The Impact of Currency Choice on Minimum Variance Portfolios

Quantitative Equity Research

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Executive Summary: The Impact of Currency Choice on Minimum Variance Portfolios

Base Currency and Portfolio Composition
In this paper we explore the effects of choice of base currency in Minimum Variance portfolio optimisation and find that choice of currency significantly affects final portfolio composition. Contrary to recent papers referenced later, we conclude however that investors should use USD returns in their optimisation regardless of their base currency.

Currency Biases
Changing the optimisation currency increases the proportion of stocks denominated in that base currency selected for the optimal portfolio. We look at regional portfolio allocations when optimisation currency changes. As expected, the optimised portfolio becomes skewed towards countries which share the same base optimisation currency.

Volatility and Returns
We find that there appears to be no material difference in final risk and return outcomes, despite the fact that the underlying portfolios change considerably.

What may an investor do?
Minimum Volatility strategies are often benchmarked against capitalisation-weighted market portfolios, using risk-adjusted performance metrics. It follows therefore that the choice of base currency greatly affects the resultant minimum variance portfolio.

However, research illustrates that there seems to be no material difference in overall portfolio volatility from changing the optimisation currency. In our opinion, investors should consider using USD-optimised portfolios because the resultant portfolio follows more closely the broad structure of the capitalisation-weighted market portfolio – and this is less risky if correlation structures were to become more unstable.
Introduction

In this note, we explore the effects of changing the currency of optimisation when constructing Minimum Variance Portfolios (MVP). This issue has been explored by Jourovski (2011) and also by Analytic Investors (2014), with both sets of authors coming to different conclusions. This is a very important topic because the choice of base currency in the optimisation has a fundamental effect on the resulting portfolios.

Why should we care about the base currency when constructing the Variance-Covariance matrix used for Minimum Variance optimisation? In multi-country universes, we expect our choice of base currency to have a sizeable impact on estimated individual stock variances and covariances (Figure 1 shows that FX volatility is rather significant when compared to equity volatility).

![Figure 1: FX Volatility vs USD Benchmark Volatility (Annualised)](image)

Of course, changing the base currency can reverse this. In this paper, we conduct an empirical exercise examining the effects of constructing MVP by changing optimisation currency.

For an optimisation using local currency, the stock returns used in calculating the Variance-Covariance matrix are calculated based on the listing currency of each stock, so a portfolio will simultaneously have returns in multiple currencies as an input into the optimisation. We construct our portfolios using our in-house approach for constructing Global Low Volatility portfolios, which initially screens for the top 300 stocks which are in line with our Value and Profitability core process and then conducts a Minimum Variance optimisation using a stock covariance matrix that has been cleaned and covariance-shrunken to enhance stability.
Methodology

For our live Lower Volatility portfolios, we currently use USD returns as the base currency for optimisation. The reason for that is simple; the US has always had the largest weight within the MSCI All Country World Index, having a weight of 51.74% as of February 2015. Therefore, it would be a natural decision to construct the portfolio in the dominant currency. However, the problem becomes slightly more complex when the investor is for example a European investor, who wishes to receive his returns in EUR. The investor might have 3 options for currency used in optimisation- 1) USD, 2) EUR or 3) Local currency.

Portfolio Characteristics

We start by looking at the number of stocks within each portfolio. We see that the number of stocks is more or less similar in the three portfolios.
We now consider how much overlap we observe with each portfolio by looking at the proportion of overlapping names out of the total unique names in the portfolios. There is on average a 37% overlap between the names of the MVP in EUR and USD and a 46% overlap between the names of the MVP in local currency and USD. It is clear that choice of currency has a significant impact on the covariance matrix, resulting in very different MVP. This comes as no surprise to us as the entire covariance matrix changes when using different base currencies.

However, despite the low overlap between names in each portfolio, the style characteristics of the portfolios appear to be similar. It is to be noted that the high positive exposures to Value and Profitability are a consequence of our initial EVROIC screening process.

