NEUBERGER BERMAN

ROB DRIJKONINGEN
Global Co-Head of Emerging Markets Debt

NIELS MERTENS[1]

LEI WAN
Quantitative Analyst—Emerging Markets Debt

FX Markets: What's Top-Down and What's Bottom-Up?

In most strategic and tactical asset allocation processes, foreign-exchange exposures—especially emerging markets foreign exchange exposures—are implicit and go unconsidered by investors. At Neuberger Berman foreign exchange has always been considered an explicit alpha source that plays an important role in an effective asset allocation process. Nonetheless, because we assess each currency using bottom-up country-by-country indicators, we have long recognized that our allocation process may be missing the top-down factors behind the performance of individual currencies. Moreover, the higher correlations among emerging markets currencies since the financial crisis of 2008–09 indicate the growing importance of these top-down factors. In this paper we propose an intuitive top-down, five-factor model of foreign exchange returns. We show that this model can be used to separate systematic from genuinely idiosyncratic return drivers in foreign exchange markets, and also to build a simple, systematic long-short strategy that would have substantially outperformed the average EM or DM currency market return over the past 10–15 years.

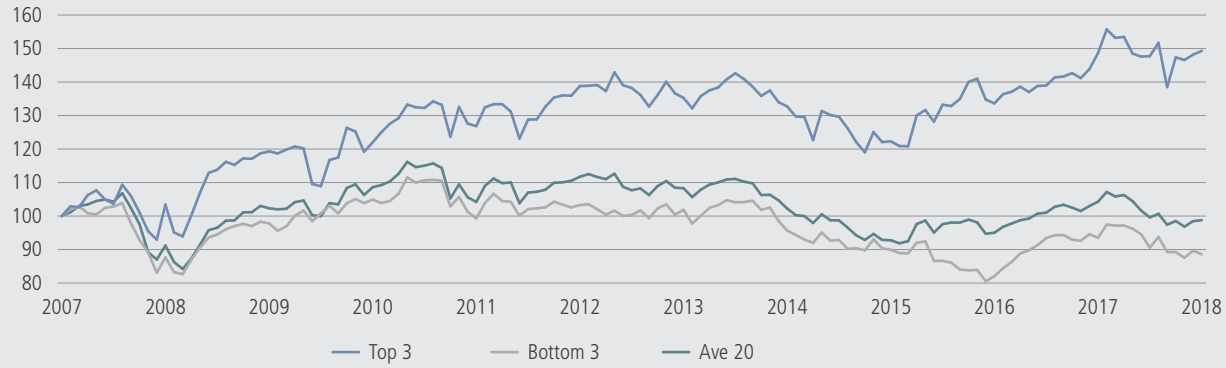
[1] Niels Mertens worked with Neuberger Berman as an intern after completing his Master's thesis in financial econometrics at the Faculty of Economics and Business, University of Amsterdam.

Executive Summary

- In most strategic and tactical asset allocation processes, foreign-exchange exposures—especially emerging markets foreign exchange exposures—are implicit and go unconsidered by investors.
- Many investors that do consider foreign exchange exposures explicitly do so bottom-up and country-by-country despite the fact that higher correlations among emerging markets currencies since the financial crisis of 2008–09 indicate the growing importance of top-down factors.
- In this paper we propose a top-down, five-factor model of foreign exchange returns, for which the following factors were selected to create a parsimonious model that could nonetheless explain a large systematic part of exchange rate movements in an economically intuitive way:
  - The market factor
  - A carry factor in emerging market currencies
  - A carry factor in developed market currencies
  - A factor based on dependence on crude oil imports among emerging economies
  - A factor based on the spread between emerging and developed currencies
- We show that this model can be used to separate systematic from genuinely idiosyncratic return drivers in foreign exchange markets, and also to build a simple, systematic long-short strategy that would have substantially outperformed the average emerging or developed currency market return over the past 10–15 years.

