Qi for Macro Risk

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Abstract

This paper builds on the "Qi for Macro Risk" White Paper written by Dr Brian Healy, which provides detailed analysis of the Quant Insight methodology. In particular, it highlighted how Qi sensitivities can offer risk managers a more accurate view of their true underlying risks. Furthermore, it cited several examples where Qi sensitivity analysis could be used to run specific thematic scenarios. This paper takes one of those case studies, a US/China trade war, and back-tests a Qi portfolio versus a control portfolio to see which approach provided the more efficient hedge.

Traditional Correlation vs Qi Sensitivities

The typical risk management approach is to use the observed prices of traded assets to derive a simple distribution for the return of each individual asset whilst also estimating the correlations between the returns of all pairs of assets. In practice these correlation estimates are found to be highly unstable and there are frequently latent variables underlying the movements in asset prices which trading in the assets themselves does not allow you to hedge.

There is a variety of theoretical and empirical evidence suggesting a need to identify the fundamental factors driving the universe of financial instruments rather than relying on the parametric models based on historical price series. A compelling approach is to assume that these factors are macroeconomic in nature and encompass variables such as economic growth, monetary policy, impact of quantitative easing, risk aversion, credit spreads, commodity prices, etc. The factor sensitivities provided by Qi give new insights and enable risk managers to understand their risks in a systematic way. What is unique in the Qi approach is that it does not reduce the problem of hedging into arbitrary dimensions but instead provides the risk manager with a set of positions in terms of fundamental macro variables.

After normalising a substantial set of macro data across asset classes, Qi employs Principal Component Analysis and OLS regression to derive an equation for each asset in terms of macro factors and weightings. To interpret the factor sensitivities from this model, each individual factor is moved by one daily standard deviation, keeping all other factors constant, and the move in model value for the asset is recorded. This results in the un-correlated sensitivities of each asset to all 35-40 macro factors on Qi.

Case Study - Trade War

In March 2018, President Trump tweeted "trade wars are good" as the US announced proposals for a 25% tariff on steel imports and a 10% levy on aluminium. That signalled a sharp escalation in market fears about a global trade war; and a corresponding need for an efficient hedge. The traditional approach for equity investors would be to identify a number of stocks most likely to suffer in a global trade war. For any fund with a European mandate, typically that would include Auto, Basic Resource and Industrial names and then take a short position in these stocks in order to benefit from the expected fall in their prices. The control portfolio below reflects this traditional approach and equally weights Volkswagen, BMW, Michelin, Daimler, Rio Tinto, Glencore, Anglo American, Seimens, Airbus and Safran as the kind of traditional hedging vehicle that may be employed. The Qi portfolio is derived using the method described below.

Method

Qi can isolate the sensitivity of European single stocks to any given macro factor. In the case of a trade war that, at least initially, creates market fears about a negative shock for Chinese and EM growth, ADXY (Asian EM currency index) is a good proxy factor to track. As of the end of March 2018, stocks which have ADXY in its top 10 factor sensitivities are considered for the portfolio. Then, the 10 stocks from this group with the highest positive sensitivity to ADXY are selected. If there aren't sufficient stocks with ADXY as a top factor, then simply select the stocks with the highest positive exposure to ADXY, without the factor's ranking being considered. Qi's short term models were used so that the change in ADXY sensitivities were picked up as early as possible. Short term models have an 83 day look back period.

Considering where ADXY ranks as a factor, as well as its absolute value, is important. A stock might have the highest sensitivity to ADXY out of all the Euro Stoxx 600, but this stock might have 15 other factors that it is actually more sensitive to. This means that this stock 1.) has the potential to be more volatile and not appropriate for the portfolio, and 2.) isn't

actually driven by ADXY. The portfolio should contain stocks which are highly affected by the movement in the ADXY Index.

The positive sensitivities are used to find stocks to short, as we expect ADXY to fall (see Figure 1) during a US/China trade war, and therefore so should the stocks with positive sensitivities to ADXY. To create a long portfolio, Qi would consider the negative sensitivities to ADXY.

