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An efficient frontier for FX hedging

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- Foreign exchange rate movements can have a huge impact on a portfolio's return.
- Nevertheless we frequently notice that many investors either neglect this risk factor or approach it in a surprisingly unsophisticated way resulting in inefficient allocations.
- In our paper, we discuss the major parameters affecting optimal hedge ratios and elaborate on common heuristics.
- Beyond this, we introduce a mean-variance based approach to foreign exchange hedging and introduce our FX Hedging Frontier application.

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How to deal with foreign exchange risk can be a surprisingly controversial topic. Some investors rigorously put hedges in place for almost every foreign currency denominated asset. Others knowingly or unknowingly take huge implicit bets on future exchange rates. We think, in most cases neither of these extreme approaches is optimal. This paper therefore introduces several heuristic ways of approaching foreign exchange rate risk management alongside an introduction to the interactive optimizer we have made available on the quantamental platform.

1 The power of the exchange rate

As Ray Dalio, undoubtedly one of the most ingenious investors of all times, found in 2021: "Most worry about whether their assets are going up or down in value; they rarely worry about whether their currency is going up or down". Dalio considers this a severe mistake and warns investors that they should pay more attention to this risk factor. His impression though seems to be rather US centric and from a Swiss perspective often the opposite seems to be the case. According to our experience, especially private investors tend to view any position not denominated in Swiss Francs with suspicion. Both phenomenon are not exactly surprising given the history of the respective currencies. The USD has weakened substantially against other major currencies such as Japanese Yen and Deutsche Mark and subsequently the Euro over the past decades. At the same time, the Swiss Franc has effectively been on a one century long bull run against most of the world with dire consequences for the performance of CHF denominated portfolios. This introductory example already illustrates how different investor's experiences with exchange rate risk can be depending on the currency pairs they are exposed to. Deriving an effective framework and universal guidelines from these lessons however is less trivial. We therefore start with the illustration some common problems and pitfalls, investors face in FX risk management before introducing our mean-variance based approach to it.

2 Five considerations on FX risk

The following section presents the five questions, we consider most important in this context.

2.1 Which is the portfolio's true reference currency?

This may look like a very trivial question. Investors usually measure performance in their home currency and their portfolios are valued accordingly. However, in the Private Wealth Management and Family Office world things can quickly get way more complicated. Today's wealthy are usually highly mobile and incur expenses in various currencies. Their purchasing power thus doesn't exclusively depend on their asset's value in a single currency. The Swiss investors who are dissatisfied with the meagre returns on their foreign investments caused by the strength of their currency should not forget that they simultaneously gained a lot of purchasing power abroad.

2.2 Which currency pair(s) really drive the performance of the foreign asset?

This can be particularly tricky with regard to investments in international funds and ETFs. Without proper

look-through capabilities, a portfolio management system will for instance treat a CHF denominated Emerging Market fund as a CHF asset. Even investors who are aware of this pitfall may find it hard to actually determine and aggregate the underlying currency exposures of multiple products. In equity investing the question is even harder to answer once the multitude of FX exposures, portfolio corporations may be subject to, is taken into consideration. For large, international corporations the accounting currency is not a good proxy for the currency of risk. Beyond this, some corporations implement (partial) FX hedges themselves while others do not. A Swiss investor who funnels funds into the S&P 500 and hedges the FX exposure through an equally sized long position in CHF/USD may unintentionally run a speculative short bet on the USD given that the index members generate roughly 30% of their revenues abroad.

2.3 How much does the FX hedge cost?

In Some like it hedged, Momtchil Pojarliev argues that: "Currency has no long-term expected return because it is not an economic asset; it is simply a source of risk"[4]. We would add though that things become a bit more complicated once interest rate differentials between risk free bonds denominated in different currencies are taken into consideration. Assuming that uncovered interest rate parity does not always hold, Swiss Franc based investors purchasing US treasuries for instance receive a higher yield to maturity by virtue of assuming the risk of USD depreciation. In other words, unmanaged foreign exchange risk can come with a positive or negative carry depending on interest rate levels in the investor's home and investment currency (see Figure 1). The cumulative cost of carry can become huge