THE FIVE-FACTOR MODEL WOULD HAVE IDENTIFIED UNDERVALUED AND OVERVALUED EM CURRENCIES OVER RECENT YEARS

Performance of 20 EM currencies versus the top and bottom three, as ranked by the Z-scores of the idiosyncratic terms generated by the global five-factor model, 2007–2018



Source: Neuberger Berman. The five-factor model is estimated once a month, and Z-scores were calculated using a window of 60 (i.e. five years') observations at the start of the backtest, extended with the latest available observations thereafter.

Past performance is no guarantee of future results.

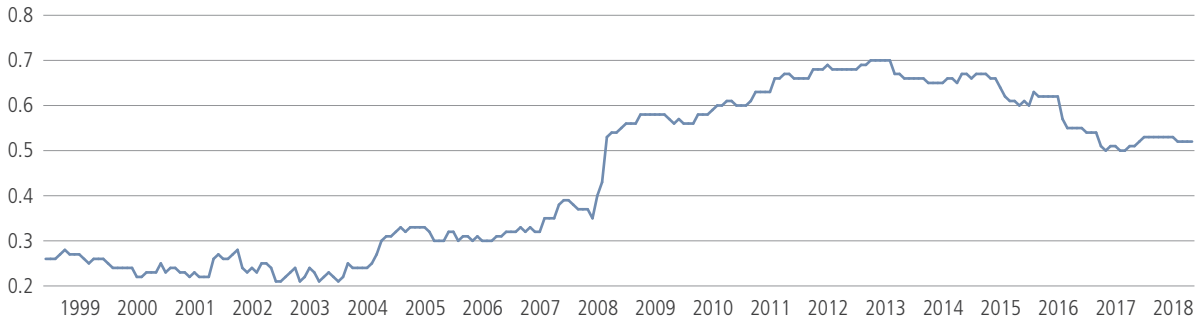
Note: When the long-short strategy was implemented using the Z-score threshold of one, there were periods when three currencies did not exceed that threshold at the top and/or bottom of the rankings; in these instances, the portfolio was constructed with however many currencies did cross that threshold; when no currencies crossed that threshold, the existing positions were maintained to limit trading costs.

Despite being the focus of numerous studies over the years, foreign-exchange exposures—especially emerging markets foreign exchange exposures—are implicit and go unconsidered in many strategic and tactical asset allocation processes.

At Neuberger Berman foreign exchange has always been considered an explicit alpha source that plays an important role in an effective asset allocation process. Nonetheless, because we assess each currency using bottom-up country-by-country indicators, we have long recognized that our allocation process may be missing the top-down factors behind the performance of individual currencies. Moreover, evidence suggests that these top-down factors have grown in importance over recent years.

For instance, when we look at the average five-year rolling correlation between the returns of 21 emerging market currencies versus the USD between 2003 and 2008, we find them in a range between 0.2 and 0.4 (with some of the individual currency correlations being negative). Since the 2008–09 financial crisis, however, that range has jumped to 0.5–0.7.

FIGURE 1. THE GROWING IMPORTANCE OF TOP-DOWN, SYSTEMATIC FACTORS IN EM CURRENCY PERFORMANCE
Average 5-Year Rolling Correlation: EM FX vs USD



Source: Bloomberg, Neuberger Berman.

That introduces the necessity to separate the top-down or systematic drivers of currency performance from the bottom-up, country-specific drivers in investment decision-making. Armed with a specific view on global, top-down factors, an investor can adopt positions based on individual foreign-exchange markets' sensitivities to those factors; or, having corrected for those global factors, leave itself with a residual factor that can be assessed as an indicator of (shorter-term) under- or overvaluation against the context of the purely idiosyncratic developments in the country concerned.

In this paper we propose an intuitive top-down, five-factor model of foreign exchange returns. We show that this model can be used to separate systematic from genuinely idiosyncratic return drivers in foreign exchange markets, and offer some examples to show how it would have performed in portfolio construction over the past 10–15 years.

