EM FX portfolio – white paper

- **Note that we published [EM FX portfolio in 2024: a new world, a new investment process (part 1 of 2).]**

Olga Yangol
Head of Emerging Market Research & Strategy, Americas
+1 212 261 3953
olga.yangol@ca-cib.com

With contributions from Blanche Lalouette

Our portfolio is based on 1M, 2M and 3M-non-develiverable forwards between the dollar and our EM currencies. Our EM FX portfolio is benchmarked against an index of 20 EM currencies, including eight Asian currencies representing 53.258% of the index weight. Our goal is to outperform the benchmark by 100bp or more on an annual basis, ie. an 'alpha target' of 100bp or more. The data used for the model is taken and updated daily from bloomberg. The approach is based on Our investment process is based on (1) a quantitative ranker; (2) a discretionary override based on in-depth analysis of our global EM research analysts; and (3) a systematic portfolio construction approach, including sizing based on relative conviction & volatility and beta calibration.

Non Deliverable Forward contracts

The pricing of most forward foreign exchange contracts is primarily based on the interest rate parity formula, which determines equivalent returns over a set period based on two currencies' interest rates and the current spot exchange rate. Here, we will mainly use Bloomberg data on a daily basis. However, let us remind basic formulas for USD/*i* FX forward contracts:

$$F_{usd,i} = S_{usd,i} \cdot \frac{1 + r_{usd} \cdot \frac{t}{360}}{1 + r_i \cdot \frac{t}{360}}$$

$$\text{Implied Yield}_{i,t} = 100 \cdot \left[\frac{F_{usd,i}}{S_{usd,i}} \left(1 + \frac{D \cdot \frac{t}{360}}{100} \right) - 1 \right] / \frac{t}{360}$$

Where

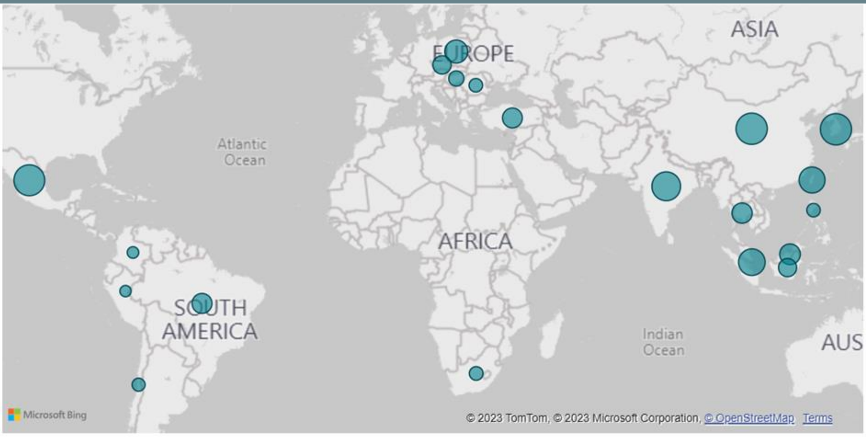
- $F_{usd,i}$ is the forward rate
- $S_{usd,i}$ is the current spot rate of the currency pair = $\frac{USD}{\text{EM Currency i}}$
- r_{usd} and r_i are respectively the domestic and foreign interest rate
- t is the time of contract in days
- D is the USD SOFR SWAP OIS (Overnight Indexed Swap)

EM portfolio construction

In addition to existing periodic trade ideas, this research publication has been tailored to clients interested in a portfolio management approach when allocating investments to EM currencies. The product formalises our global EM country and currency views in an EM FX portfolio that is updated and rebalanced at least monthly and often much more frequently as markets/views change.

Our EM FX portfolio is benchmarked against an index of 20 EM currencies, including eight Asian currencies representing 55.15% of the index weight. Our goal is to outperform the benchmark by 100bp or more on an annual basis, aka an 'alpha target' of 100bp or more.