This portfolio is re-balanced bi-monthly, to find new stocks where ADXY is becoming a more prominent factor. The weights of each stock in the portfolio are a function of ADXY's importance, relative to all other macro factors. The more important ADXY is as a factor in explaining the price of an asset, the higher the weighting given to that asset.

Qi's short portfolio is then compared to the control for a 5 month period during the trade war scenario (30/03/2018 - 30/08/2018). No transaction costs were considered in this method.

Figure 1: The spot price of the ADXY Index over the duration of the portfolio back-tests.
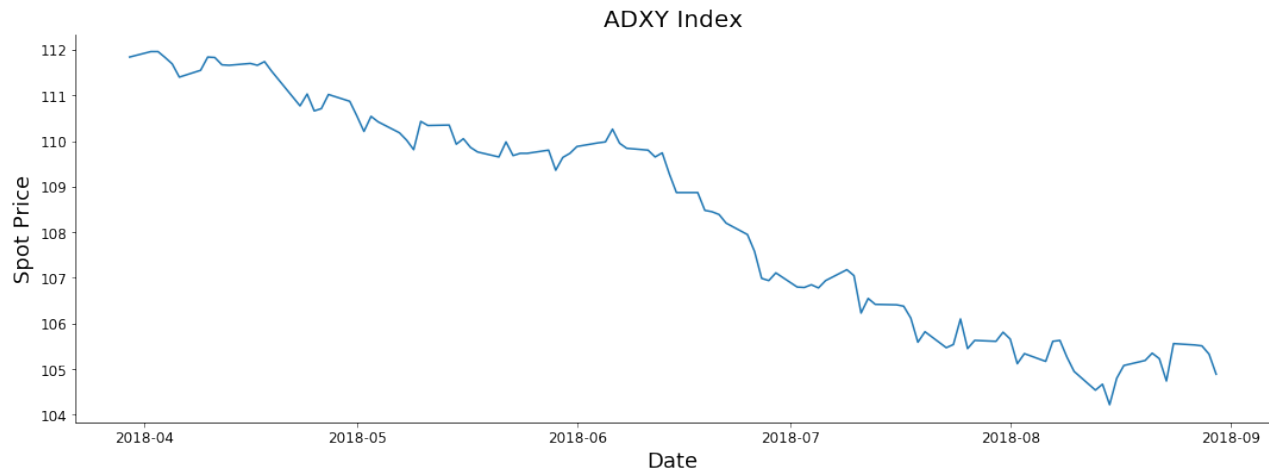
Results

Control Portfolio

Table 1 below shows the control portfolio at inception, with all stocks equally weighted, and a portfolio value of €1,000,000 distributed accordingly. The fourth column shows each stocks sensitivity to ADXY, in terms of the percentage move in the stock price due to one daily standard deviation move in ADXY. To find the actual exposure in cash terms, the position value of each stock is multiplied by its sensitivity to ADXY. Summing up all the ADXY exposures gives the total exposure of the portfolio to ADXY: -€1,350.40. This means that if ADXY is to fall by one daily standard deviation, with everything else held constant, the value of this portfolio is predicted to rise by €1,350.40.

Table 1: Control Portfolio - 30/03/2018

Stock Name	Weight	Position Value (EUR)	ADXY Sensitivity	ADXY Exposure (EUR)
Daimler	10%	-100,000	0.09	-87.70
Volkswagen	10%	-100,000	0.06	-59.80
BMW	10%	-100,000	0.14	-144.60
Michelin	10%	-100,000	0.07	-69.80
Rio Tinto	10%	-100,000	0.21	210.50
Glencore	10%	-100,000	0.23	-231.8
Anglo American	10%	-100,000	0.32	-320.50
Siemens	10%	-100,000	0.21	-212.40
Airbus	10%	-100,000	-0.01	13.40
Safran	10%	-100,000	0.03	26.70
TOTAL	100%	-1,000,000	1.35	-1,350.40

Table 2 below shows the control portfolio 3 months later. A hedge executed via this control portfolio resulted in a loss of 2.12%. Traditional name selection has not, in this instance, provided an efficient hedge for a trade war scenario.