Describing Our Five-Factor Model

The five-factor model for foreign-exchange rates presented here is an extension of the three-factor model originally described by Niels Mertens, in which global factors are expected to capture the cross-sectional interdependencies among currencies.[2] That is an asset-pricing model extending the classic capital asset pricing model (CAPM), similar to the Fama-French three-factor model for describing stock returns, which builds on the work of Adrien Verdelhan, who showed that the market-average and carry-trade factors explain a large share of spot foreign-exchange rate variation.[3] In addition to the market factor, to create his three-factor model, Mertens split Verdelhan's single carry-trade factor into two different carry-trade vectors: one for emerging markets (EM) and the other for developed markets (DM) currencies.

[2] Niels Mertens, "A Global Factor Model for Foreign Exchange Rate Prediction" (2019), Master's thesis with combined internship research within the Neuberger Berman EMD Team.
[3] Adrien Verdelhan, "The share of systematic variation in bilateral exchange rates", *Journal of Finance* 73.1 (2018), pp. 375–418.

The five-factor model presented here extends the market average and two carry-trade factors by an oil-related factor and another factor which captures fundamental differences between EM and DM. These additional factors further increase the explained variation in exchange rate movements relative to the three-factor model.

The factors were selected to create a parsimonious model that could nonetheless explain a large systematic part of exchange rate movements in an economically intuitive way. This is in stark contrast to the use of purely statistical principle components analysis. In any case, the market average factor is nearly perfectly correlated with the first principal component. Moreover, when developing his original three-factor model, as a robustness check, Mertens conducted a principal components analysis on the residual terms of the model, which revealed that the three factors already substantially reduced the factor structure in the residuals. Unless all principal components are included, however, there will remain factor structure in the residuals due to the construction of these orthogonal principal components.

The Five Factors in Detail

The following five global factors are included in our model:

- **The first factor consists of a market average of exchange rate returns against the USD.** This market factor captures global market sentiment and therefore includes the effects of the business cycle on exchange rate returns. The DM currencies in this market factor are the G10 currencies (excluding CHF and JPY due to their safe-haven characteristics during periods of risk aversion). The EM currencies consist of the 21 major, non-pegged currencies in our investment universe. Currencies with a fixed regime or a peg to the USD are also, together with redenominated currencies, partially removed from the historical datasets presented below.
- **The second and third factors are two carry-trade factors: one for EM currencies and one for DM currencies.** This widely used investment strategy in the foreign-exchange market contains a time-varying systematic risk component, manifested in higher beta to equity markets and mean-reversion during volatile periods in markets.[4] Separating EM and DM carry ensures that our model captures the different exposures of EM and DM currencies to the carry factor. The DM carry factor is represented by the Bloomberg Cumulative FX Carry Trade Index, which measures the cumulative total return of equal-weighted long positions in the three highest-yielding G10 currencies fully funded with short positions in the three lowest-yielding G10 currencies, rebalanced daily. The EM carry factor is based on a similar strategy tailored for the EM universe.
- **The fourth factor is based on the level of dependence on imported crude oil among EM countries.** This factor is included to capture the substantial effect of oil price changes on exchange rate returns among EM currencies. It is constructed as a buy-and-hold carry trade that is long EM currencies of major crude oil exporting countries, fully funded with short positions in the EM currencies of major crude oil importing countries. Although the majority of emerging markets considered are net importers of oil, and our definition of the universe of EM currencies excludes OPEC countries, the group does include some large oil exporters such as Russia and Colombia.
- **The fifth factor is the spread between EM and DM currency returns.** This factor is included to capture the different characteristics of EM and DM currencies—for example, the difference in liquidity. This factor is also constructed as a carry trade return index, being equal-weighted long eight of the 10 DM currencies (again with CHF and JPY excluded), fully funded with short positions in the EM currencies.