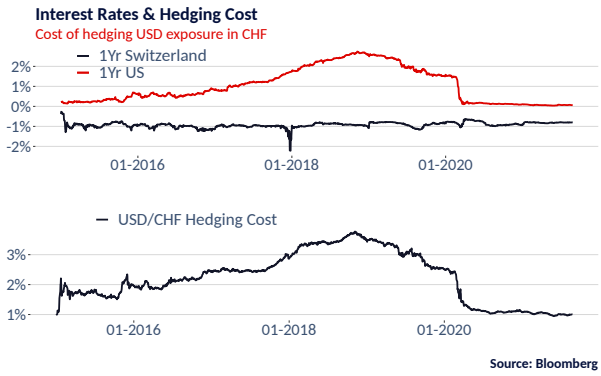

Figure 1: *Cost of hedging USD exposure in CHF*

over time as the following example illustrates, sticking with the popular example of Swiss investors buying USD denominated assets. Between 1999 and 2021, the CHF appreciated by more than 60% but according to our analysis, hedging against this appreciation would have only made a single digit contribution to performance. Figure 2 illustrates the performance of a short CHF/USD position alongside the simulated performance of the same position including cost of carry. The simulation thereby uses the Swiss Franc 12 Month Forwards Points from Bloomberg and for the sake of simplicity deducts the cost of carry on a daily basis. On top of this, we assume annual trading cost of 20 basis points for the hedging position. According to this simulation, carry and transaction cost consumed 57% of the 66% gain on the FX short USD position between June 1999 and August 2021. We also ran a more realistic simulation, that rolls the hedge on a quarterly basis. In this case, results are a bit more favorable, leaving investors with a 17% gain on the hedge after cost. Obviously, based on long-term economic and in-

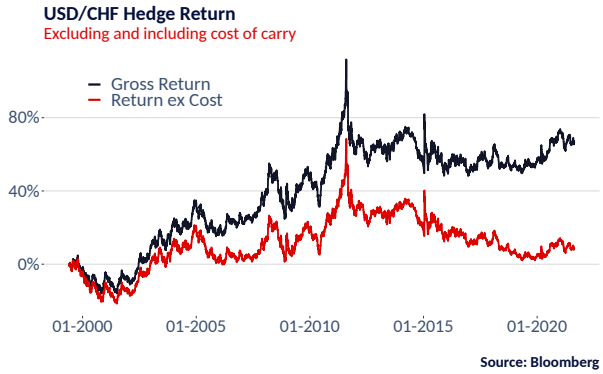

Figure 2: *Sharpe ratio 2000-2017*

flation trends, some currencies have been appreciating or depreciating for decades or even more than a century. Deviations from Purchase Power Parity (PPT) can be substantial in the short- to medium-term but in the long-term, currencies tend to revert to their fair value. To a certain degree differences in inflation and depreciation risk will indirectly be priced into FX forwards as they are reflected by interest rates. Nevertheless, differences in real interest rates and mispricings (QE) can still make it more attractive for some investors to hedge than for others. On top of that it has empiricaly been shown that in the post 2008 Greate Financial Crisis world, covered interest rate parity does not always hold[2].

2.4 Can unmanaged currency exposure help diversification

Foreign exchange exposure can be a source of diversification and tail risk protection. Some assets are naturally negatively correlated with certain currency pairs. Especially equities in small, open countries usually have high foreign revenue exposure. If the home currency appreciates, firms consequently tend to report lower revenues and profits and vice versa. Therefore, it for instance makes little sense for a EUR based investor to completely hedge the exchange rate when investing in Swiss corporations that generate a significant part of their revenues in the EUR area. The characteristics of a currency can also play an important role. As Pojarliev 2018 found, leaving the currency unhedged

significantly increased the volatility incurred by a typical multi-asset US investor between 2002 and 2018 while the unhedged portfolio was not more risky than the hedged one for a typical Canadian investor. The example is well chosen as the USD as a save haven tends to appreciate during major stock market crashes resulting in a further blow to US investors. The CAD on the other hand is more of a risk-on currency and its depreciation during crisis can benefit the Canadian investor during market crashes.

2.5 Does the hedge induce liquidity risks and how likely is the investor to unintentionally over-hedge?

Currency hedges result in significant negative cashflows if there is a positive cost of carry or if the shorted currency appreciates. This may be compensated or even overcompensated for by the performance of the foreign asset but investors may face an unpleasant mismatch in cashflows and liquidity. This is especially problematic if the foreign asset is not publicly traded such as in the case of Private Equity or Venture Capital positions. Pojarliev 2018 showed "that between 2000 and 2011, the cumulative negative cash flow was as high as 40%, forcing US investors to sell international assets to cover the losses on the currency forwards." and concludes: "You can't eat Sharpe ratios; you need dollars". A rapid deterioration in value of the foreign asset can also result in a huge unintentional, active bet on the currency. Imagine an investor who hedges an investment for several years that subsequently looses half or all of its value. Suddenly the long side of the trade (the asset) is gone and for the whole time the investor effectively ran a naked short position in the foreign currency.