EM FX Portfolio Benchmark decomposition



BRL	CLP	CNY	COP	CZK	HUF	IDR	INR	KRW	MXN	MYR	PEN	PHP	PLN	RON	SGD	THB	TRY	TWD	ZAR
4.8%	1.7%	10.0%	1.0%	4.1%	2.7%	4.0%	8.9%	10.0%	9.8%	5.1%	0.9%	1.9%	6.2%	1.9%	7.9%	5.0%	4.8%	7.6%	2.0%

Source: Credit Agricole CIB

Note: The index is analogous to the some widely used indices, such as JP Morgan ELMI+ index for instance, but does not include the ILS (~1% in ELMI+ and 0% in CACIB index) given that the currency is not in our research coverage. Frontier currencies, currently just EGP, as well as developed market currencies, such as the EUR and JPY, are in our investment universe, but represent 'out-of-benchmark' exposure. We have removed the RUB from our benchmark and investment universe as of 1 April, 2022

In parallel, we run a systematic EM FX portfolio, based on a back tested quantitative model. The project currently incorporates 12 models. All models use a combination of a compound valuation and momentum metric, trade balance and carry. The model portfolio, 'the Machine', informs the discretionary portfolio, 'the Human'. As of now, the two are run separately. The mission of the project is to find the 'perfect cyborg', which is to say the combination of the general intelligence, the Human and the artificial intelligence of the ever-evolving quantitative model, the Machine.

Step 1: Ranking

1. **Technicals**: we want to look at the nominal exchange rate momentum, calculated as the 5-day and 20-day nominal exchange rate crossover, and defined as 1 if the currency is appreciating in nominal terms and 0[1] if the currency is depreciating. Positive momentum "unlocks" value, which can be understood as something positive happening in the external environment or domestically, to justify closing the valuation gap.
   For each EM currency *i* in our portfolio at a given date *T*, we have:

$$Momentum_{i,T} = \begin{cases} 1 \ if \ \frac{1}{5}\sum_{t=T-5}^{T} S_{USD,i} < \frac{1}{20}\sum_{t=T-20}^{T} S_{USD,i} \\ 0 \ elsewhere \end{cases}$$

2. **Valuation** is taken into account through the Real Effective Exchange Rate (REER) discount to the 5-year historical average. The REER is the weighted average of a country's currency, *i*, in relation to an index of its major trading partners' currencies. The weights are determined by comparing the relative trade balance of a country's currency against each country in the index.
   For each EM currency *i* in our portfolio at a given date *T*, we have:

$$REER\ discount_{i,T} = \frac{REER_{i,T}}{\frac{1}{60}\sum_{t=T-59}^{T} REER_{i,t}} - 1$$

   Additionally to the REER discount, we have defined two variables. For each EM currency *i* in our portfolio at a given date *T*, we have:

- Conditional REER discount avoids buying value traps :

$$Conditional\ REER\ discount_{i,T} = Momentum_{i,T} * REER\ discount_{i,T} * \mathbb{I}_{\{REER\ Discount_{i,T}<0\}}$$

- Symmetrical REER[1] avoids buying value traps and selling consistent winners. The idea is to buy currencies that are cheap and started to appreciate and sell currencies that are expensive and started to depreciate.

$$Symmetrical\ REER\ discount_{i,T} = Momentum_{i,T} * REER\ discount_{i,T} * \mathbb{I}_{\{Momentum_{i,T} * REER\ Discount_{i,T}<0\}}$$

3. **Fundamentals** refer to macroeconomics basics influencing the currency's evolution. Here, we take the 3-months change in cumulative 12-month Trade Balance as % of GDP.
4. **Carry** (C_t) is a final but crucial variable, referring to the return generated by holding a currency, assuming no change in the interest rate differential or the spot differential. *Nominal Carry* (NC_t) is computed as the 3-month implied local and US yield differential from 3-month non-deliverable forward contract. Depending on our needs, we also consider the possibility to include the *Real Carry* (RC_t), which is the nominal carry adjusted for inflation, with the most recent actual annual headline inflation rate. For each EM currency *i* in our portfolio at a given date *t*, we have :

$$C_{i,t} = \frac{r_{t,i} - r_{t,USD}}{1 + r_{t,USD}}$$

$$NC_{i,t} = r_{t,i} - r_{t,USD}$$

$$RC_{i,t} = \frac{1 + r_{t,i}}{1 + inflation_{t,i}} - \frac{1 + r_{t,USD}}{1 + inflation_{t,USD}}$$

