1.allocate_ead()
allocation_with_vm = eulerAllocator2.allocate_ead()
allocation_with_im_and_im = eulerAllocator3.allocate_ead()
allocation_im = eulerAllocator3.allocate_im()
```

we can calculate how far the sum of the allocated values deviates from the risk measure:

```
Diff EAD no margin:    0.00 EUR
Diff EAD only VM:      0.00 EUR
Diff EAD VM + IM:   1068.64 EUR
Diff calculated IM:    6.74 EUR
```

In relation to the EAD of 345,874 EUR the deviation of the allocated EAD under VM and IM of 1,068.64 EUR is not large but can be improved nevertheless.

By, default the implemented Euler allocation class uses a forward difference approach. If we switch over to a central difference approach the deviation shrinks significantly.

[10]:
```
eulerAllocator3.fdApproach2 = FdApproach2.Central
allocation_im = eulerAllocator3.allocate_im()
allocation_with_im_and_im = eulerAllocator3.allocate_ead()
```

```
Diff EAD VM + IM:   0.01 EUR
Diff calculated IM: 0.00 EUR
```

Displaying the allocation results

[13]:

	2Mn ADS Call	3Mn ADS Put	Portfolio Risk Measure
SIMM	-33.75%	133.75%	14,231,564 USD
No margin	99.21%	0.79%	37,643,536 USD
VM only	232.47%	-132.47%	3,519,458 USD

```
VM+IM          622.10%    -522.10%            345,874 USD
```

For SIMM the Put has the higher risk and the Call is considered a hedge trade while for SA-CCR with only VM, the Call has the higher risk and the Put is considered a hedge trade.

The reason for this are the different holding periods between the two models. If we lower the maturity of the trades to 10 days instead, we can see that for SA-CCR with only VM the call is considered the hedge trade.

[14]:
```
eq_opt_ads_call_10d = EquityOption(underlying=Stock.ADS,
                              maturity=ql.Period(10, ql.Days),
                              notional=2000000,
                              tradeType=TradeType.CALL,
                              tradeDirection=TradeDirection.LONG)

eq_opt_ads_put_10d = EquityOption(underlying=Stock.ADS,
                             maturity=ql.Period(10, ql.Days),
                             notional=3000000,
                             tradeType=TradeType.PUT,
                             tradeDirection=TradeDirection.LONG)
```

[15]:
```
ca_vm.remove_all_trades()
ca_vm.add_trades([eq_opt_ads_call_10d,eq_opt_ads_put_10d])
```

[16]:
```
allocation_with_vm = eulerAllocator2.allocate_ead()
```

[18]: <pandas.io.formats.style.Styler at 0x1d535bb3d00>

Going back to 1Y maturity equity options we can see that the allocations of the preexisting trades can change significantly, when we add another equity option to the portfolio. We choose a position of 10Mn call options on deutsche Bank.

[19]:
```
eq_opt_dbk_call = EquityOption(underlying=Stock.DBK,
                              maturity=ql.Period(1, ql.Years),
                              notional = 10000000,
                              tradeType=TradeType.CALL,
                              tradeDirection=TradeDirection.LONG)

ca.remove_all_trades()
ca.add_trades([eq_opt_ads_call,eq_opt_ads_put,eq_opt_dbk_call])
ca_vm.remove_all_trades()
ca_vm.add_trades([eq_opt_ads_call,eq_opt_ads_put,eq_opt_dbk_call])
ca_im.remove_all_trades()
ca_im.add_trades([eq_opt_ads_call,eq_opt_ads_put,eq_opt_dbk_call])
```

[20]:
```
allocation_no_margin = eulerAllocator1.allocate_ead()
allocation_with_vm = eulerAllocator2.allocate_ead()
allocation_with_im_and_im = eulerAllocator3.allocate_ead()
```

```
allocation_im = eulerAllocator3.allocate_im()
```

[21]:

```
           10Mn DBK Call  2Mn ADS Call  3Mn ADS Put  PF Risk Measure
SIMM              63.10%        15.23%       21.67%   27,551,513 USD
No margin         57.45%        33.16%        9.39%   76,295,560 USD
VM only           80.79%        44.65%      -25.44%   10,230,051 USD
VM+IM            106.19%        86.85%      -93.04%    1,847,365 USD
```

[22]:

```
import imgkit

img = imgkit.from_string(result_df.to_html(), False, options = {
    'format': 'png'})
Image(img)
```

```
Loading page (1/2)
Rendering (2/2)
Done
```

[22]:

	10Mn DBK Call	2Mn ADS Call	3Mn ADS Put	PF Risk Measure
SIMM	63.10%	15.23%	21.67%	27,551,513 USD
No margin	57.45%	33.16%	9.39%	76,295,560 USD
VM only	80.79%	44.65%	-25.44%	10,230,051 USD
VM+IM	106.19%	86.85%	-93.04%	1,847,365 USD

[23]:

```
print(allocation_with_im_and_im[eq_opt_ads_call])
print(allocation_with_im_and_im[eq_opt_ads_put])
print(allocation_with_im_and_im[eq_opt_dbk_call])
```

```
1604516.6952186264
-1718839.1267764382
1961687.8635040484
```

Further analysis of the results shown above may be found in section Enter Reference

[25]:

```
export('SA-CCR Euler allocation of an exemplary equity portfolio.ipynb')
```