3 A mean-variance driven approach

All this being said, how to deal with these problems and pitfalls? A popular approach to the topic is the application of heuristics. This can, for instance, mean to hedge the currency for Fixed Income positions but to leave it unhedged if caused by investments in equities and other more volatile assets. Another method could be to hedge when and where it is relatively cheap but to keep the currency risk if the cost of carry is high. It can also imply to reduce tail risk by seeking some unhedged exposure to save haven currencies like the CHF, the JPY or the USD while carefully hedging commodity currencies. Figure 3 and Figure 4 compare the risk transition matrix, faced by an EUR based investor when investing in Switzerland and Canada. While a hedge ratio of 100% minimizes risk for the Canadian investment, the investment in the SMI is actually less risky if only 50% of the currency exposure is hedged. In the end the previously covered heuristics usually have

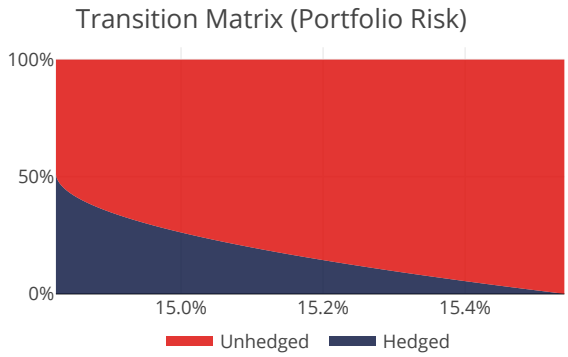

Figure 3: *Standard deviation of a EUR Investment in the SMI subject to different hedge ratios (2015-2021)*

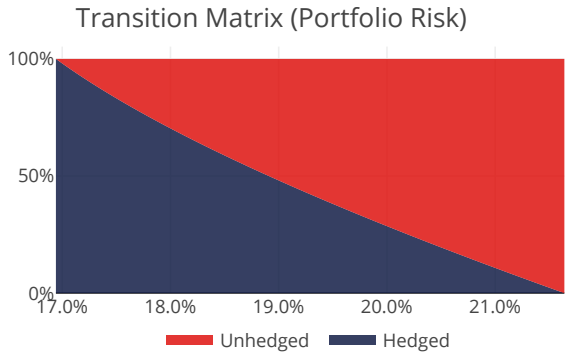

Figure 4: *Standard deviation of a EUR Investment in the MSCI Canada subject to different hedge ratios (2015-2021)*

their roots in historical correlation and return pattterns. Hence, in our view it makes a lot of sense to directly look at them through the lense of mean-variance optimization. Investors face the choice to either hedge or not hedge a foreign asset which means, they can effectively choose between two assets, the hedged asset and the unhedged one. We can thus derive two expected returns, namely the return including (hedged) and excluding (unhedged) hedging cost. Furthermore, it is straight forward to estimate the volatility of the returns of the hedged and the unhedged asset (measured in the base currency). The last parameter to estimate is the correlation between both asset's returns. If we insert these parameters into an optimizer we can derive an efficient frontier, illustrating the trade-off between expected hedging cost and risk. Based on this idea we have developed a flexible, interactive application, the FX Hedging Frontier app available on the quantamental platform. The tool builds on the public API of investing.com[1] and thus provides users with access to historical prices of almost all currencies and a wide range of indices, funds, ETFs, stocks, government bonds and even cryptocurrencies worldwide. Upon selection of a base currency and a foreign asset, the user can provide estimates for the expected return in local currency as well as the annualized cost of the hedge and thus derive the range of mean-variance efficient hedge ratios. Figure 5 illustrates the efficient

frontier for an investment in the S&P 500 by a CHF based investor. It assumes an annual expected local currency return of 7% and hedging cost of 1% given by the current 12 months forward.