Currency-Return Decomposition

To measure the sensitivity of each individual currency to these five top-down factors, the spot returns of each individual currency are regressed on them, using monthly data. The residual in this multiple regression then represents the idiosyncratic risk premium, a currency-specific premium that is not captured by the five global factors. Mathematically, this decomposition is defined as follows:

$$FX_{i,t} = \alpha + \beta_1 \cdot USD_t + \beta_2 \cdot CarryDM_t + \beta_3 \cdot CarryEM_t + \beta_4 \cdot OilEM_t + \beta_5 \cdot DM\_EM_t + \varepsilon_{i,t}$$

[4] See Charlotte Christiansen, Ronaldo Christiansen and Paul Söderlind, "The Time-Varying Systematic Risk of Carry Trade Strategies" (2010) *Journal of Financial and Quantitative Analysis.*

In this regression, $FX_{i,t}$ is the spot rate return of currency i at time t, where returns are used to avoid spurious regression results as a consequence of non-stationarity. In this regression, the five factors multiplied by their respective coefficient form the systematic risk. The residual $\mathcal{E}_{i,t}$, together with the intercept α, comprises the currency-specific idiosyncratic term.

These idiosyncratic terms are subsequently used to identify overpriced and underpriced currencies relative to the fair value implied by the global factors at time t. For this purpose, the idiosyncratic terms at time $t-1$ are normalized for each currency by Z-scores. The obtained Z-scores across currencies are then ranked. The most overpriced currencies are identified by the largest Z-scores and the most underpriced currencies by the lowest Z-scores. Furthermore, a threshold of one standard deviation is introduced to ensure that the standardized idiosyncratic term is substantially away from its mean.

This information can then be used in a carry-trade strategy that, conditional on being more than one standard deviation away from its mean, positions equal-weighted long in the three currencies with the lowest Z-scores, fully funded with short positions in the three currencies with the highest Z-scores.

Model Outcomes

The model reveals some very strong and clear relationships: for example, high beta to the Carry factor is strongly associated with depreciation over time—an intuitive result that reflects the higher susceptibility to inflation of countries with higher-yielding currencies. On average, the global factors tend to explain more of the DM spot return variations than they do the EM spot return variations, the R-Squared coefficients being 71% and 61%, respectively. Not surprisingly, the EM Carry and EM Oil Exporter-Importer factors are less important than the other three for explaining DM currency returns, and the DM Carry factor is not significant at all in EM currency return variations.

On the whole, one-step-ahead forecasts generated with a linear autoregressive (AR) model and a non-linear autoregressive neural network (AR-NN) model, respectively, result in high forecast accuracy from the five factors, as measured by the Hit Ratio, or the proportion of correctly predicted signs. All but the DM Carry factor are forecastable by both models, with a Hit Ratio above 50%. For the Market and EM Carry factors in particular, the Hit Ratio achieved by the AR-NN model shows the obvious gains of considering nonlinearity.

FIGURE 2. HIGH FORECAST ACCURACY FROM THE FIVE-FACTOR MODEL

Hit ratios of currency return forecasts generated with a linear autoregressive (AR) model and a non-linear autoregressive neural network (AR-NN) model, for each individual factor

Monthly	AR	AR-NN
Market	50%	55%
DM Carry	48%	48%
EM Carry	55%	59%
Oil Exp-Imp	53%	54%
DM-EM	51%	51%

Source: Neuberger Berman.

From the top-down perspective, then, it is clear that forecasts derived from these five global factors can help when formulating views on the potential determinants of future spot currency returns. From the bottom-up perspective, the idiosyncratic terms generated by the model also prove to be useful for identifying relative value opportunities across currencies.