Now that we have the list of variables we want to include, we set up six different combinations of criteria for currency ranking: (1) REER, TB, nominal carry; (2) conditional REER, TB, nominal carry; (3) symmetrical REER, TB, nominal carry; (4) REER, TB, real carry; (5) conditional REER, TB, real carry; and (6) symmetrical REER, TB, real carry. One combination defines one model. We thus have, at this point, **six different models**.

For simplification, we will refer to **M** as the model currently used where M takes value in [RN, CN, SN, RR, CR, SR]. Note that the first letter gives information about the type of REER (**R**EER discount, **C**onditional REER discount, **S**ymmetrical REER discount) and the second letter gives information about the type of carry (**N**ominal or **R**eal)

The weighted average of those criteria for each model gives us a Z-score, with each variable given an equal weight of 1/3. From the Z-score, we can rank our currencies in the portfolio.

For each currency ***i*** in [BRL, CLP, CNY, COP, CZK, HUF, IDR, MYR, MXN, PEN, PHP, PLN, RON, RUB, ZAR, THB, TRY, INR, SGD, TWD, KRW],

[1] *If the model uses symmetrical REER discount, momentum is -1 when the currency is depreciating*

For a given date ***t,***
For ***M*** in [RN, CN, SN, RR, CR, SR],

$$zscore_{i,t,M} = \frac{1}{3}\left(\frac{REER\ Discount_{i,t,M}}{\sigma_{t,M}(REER\ Discount_{i,tM})} + \frac{3m\ Chge\ in\ TB\%GDP_{i,t}}{\sigma_t(3m\ Chge\ in\ TB\%GDP_{i,t})} + \frac{Carry_{i,t,M}}{\sigma_{t,M}(Carry_{i,t,M})}\right)$$

Step 2: sizing

We assign a “conviction” score to each currency based on its ranked position. The conviction is equal to 3 for “high”, 2 for “medium” and 1 for “low”. That being said, we thought about two different ways to build our conviction score:

1. **β-Agnostic (Agn)**: We initially assumed 16 active positions, with 8 overweights assigned a conviction of 3, 3, 2, 2, 2, 1, 1 and 1 to the top eight positions per the automatic order of the ranker and vice versa for the 8 underweights.
2. **β-Aware (Awa):** the second one is not centered in 0 but follows the general trend of the market.

Here is the detailed computation: for each currency *i* in [BRL, CLP, CNY, COP, CZK, HUF, IDR, MYR, MXN, PEN, PHP, PLN, RON, RUB, ZAR, THB, TRY, INR, SGD, TWD, KRW]

$$conviction_{\mathbf{i,t,Agn}} = \begin{cases} 3 - \left\lfloor \frac{rank_{i,t,M}}{3} \right\rfloor \ if\ rank_{i,t,M} \le 8 \\ 0\ \ if\ 9 \le rank_{it,M} \le 12 \\ -3 + \left\lfloor \frac{rank_{i,t,M}}{3} \right\rfloor \ \ if\ rank_{i,t,M} \ge 12 \end{cases}$$

$$conviction_{\mathbf{i,t,Awa}} = \max\left(-3, \min\left(3, \begin{cases} \left\lceil \frac{zscore_{i,t,M}}{0.5} \right\rceil * 0.5\ if\ rank_{i,t,M} \le 8 \\ 0 \qquad\qquad if\ 9 \le rank_{i,t,M} \le 12 \\ \left\lfloor \frac{zscore_{i,t,M}}{0.5} \right\rfloor * 0.5\ if\ rank_{i,t,M} \ge 12 \end{cases}\right)\right)$$

These two different convictions give us two more possibilities of different models. We have now 12 different models M referred to as RN-Agn, CN-Agn, SN-Agn, RR-Agn, CR-Agn, SR-Agn and RN-Awa, CN-Awa, SN-Awa, RR-Awa, CR-Awa, SR-Awa.