A critical observation is that the total exposure to ADXY is now positive, which indicates that the returns from this portfolio might continue to move in the opposite direction to ADXY. If the trade war narrative continues, this naive portfolio could generate even bigger losses.

Table 2: Control Portfolio - 29/06/2018

Stock Name	Weight	Position Value (EUR)	ADXY Sensitivity	ADXY Exposure (EUR)
Daimler	10%	-83,906	-0.08	65.36
Volkswagen	10%	-94,542	-0.13	118.17
BMW	10%	-91,877	-0.13	118.89
Michelin	10%	-89,519	0.22	-195.89
Rio Tinto	10%	-118,833	-0.47	557.92
Glencore	10%	-104,531	-0.09	97.53
Anglo American	10%	-102,610	-0.05	55.00
Siemens	10%	-111,632	-0.29	332.73
Airbus	10%	-105,448	0.07	-69.17
Safran	10%	-118,346	-0.50	589.01
TOTAL	100%	-1,021,245	-1.45	1,659.58

Qi Portfolio

Table 3 below is the Qi portfolio that offers an alternative hedging vehicle. These names are European stocks which feature ADXY as a top factor; moreover, those which are the most sensitive to this factor. The weights are then derived from where ADXY ranks in each stock's list of most sensitive factors. If ADXY ranks as the number one factor in terms of sensitivity, this stock will get the largest weighting.

The value of the positions in each stock were calculated from the weights, with Qi's portfolio worth the same as the control (€1,000,000). These are displayed in Table 3 below. The total exposure to ADXY is, as expected, bigger than the control's at inception, as the stocks most sensitive to ADXY have been picked.

Table 3: Qi Portfolio - 30/03/2018

Stock Name	Weight	Position Value (EUR)	ADXY Sensitivity	ADXY Exposure (EUR)
Galapagos	9.49%	-94,887	0.46	-436.48
Banco Sabadell	8.70%	-86,979	0.36	-316.00
Erste Bank	9.49%	-94,887	0.36	-341.78
Anglo American	10.44%	-104,375	0.32	-334.52
NMC Health	10.44%	-104,375	0.27	-279.31
Hexagon	9.49%	-94,887	0.26	-245.28
Smiths Group	9.49%	-94,887	0.24	-227.54
Melrose Industries	11.60%	-115,973	0.24	-277.64
Wienerberger	10.44%	-104,375	0.18	-189.02
CNP Assurances	10.44%	-104,375	0.17	-175.77
TOTAL	100%	-1,000,000	2.86	-2,823.34

Three months later, the re-balancing process has produced a different set of stocks bar one, Erste Bank. Across the European equity complex, ADXY has become a more important factor in explaining the variance in stock prices. The stocks in Table 4 are now the most sensitive to ADXY.

The returns of this short portfolio as of 29th June 2018 are +2.48%. It has behaved as expected: as ADXY has fallen (Figure 1), the value of the positions in the portfolio have gone up. Relative to the control portfolio, the Qi sensitivity-weighted basket is a far more efficient hedge.

The total exposure to ADXY is now at -€7,543.60, meaning if ADXY falls by one daily standard deviation, the portfolio is estimated to rise by €7,543.60.

Table 4: Qi Portfolio - 29/06/2018

Stock Name	Weight	Position Value (EUR)	ADXY Sensitivity	ADXY Exposure (EUR)
Philips Lighting	8.16%	-79,608	1.31	-1,041.44
AMS	8.16%	-79,608	1.15	-918.60
ASM International	8.16%	-79,608	0.95	-752.94
Orkla	8.16%	-79,608	0.85	-673.09
Renault	14.69%	-143,295	0.75	-1,072.56
Telecom Italia	7.35%	-71,648	0.70	-500.24
VAT Group AG	14.69%	-143,295	0.67	-957.78
SocGen	9.18%	-89,600	0.66	-587.78
Erste Bank	9.18%	-89,600	0.51	-454.87
Smurfit Kappa Group	12.24%	-119,413	0.49	-584.29
TOTAL	100%	-975,203	8.02	-7,543.60

Control vs Qi

Figures 2 and 3 show the top 10 factor sensitivities of the control portfolio, at inception and 3 months later. Each pie chart show the comparisons in the size of the sensitivities. At inception (03/30/2018) the portfolio's largest factor sensitivity was Natural Gas. Critically, the only trade war related factors are Copper and DXY, but they only rank as the 4th and 8th most important factors, showing empirically that the control portfolio is not really exposed to the trade war scenario.