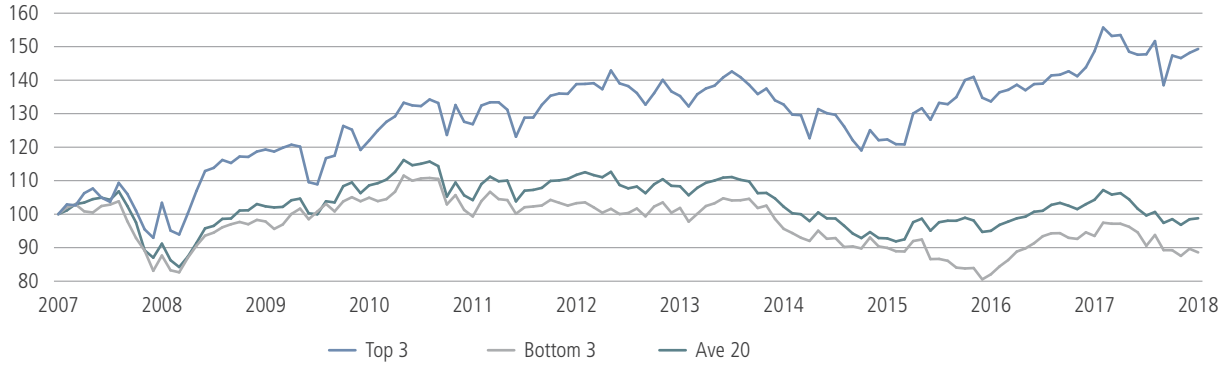
In the backtest shown in figure 3, the five-factor model was estimated every month by expanding the time series, and mean-reversion risk signals were generated based on the Z-scores of the idiosyncratic terms for 20 EM currencies. The mean-reversion risk signals were ranked, and we found that the top three outperformed the bottom three over the long term, and that a portfolio holding equal-weighted long and short positions emerged with a better risk-return profile and a much smaller maximum drawdown than the average

return of the 20 EM currencies. In other words, the idiosyncratic terms generated by the five-factor model distinguished undervalued from overvalued currencies.

By introducing a Z-score threshold of one to determine our top- and bottom-ranked currencies, the model's Hit Ratio was further improved, as was the long-short portfolio's risk-return profile. Moreover, this strategy exhibited low correlation with the average returns of 20 EM currencies—and while its returns exhibited fatter tails and higher volatility, the improvement in skewness indicates that those fatter tails were concentrated more on the right than the left side of the returns distribution.

FIGURE 3. THE FIVE-FACTOR MODEL WOULD HAVE IDENTIFIED UNDERVALUED AND OVERVALUED EM CURRENCIES OVER RECENT YEARS

Performance of 20 EM currencies versus the top and bottom three, as ranked by the Z-scores of the idiosyncratic terms generated by the global five-factor model, 2007 – 2018



Return and risk metrics, 2007 – 2018

Monthly	Top 3 - Bottom 3	Ave 20	Top 3 - Bottom 3: abs(Zscore)>=1
Annualized Return	4.8%	-0.1%	7.0%
Annualized Vol	7.9%	8.3%	9.8%
Return/Vol	0.61	-0.01	0.71
Skewness	0.2	-0.6	0.1
Kurtosis	0.1	1.4	3.1
Hit Ratio	56.8%	57.6%	58.3%
Ave +	1.9%	1.6%	2.3%
Ave -	-1.6%	-2.1%	-1.8%
Max DrawDown	-13.0%	-21.2%	-13.6%

Correlations, 2007 – 2018

Monthly	Top 3 - Bottom 3	Ave 20	Top 3 - Bottom 3: abs(Zscore)>=1
Top 3 - Bottom 3	1	0.33	0.79
Ave 20		1	0.28
Top 3 - Bottom 3: abs(Zscore)>=1			1

Source: Neuberger Berman. The five-factor model is estimated once a month, and Z-scores were calculated using a window of 60 (i.e. five years') observations at the start of the backtest, extended with the latest available observations thereafter.