Finally, we sized each position based on the assigned conviction and historical three-month currency *i* volatility $3m\sigma_i$, assuming a standard size of **3%** for agnostic model and **3.5%** for aware model[2] for average volatility and medium conviction, subject to a maximum **concentration limit of 5%.**

For each currency ***i*** in [BRL, CLP, CNY, COP, CZK, HUF, IDR, MYR, MXN, PEN, PHP, PLN, RON, RUB, ZAR, THB, TRY, INR, SGD, TWD, KRW],
For ***M*** in [RN-Agn, CN-Agn, SN-Agn, RR-Agn, CR-Agn, SR-Agn and RN-Awa, CN-Awa, SN-Awa, RR-Awa, CR-Awa, SR-Awa],
For a given date ***t,***

$$size_{i,t,M} = \max\Bigg[-concentration\ limit, \min\left(\frac{\frac{1}{20}\sum_i 3m\sigma_{i,t}}{3m\sigma_{i,t}} \cdot conviction_{i,t,M} \cdot \frac{standard\ size_M}{medium\ conviction}, concentration\ limit\right)\Bigg]$$

[2] *Note that the standard size vary according to conviction (agnostic or aware) because aware models tend to take less positions than agnostic ones.*

$$where \begin{cases} concentration\ limit = 5\% \\ medium\ conviction = 2 \\ standard\ size_M = \begin{cases} 3.0\ \%\ if\ M\ in\ Agn \\ 3.5\%\ if\ M\ in\ \mathrm{Awa} \end{cases} \end{cases}$$

Step 3: calibrating

We want to control for carry and tracking error (TE).

1. **Introduction of a carry cap**: As a reminder, the carry captures an investment in a currency by putting cash into a country's money market, which earns the interest rate if the price of the currency (exchange rate) does not change. We want to make sure the individual carry contribution of an active currency in the portfolio does not go under -0.3%.
2. **Introduction of ex-ante TE upper and lower bounds**: the ex-ante tracking error is the annualized standard deviation of alpha[3], estimated based on fixed positions applied to past market returns. As a measure of active risk, an ex-ante tracking error of 1% implies that the portfolio is expected to outperform or underperform the benchmark by 100bp, excluding carry, two thirds of the time. Here, we decide to introduce a **lower bound of 0.8%** and an **upper bound of 1.2%,** which would be consistent with our alpha target of 100bp or above.

In order to calibrate the size of each currency, we repeat 6 times a procedure that will insure that (1) the nominal carry per currency is below the carry cap, and that (2) the probability that the ex-ante TE ranges between its lower and upper bonds is close to one.

Let us indicate the step with the letter u in [0, 1, 2, 3, 4, 5, 6]

- **First step – we initiate the size of each currency** and control for carry:

$$size_{0,i,t,M} = \max\left[-\,concentration\ limit,\ \min\left(\frac{\frac{1}{20}\sum_i 3m\sigma_{i,t}}{3m\sigma_{i,t}} \cdot conviction_{i,t,M} \cdot \frac{standard\ size_M}{medium\ conviction}, concentration\ limit\right)\right]$$

$$size_{1,i,t,M} = \begin{cases} size_{0,i,t,M}\ if\ size_{0,i,t,M} * nominal\ carry_{i,t} \geq carry\ cap \\ \dfrac{carrycap}{nominal\ carry_{i,t}}\ elsewhere \end{cases}$$

- **Second step – for u in [2, 3, 4, 5, 6], we iterate a procedure** where we look at the ex-ante TE of the size defined in the previous step. If it is below the lower bound, we increase the standard size when computing the new size. If it is above the upper bound, we decrease the standard size when computing the new size. We then control for carry cap.

$$\boldsymbol{If\ ex\ ante\ TE}\left(size_{u-1,i,t,M}\right) < lower\ bound\ TE,$$