Three months later (29/06/2018), the control portfolio was most sensitive to FinSub Credit. More significantly, the top drivers display little sensitivity to a trade war narrative. US economic growth does feature as a driver, but none of the other macro factors that speak to trade war dynamics feature prominently. This shows how hedges derived from orthodox thinking don't necessarily always insure against the scenario they are intended to.
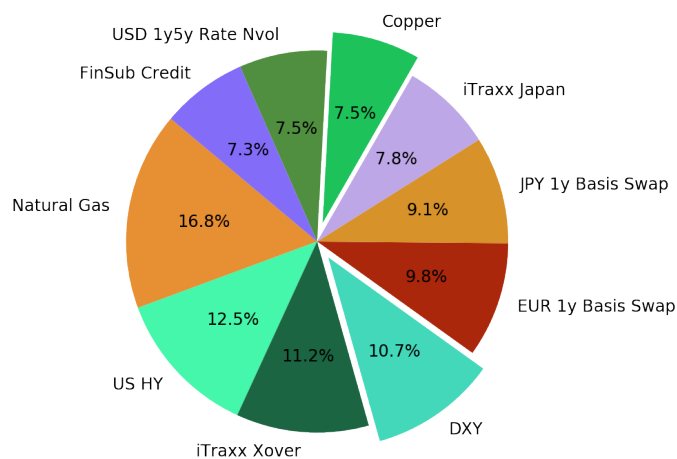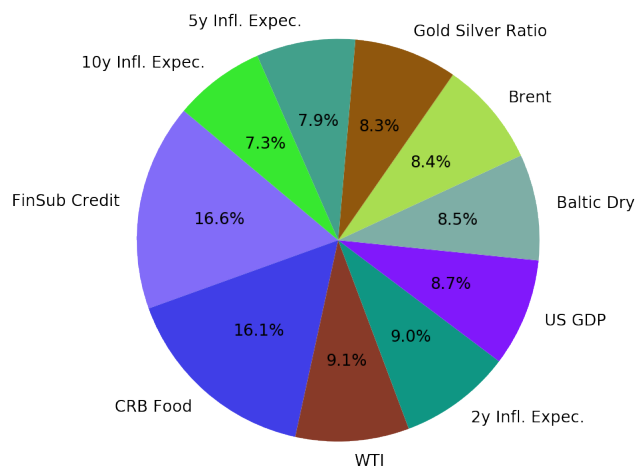

Figure 2: Control Portfolio - 30/03/2018

Figure 3: Control Portfolio - 29/06/2018

Figures 4 and 5 show the factors which Qi's portfolio are most sensitive to. At inception, ADXY ranks as the 8th most important factor, as there aren't many stocks yet that are highly sensitive to Asian EM FX. Note however, both copper and DXY also feature as drivers, and both clearly speak to a regime where global growth and risk appetite is threatened.

At the end of June in Figure 5, the top 4 factors are all highly related to a US/China trade war. ADXY is now the second most important factor regarding sensitivities. Moreover, CRB Rind has joined DXY and copper as a top driver. Indeed, these four macro factors explain 50% of the top ten drivers in Qi's macro regime. These results show how Qi can allow you to back your economic view with real empirical data, instead of opinion.