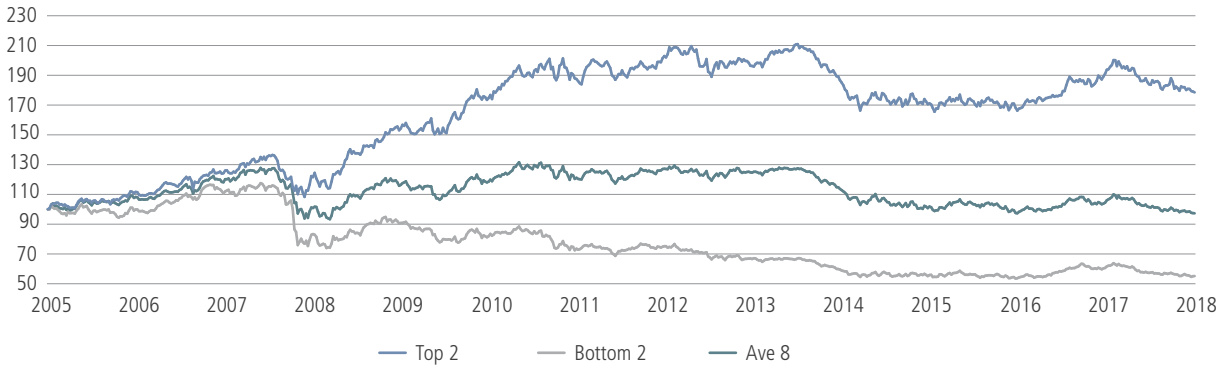
Past performance is no guarantee of future results.

Note: When the long-short strategy was implemented using the Z-score threshold of one, there were periods when three currencies did not exceed that threshold at the top and/or bottom of the rankings; in these instances, the portfolio was constructed with however many currencies did cross that threshold; when no currencies crossed that threshold, the existing positions were maintained to limit trading costs.

We conducted the same exercise for eight DM currencies, with JPY and CHF excluded due to their safe-haven characteristics. Only the top two undervalued and bottom two overvalued currencies were considered here due to the relatively small universe, but we estimated the five-factor model once a week rather than once a month. Figure 4 shows that similar results were obtained, indicating that the DM foreign exchange market, with its quicker reversion to the mean, is more efficient than the EM foreign exchange market.

FIGURE 4. THE FIVE-FACTOR MODEL WOULD HAVE IDENTIFIED UNDERVALUED AND OVERVALUED DM CURRENCIES OVER RECENT YEARS

Performance of eight DM currencies versus the top and bottom two, as ranked by the Z-scores of the idiosyncratic terms generated by the global five-factor model, 2005 – 2018



Return and risk metrics, 2005 – 2018

Monthly	Top 2 - Bottom 2	Ave 8	Top 2 - Bottom 2: abs(Zscore)>=1
Annualized Return	8.9%	-0.1%	4.9%
Annualized Vol	8.3%	9.0%	10.7%
Return/Vol	1.07	-0.01	0.46
Skewness	1.9	-0.6	0.1
Kurtosis	15.4	3.1	3.6
Hit Ratio	54.6%	52.7%	52.9%
Ave +	0.9%	0.9%	1.1%
Ave -	-0.7%	-1.0%	-1.1%
Max DrawDown	-8.3%	-27.0%	-23.7%

Correlations, 2005 – 2018

Weekly	Top 2 - Bottom 2	Ave 8	Top 2 - Bottom 2: abs(Zscore)>=1
Top 2- Bottom 2	1	-0.19	0.63
Ave 8		1	-0.11
Top 2 - Bottom 2: abs(Zscore)>=1			1

Source: Neuberger Berman. The five-factor model is estimated once a week, and Z-scores were calculated using a window of 150 (i.e. three years') observations at the start of the backtest, extended with the latest available observations thereafter.

Past performance is no guarantee of future results.

Note: When the long-short strategy was implemented using the Z-score threshold of one, there were periods when two currencies did not exceed that threshold at the top and/or bottom of the rankings; in these instances, the portfolio was constructed with the single currency that did cross that threshold; when no currencies crossed that threshold, the existing positions were maintained to limit trading costs.

Conclusions

Developing existing research, in this paper we have presented an economically intuitive model that separates the systematic or global factors from the truly idiosyncratic drivers of EM currency performance.

This model is designed to assist decision-making in emerging markets portfolio management. Assessing and potentially formulating views on the relevant global factors is helpful in its own right. However, by helping to tie bottom-up fundamental country analysis with the shorter-term valuation signals on individual currencies that are identified by the global five-factor model, we also believe it can help strengthen convictions on emerging markets currency portfolio positions.

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Neuberger Berman
1290 Avenue of the Americas
New York, NY 10104-0001

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