**Figure 4: Average Style Exposures (Minimum Average Portfolio)**

<table>
<thead>
<tr>
<th></th>
<th>USD</th>
<th>Local</th>
<th>EUR</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Value</strong></td>
<td>0.25</td>
<td>0.30</td>
<td>0.27</td>
</tr>
<tr>
<td><strong>Quality</strong></td>
<td>0.42</td>
<td>0.40</td>
<td>0.37</td>
</tr>
<tr>
<td><strong>Volatility</strong></td>
<td>-0.79</td>
<td>-0.78</td>
<td>-0.73</td>
</tr>
<tr>
<td><strong>Momentum</strong></td>
<td>0.04</td>
<td>0.04</td>
<td>0.03</td>
</tr>
<tr>
<td><strong>Size</strong></td>
<td>-0.63</td>
<td>-0.61</td>
<td>-0.61</td>
</tr>
<tr>
<td><strong>Leverage</strong></td>
<td>-0.11</td>
<td>-0.03</td>
<td>-0.08</td>
</tr>
<tr>
<td><strong>Trading Activity</strong></td>
<td>-0.16</td>
<td>-0.22</td>
<td>-0.19</td>
</tr>
<tr>
<td><strong>Dividend Yield</strong></td>
<td>0.35</td>
<td>0.40</td>
<td>0.39</td>
</tr>
<tr>
<td><strong>Growth</strong></td>
<td>-0.20</td>
<td>-0.17</td>
<td>-0.18</td>
</tr>
<tr>
<td><strong>Earnings Variability</strong></td>
<td>-0.05</td>
<td>-0.05</td>
<td>-0.03</td>
</tr>
</tbody>
</table>


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It follows that we would expect the ex-ante volatility of these portfolios to be similar.

Figure 5 looks at regional allocations based on returns currency. We sort the top 10 currencies based on regions and put the remainder under others (note we do not sort others into regions). When the global MVP is constructed using EUR as a base currency, we find that the average allocation to stocks in EUR is substantially higher than that of the USD portfolio 18% vs 5%. This is to be expected, in unexceptional circumstances, stocks denominated in EUR will appear to be the least relatively risky/volatile of the lot, as the currency risk in EUR-denominated stocks would have been stripped out due to our choice of base currency. We also see higher weights to currencies that are very closely tied to the EUR, like the CHF (if we exclude recent volatility). With the objective of Minimum Variance portfolio construction being to pick stocks which in combination minimise overall volatility, it is natural that the ‘lower volatility’ EUR-denominated stocks are more attractive and given higher weights in the EUR-optimised portfolios.

Similarly, when we compare the USD portfolio to that of the Local currency portfolio, we see that the USD portfolio has a higher average weight in USD-denominated stocks; with an average allocation of 43% vs 38% in the Local currency portfolio (see Figure 5). However, it should be noted that the USD-optimised portfolio still has a lower weight in the USD-denominated stocks than the MSCI All Country World benchmark, as well as the selection of the top 300 ranked stocks, while on the other hand the EUR-optimised portfolio has a higher weight in EUR-denominated stocks than the MSCI All Country World benchmark and the top 300 stocks.

In February 2006, the MVP EUR-optimised had 2.13x the MSCI All Country World benchmark’s weight in EUR-denominated stocks. It is vital for an investor to decide if he/she is comfortable with having such a significant overweight position. On the other hand, the maximum that the USD-denomination skew goes to is 1.22x in December 2006.

Figure 5: Top 10 currencies of MVP and Benchmark

The figures above extend our analysis to a few other currencies, namely CHF, JPY and GBP and as anticipated; we see a weight bias towards currency of optimisation.

Portfolio Volatility and Returns

Having described the country and stock characteristics of the portfolios, we now proceed to look at the risk and return characteristics of the portfolios. MVP optimised from returns in different currencies have different country and stock allocations, it is important to investigate how this would affect final portfolio outcomes. To start off, we have to choose the currency we wish our returns to be generated in. We also assume that our portfolios are unhedged. This is in line with HSBC’s views on currency hedging of equities.