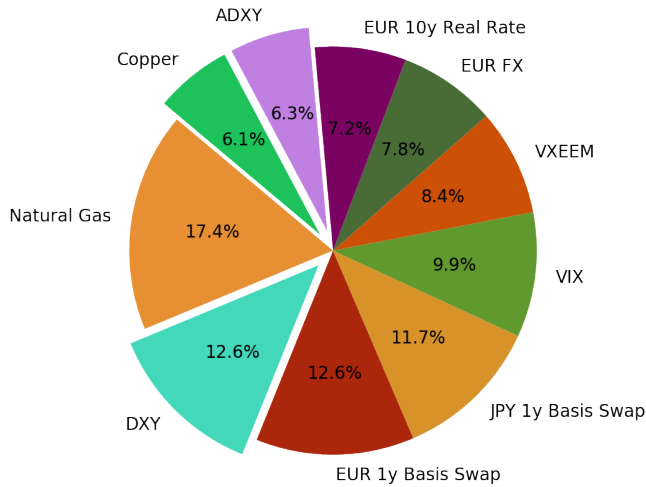Figure 4: Qi Portfolio - 30/03/2018

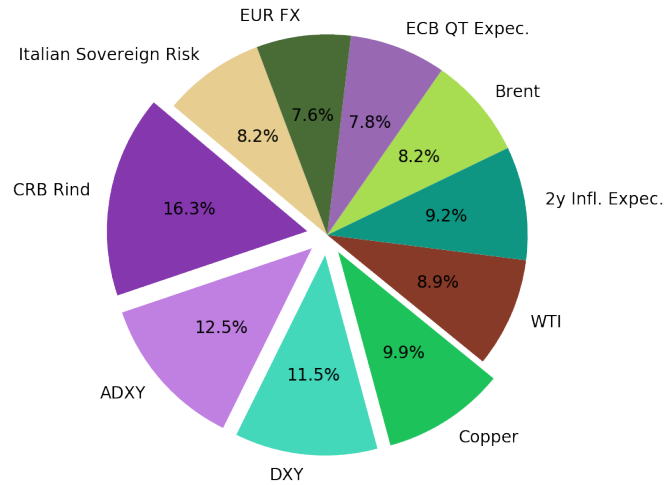Figure 5: Qi Portfolio - 29/06/2018

Table 7 shows the exposures, in Euros, of every stock in Qi's portfolio as of 29/06/2018 to the top ten factors. Each figure shows the change in value of the position in each stock, if the factor moves up by one daily standard deviation. Qi's data is used here to present a portfolio's risk in terms of fundamental macroeconomic factors.

Table 5: Qi Portfolio - exposure to each factor (Euros) - 29/06/2018

Stock Name	CRB Rind	ADXY	DXY	Copper	WTI	2y Infl. Expec.	Brent	ECB QT Expec.	EUR FX	Italian Sovereign Risk
Philips Lighting	-1,952	-1,041	975	-1,188	1,731	997	1,600	-505	-1,093	118
AMS	-1,855	-919	815	-1,129	1,038	915	959	-746	316	-426
ASM International	-1,240	-753	705	-755	1,103	861	1,020	-339	-790	364
Orkla	-783	-673	611	-476	835	91	771	-606	4	160
Renault	-777	-1,073	1,004	-473	234	989	216	-619	-1,126	-1,136
Telecom Italia	-86	-500	469	-53	-448	274	-414	-331	-525	-1,203
VAT Group AG	-1,297	-958	850	-789	519	382	479	-633	329	-808
SocGen	-570	-588	550	-347	-88	302	-81	-343	-617	-990
Erste Bank	-298	-455	426	-182	-92	312	-85	-272	-478	-759
Smurfit Kappa Group	-985	-584	547	-599	515	409	476	-299	-613	-259
TOTAL	-9,843	-7,544	6,952	-5,992	5,347	5,531	4,940	-4,692	-4,593	-4,937

The final results of Qi's portfolio compared to the control portfolio over the 5 month test period are shown in Figure 6. Both are designed to provide a hedge against a trade war hurting global growth stocks. As such, we want their value to fall to generate a profit. Over the test period, shorting Qi's portfolio generated results of +10.6%, whereas shorting the control portfolio would have meant a loss of 2.4%. Over the same period ADXY fell 6.25%, meaning the Qi portfolio has provided a beta above 1 to the macro factor we are seeking to track.