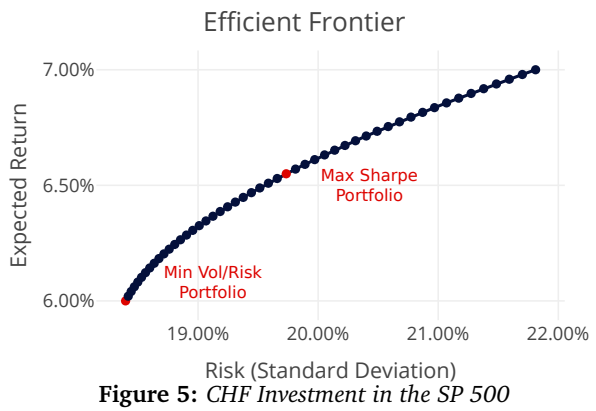

Figure 5: *CHF Investment in the SP 500*

As Figure 6 shows, in this case, the minimum variance portfolio would be fully hedged. But as can be seen in Figure 7, at 1% negative carry (Figure 8), a partially hedged portfolio would be expected to generate a higher Sharpe Ratio. Beyond this, the optimizer allows us to simulate a wide range of scenarios. The expected cost of carry which is a function of the interest rate differential could for instance be reduced by expected appreciation of the CHF caused by different inflation rates. It is important to keep in mind that the

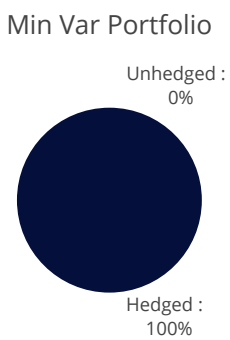

Figure 6: *CHF Investment in the SP 500 Min Var*

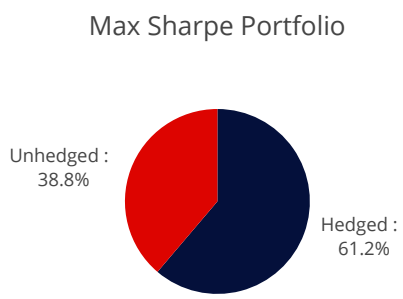

Figure 7: *CHF Investment in the SP 500 Max Sharpe*

sample covariance matrix is subject to significant estimation error. We have therefore embedded two alternative estimation methods, namely resampling based on Monte Carlo simulation and covariance shrinkage following Ledoit Wolf, Schaeafer and Strimmer and Opgen-Rhein and Strimmer[3]. Instead of using the

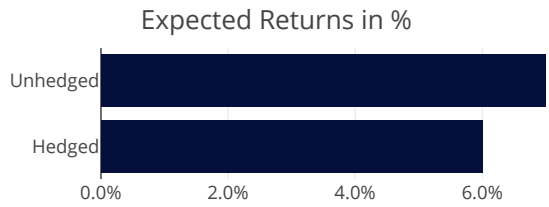

Figure 8: *CHF Investment in the SP 500 Assumptions*

simple sample covariance matrix, the user can choose to apply one of these two algorithms and specify parameters such as the shrinkage intensity lambda and the number of simulations. Further flexibility is introduced by the possibility to use different rolling windows to estimate correlation. One shortcoming of the current version of the optimizer is that it does not yet reflect tail risk. The inclusion of a mean/cvar optimization for instance could further improve the model. As the infamous example of the Swiss Francs showed, foreign exchange rate can be subject to sudden and pretty dramatic moves preceded and followed by range bound trading.

4 Conclusion - no one size fits all

The topic of FX hedging is often neglected or approached in an overly simplistic way. This can lead to subdued returns and higher portfolio volatility than necessary. We show that the optimal hedge ratio depends on a range of factors including the risk-on/risk-off characteristics of currency pairs, the cross-correlation with the assets held and interest rate differentials. While heuristics and economic considerations are certainly helpful, a relatively simple mean/variance approach can serve as a handy tool when approaching the topic. To better illustrate this and allow investors to try out this approach themselves, we have published the FX Hedging Frontier app on the quantamental platform, utilizing market data from investing.com. The app supports thousands of financial instruments from all parts of the world and almost all currency pairs. Portfolio optimization is often difficult to apply and criticized for its high sensitivity to minor changes in input parameters and constraints. We however believe, that it can be quite useful in the more limited and manageable problem of FX hedging and by utilizing resampling and covariance shrinkage we can derive stable parameters and reduce sampling error. The current version of our public optimizer is limited to finding optimal hedge ratios for single assets but we will follow-up with a more advanced optimizer that allows the utilization of the same methodology in a fully fledged portfolio optimization.

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