Currency choice has an impact on both returns and volatilities, even at the benchmark level, as can be seen from Figure 12. It can be seen that an investor that buys a EUR-denominated MXWD benchmark will have lower volatility and returns than an investor that buys a USD-denominated index. We do not discuss the Local currency portfolios as we assume all returns will be converted to the currency of choice.

Figure 12: MSCI ACWI Benchmark Risk-Return in USD, Local currency, EUR and JPY (Jan 2000 – Jun 2015)

<table>
<thead>
<tr>
<th>Currency</th>
<th>USD</th>
<th>Local</th>
<th>EUR</th>
<th>JPY</th>
</tr>
</thead>
<tbody>
<tr>
<td>Annualised return</td>
<td>4.2%</td>
<td>4.0%</td>
<td>3.4%</td>
<td>5.1%</td>
</tr>
<tr>
<td>Annualised volatility</td>
<td>16.1%</td>
<td>14.3%</td>
<td>14.5%</td>
<td>19.0%</td>
</tr>
<tr>
<td>Sharpe Ratio</td>
<td>0.26</td>
<td>0.28</td>
<td>0.23</td>
<td>0.27</td>
</tr>
</tbody>
</table>

Source: Factset, MSCI as at 30/06/15
Returns are net of trading costs. Past performance should not be seen as an indication of future returns.

Now consider Minimum Variance optimisation using different base optimisation currencies. As can be seen from Figure 13, all of HSBC’s MVPs have substantially lower average ex-post volatility than the MSCI All Country World benchmark. They also have much higher Sharpe Ratios than the benchmark.

Figure 13: Annualised Volatility of MVPs under different optimisation currencies

<table>
<thead>
<tr>
<th>Portfolio Returns currency</th>
<th>USD</th>
<th>Local</th>
<th>EUR</th>
<th>GBP</th>
<th>JPY</th>
<th>CHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD</td>
<td>10.0%</td>
<td>11.3%</td>
<td>11.2%</td>
<td>11.7%</td>
<td>10.2%</td>
<td>10.7%</td>
</tr>
<tr>
<td>EUR</td>
<td>10.2%</td>
<td>10.6%</td>
<td>9.7%</td>
<td>10.2%</td>
<td>10.2%</td>
<td>10.0%</td>
</tr>
<tr>
<td>JPY</td>
<td>12.7%</td>
<td>13.6%</td>
<td>13.4%</td>
<td>13.2%</td>
<td>12.5%</td>
<td>13.0%</td>
</tr>
</tbody>
</table>

Figure 14: Sharpe Ratio of MVPs under different optimisation currencies

<table>
<thead>
<tr>
<th>Portfolio Returns currency</th>
<th>USD</th>
<th>Local</th>
<th>EUR</th>
<th>GBP</th>
<th>JPY</th>
<th>CHF</th>
</tr>
</thead>
<tbody>
<tr>
<td>USD</td>
<td>1.16</td>
<td>0.95</td>
<td>0.99</td>
<td>1.00</td>
<td>1.00</td>
<td>1.07</td>
</tr>
<tr>
<td>EUR</td>
<td>1.04</td>
<td>0.92</td>
<td>1.05</td>
<td>1.06</td>
<td>0.91</td>
<td>1.04</td>
</tr>
<tr>
<td>JPY</td>
<td>1.01</td>
<td>0.88</td>
<td>0.92</td>
<td>0.98</td>
<td>0.91</td>
<td>0.97</td>
</tr>
</tbody>
</table>