Figure 6
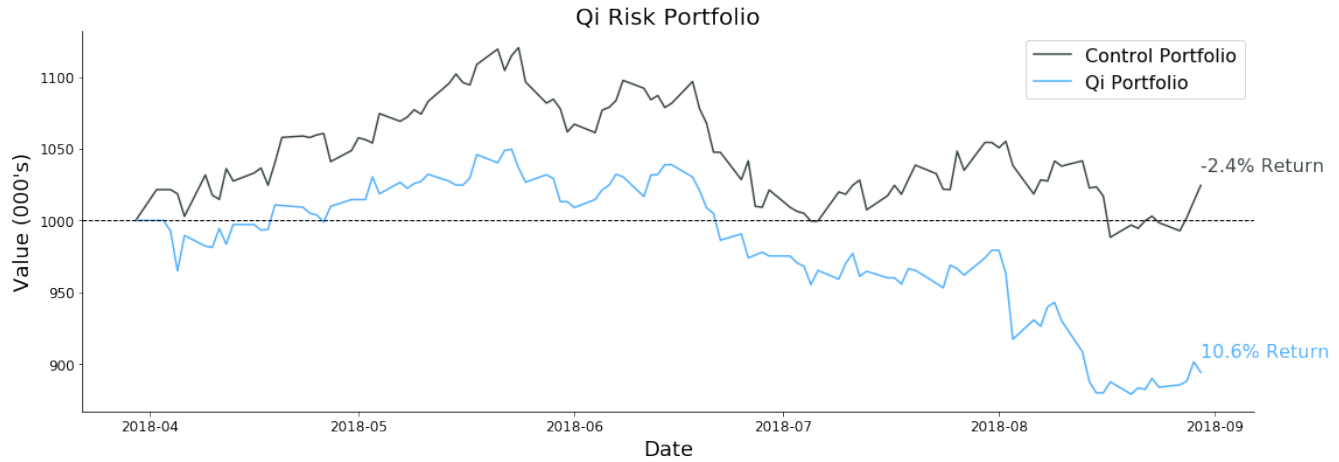
Conclusion

These results show that Qi's sensitivities are able to find a portfolio which hedges risk more effectively than a standard approach. Using the example of a US/China trade war we found that the Qi generated portfolio outperformed the control by 13.0%.

Qi Risk is a powerful new tool for risk managers which allows them to identify the fundamental factors which are driving the securities in their portfolio. Individual exposures can then be aggregated to provide a portfolio or firm wide view of risk.

In summary, the Qi approach provides a much needed alternative to the traditional approach to portfolio risk management and allows for a much clearer understanding of the real macro factors affecting the value of a portfolio.

This is the fourth in a series of White Papers designed to showcase empirical examples of the Qi output. Here Qi used the macro factor sensitivities to find a portfolio of stocks to hedge against a trade war. Topics to follow include. . .

- New trading strategies with different constraints and on different asset classes.

- RSq and macro regimes. How long do regimes last? Which asset class enjoys regimes with the greatest longevity?

- Closing the FVG – model to market or market to model? An empirical look at the most efficient way to capture the 'correct' mean reversion.

Appendix

Below we illustrate how an interested party could download Qi's data via API. Using the global trade war scenario above, the script provides an example of how a user could import Qi sensitivity analysis and then use it to derive portfolio weights, factor exposures and the impact on any given portfolio.

```python
def get_portfolio(factor,size,date):

    FACTOR_sensitivity = []
    names = []
    POSITION = []

    Euro_stoxx_600_IDs = range(4690,5890,2)

    for i in Euro_stoxx_600_IDs:

        sensitivity = client.models.getModelSensitivities(model=i,date_from=date,date_to=date).response().result

        df_sensitivities = pandas.DataFrame()
        date_string = date.strftime('%Y%m%d')

        for data in sensitivity[date_string]:
            df_sensitivities[str(data['driver_short_name'])]=[data['sensitivity']]

        top10 = df_sensitivities.transpose().nlargest(10,0)
        Factor_sens = float(df_sensitivities[factor])

        if factor in top10.index and Factor_sens > 0:
            FACTOR_sensitivity.append(Factor_sens)
            names.append(client.models.getModel(model=i).response().result['name'])
            position = top10.index.tolist().index(factor)+1
            POSITION.append(position)

    portfolio_size = size

    df_factor_sensit = pandas.DataFrame({'Name':names,'Position':POSITION,factor+' Sensitivity':FACTOR_sensitivity})
    portfolio = df_factor_sensit.nlargest(portfolio_size,str(factor)+' Sensitivity')

    sw = 1/(portfolio['Position']+2)
    summ = sum(sw)
    Weights = sw/summ
    position_values = [1000000*x for x in Weights]
    factor_exposure = [a*b/100 for a,b in zip(portfolio[factor+' Sensitivity'],position_values)]

    portfolio = portfolio.drop(['Position'], axis=1)
    portfolio.insert(1,'Weight',Weights)
    portfolio.insert(2,'Position Value',position_values)
    portfolio[factor+' Exposure'] = factor_exposure

    return portfolio
```

```python
get_portfolio('ADXY',10,datetime(2018,6,29))
```