Source: Factset, IBES, Worldscope as at 30/06/15
Returns are net of trading costs. Past performance should not be seen as an indication of future returns.
As the overall aim of a Minimum Variance optimisation is to find the set of portfolio weights which minimises estimated volatility (ex-ante) and this should result in low realised volatility, we look more closely at the ex-post volatilities of the resulting portfolios. Here, there is little difference in ex-post volatility despite us having constructed three very different portfolios. Looking more closely at the rolling 3-year volatility in Figures 15 and 16, we can see that there are periods where having USD as an optimisation currency results in lower volatility than when using EUR as an optimisation currency and vice versa. This is most probably because it is hard to accurately estimate FX correlations and volatility to such accuracy. Despite having an optimisation problem that aims to find the portfolio of Minimum Variance relative to a particular currency, it estimates volatility with large enough error such that the ex-post volatility is not necessarily always lower than when using another optimisation currency. We should note that with a rolling 3-year volatility window, the ex-post volatility, regardless of optimisation base currency, is lower than the cap-weighted benchmark.

Even though our portfolio construction process is based on Minimum Variance optimisation, there is a degree of alpha that is included in the portfolio due to the stock ranking method used, thus we are interested in observing the effect of optimisation currency on portfolio returns. When looking at absolute returns, it is hard to draw a clear conclusion either way. However, it is comforting to note that the general pattern of returns appears to be rather similar regardless of choice of optimisation currencies. For portfolios where we convert returns to USD, USD-optimisation outperforms EUR and Local currency optimisations in 6 out of 15 years of data, EUR-optimisation outperforms for 4 years while Local currency optimisation outperforms for the remaining 5 years. We see similar results for portfolios where we convert returns to EUR, so there seems to be no strong argument to support matching the currency of optimisation to the currency of the portfolio’s final returns.

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Figures 15 & 16 Source: Factset, IBES, Worldscope as at 31/01/2015

Returns are net of trading costs. Past Performance should not be seen as an indication of future returns.

Figures 17 & 18 Source: Factset, IBES, Worldscope as at 31/12/2014
USD as a perceived ‘safe-haven’ currency

We believe that the methodology of running Minimum Variance optimisation with USD as a base currency is the most appropriate one. Practically speaking, the USD has historically been treated as a perceived ‘safe haven’ currency, with many portfolios holding USD as a form of hedge against equity market volatility. The idea behind the USD as a perceived ‘safe haven’ currency is simply that when there are crises, investors buy more USD, thereby hedging against riskier assets that are held.

This can be seen on Figure 20, where we show the correlations between the changes in the MSCI World Local Currency Index and the nominal Effective Exchange Rate (EER) from the Bank of International Settlement (BIS). These EERs are geometric weighted averages of bilateral exchange rates. We can see that the USD and JPY tend to have negative correlations with equity market returns.

When looking at this relationship through time, it clearly demonstrates the USD’s role as a perceived ‘safe-haven’ currency, through its negative correlations with the market especially during market crashes (note tech bubble and GFC period). One could argue that the JPY has also provided this behavior, though it has been more volatile recently.
Conclusion

In this note, we show the results of running the Minimum Variance portfolio optimisation in USD, EUR, GBP, JPY, CHF and local currency. Although the final risk and return metrics appear to be rather similar, it is important to observe how the choice of currency for optimisation fundamentally affects portfolio composition. It is important to note that these results are specific to our Minimum Variance construction process and cannot be necessarily generalised for all MVP.

For investors looking to choose a base currency for optimisation, it is important to be aware that running the optimisation using a non-USD currency would most likely result in an overall systematic overweighting of stocks in the currency of choice. This is due to the nature of the Minimum Variance optimisation, which incorporates the effects of currency volatility on stock returns in the optimisation.

Practically speaking, we believe that an investor should remain in USD-optimised portfolios as the US Dollar maintains its perceived 'safe haven' currency status and the resulting increased exposure to stocks denominated in USD when choosing USD as the base optimisation currency should certainly improve the safety of the portfolios.
Important Information

Appendix

Figure 22: Yearly excess returns
Portfolio returns in USD

Figure 23: Yearly excess returns
Portfolio returns in EUR

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