Table 6: Qi Portfolio - 29/06/2018

Stock Name	Weight	Position Value (EUR)	ADXY Sensitivity	ADXY Exposure (EUR)
Philips Lighting	8.16%	-77,634	1.31	-1,015.61
AMS	8.16%	-77,634	1.15	-895.82
ASM International	8.16%	-77,634	0.95	-734.27
Orkla	8.16%	-77,634	0.85	-656.40
Renault	14.69%	-139,742	0.75	-1,045.97
Telecom Italia	7.35%	-69,871	0.70	-487.84
VAT Group AG	14.69%	-139,742	0.67	-934.04
SocGen	9.18%	-87,339	0.66	-573.20
Erste Bank	9.18%	-87,339	0.51	-443.59
Smurfit Kappa Group	12.24%	-116,452	0.49	-569.80
			TOTAL	-7,356.54

```python
def get_portfolio_exposures(portfolio, date):

    stock_names = portfolio['Name']
    df_tot = pandas.DataFrame()

    for stock in stock_names:

        sensitivity = client.models.getModelSensitivities(model=stock, date_from=date, date_to=date).
response().result
        df_sensitivities = pandas.DataFrame()
        date_string = date.strftime('%Y%m%d')

        for data in sensitivity[date_string]:
            df_sensitivities[str(data['driver_short_name'])]=[data['sensitivity']]

        df_sensitivities = df_sensitivities.rename(index={0:stock})
        df_sensitivities = df_sensitivities.sort_index(axis=1)
        if df_tot.empty:
            df_tot = df_sensitivities
        else:
            df_tot = df_tot.append(df_sensitivities)

    SUMS = [sum(df_tot[x]) for x in df_tot.columns]
    df_tot.loc['Sum'] = SUMS
    portfolio_sensitivities = df_tot[df_tot.transpose().nlargest(10,'Sum').index].transpose()

    for stock in stock_names:

        portfolio_sensitivities[stock] = [a*float(portfolio.loc[portfolio['Name']==stock]['Position Value
'])/100 for a in portfolio_sensitivities[stock]]

    portfolio_sensitivities = portfolio_sensitivities.drop(columns = 'Sum')

    ex_SUMS = [sum(portfolio_sensitivities.loc[x]) for x in portfolio_sensitivities.index]
    portfolio_sensitivities['TOTAL'] = ex_SUMS
    portfolio_exposures = portfolio_sensitivities.transpose()

    return portfolio_exposures
```

```python
get_portfolio_exposures(portfolio, datetime(2018,6,29))
```

Table 7: Qi Portfolio - exposure to each factor (Euros) - 29/06/2018

Stock Name	CRB Rind	ADXY	DXY	Copper	WTI	2y Infl. Expec.	Brent	ECB QT Expec.	EUR FX	Italian Sovereign Risk
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Renault	-777	-1,073	1,004	-473	234	989	216	-619	-1,126	-1,136
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SocGen	-570	-588	550	-347	-88	302	-81	-343	-617	-990
Erste Bank	-298	-455	426	-182	-92	312	-85	-272	-478	-759
Smurfit Kappa Group	-985	-584	547	-599	515	409	476	-299	-613	-259
TOTAL	-9,843	-7,544	6,952	-5,992	5,347	5,531	4,940	-4,692	-4,593	-4,937

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