[3] *Alpha refers to excess returns earned above the benchmark.*

$$size_{u,i,t,M} = \max\left[-concentration\ limit, \min\left(\frac{\frac{1}{20}\sum_i 3m\sigma_{i,t}}{3m\sigma_{i,t}} \cdot conviction_{i,t,M} \cdot \frac{standard\ size_M}{medium\ conviction} \cdot \left\lceil\frac{lower\ bound\ TE}{ex\ ante\ TE(size_{u-1,i,t,M})}\right\rceil, concentration\ limit\right)\right]$$

$$size_{u,i,t,M} = \begin{cases} size_{u,i,t,M}\ if\ size_{u,i,t,M} * nominal\ carry_{i,t} \geq carry\ cap \\ \dfrac{carrycap}{nominal\ carry_{i,t}}\ elsewhere \end{cases}$$

$\boldsymbol{If\ ex\ ante\ TE}\left(size_{u-1,i,t,M}\right) > upper\ bound\ TE,$

$$size_{u,i,t,M} = \max\left[-concentration\ limit, \min\left(\frac{\frac{1}{20}\sum_i 3m\sigma_{i,t}}{3m\sigma_{i,t}} \cdot conviction_{i,M} \cdot \frac{standard\ size_M}{medium\ conviction} \cdot \left\lfloor\frac{upper\ bound\ TE}{ex\ ante\ TE\left(size_{u-1,i,t,M}\right)}\right\rfloor, concentration\ limit\right)\right]$$

$$size_{u,i,t,M} = \begin{cases} size_{u,i,t,M}\ if\ size_{u,i,t,M} * nominal\ carry_{i,t} \geq carry\ cap \\ \dfrac{carrycap}{nominal\ carry_{i,t}}\ elsewhere \end{cases}$$

EM portfolio backtesting

As mentioned above, our portfolio actually groups 12 different models as combinations of (1) REER discount, Conditional REER discount, Symmetrical REER discount on the one hand and (2) Real Carry, Nominal Carry on the other, and finally (3) Beta aware or Beta agnostic convictions. To assess the performance of our models, we refer to standard portfolio management concepts, such as “alpha”, “tracking error” and “information ratio”. The concepts are defined as follows:

- **Alpha**: the difference between portfolio and benchmark return, return being the sum of the spot and the carry.
- **Ex-post Tracking Error**[4]: annualized standard deviation of alpha, also known as the measure of “active” portfolio risk.
- **Information ratio:** the ratio of alpha to tracking error.

We then calculated the performance of the 12 models, including alpha, tracking error and information ratio, initially over discrete (almost) 20-year. The results were promising, but were inconclusive as no single ranking method or ‘model’ stood out as superior. While no apparent winner emerged at first, with no line representing the rolling information ratio clearly above the others at all times, we were able to make several observations.

[4] Note that Ex-post Tracking Error is the real standard deviation of alpha whereas Ex-ante Tracking Error used in the formula of the size is an approximation of simulated TE using a fixed sized on past spot returns.

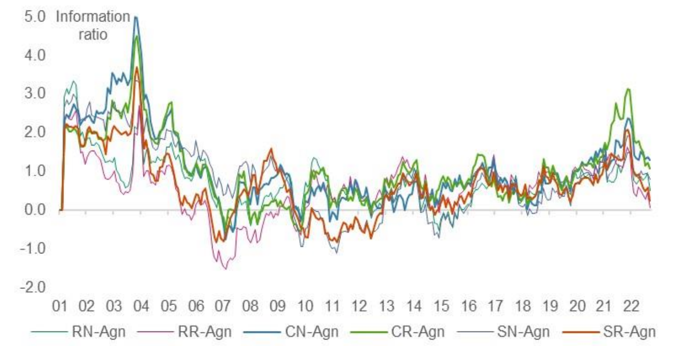
Nominal or real carry

During the first decade of the 2000s, the three models using nominal carry outperformed. Given that EM currencies generally appreciated up to 2008 and trade balances improved, this result was to be expected as choosing currencies with the highest nominal carry was the winning strategy at that time. Over the past decade or so however, models using real carry also started outperformed those with nominal carry as real carry penalized high inflation, eg, the TRY in 2020 and 2021.

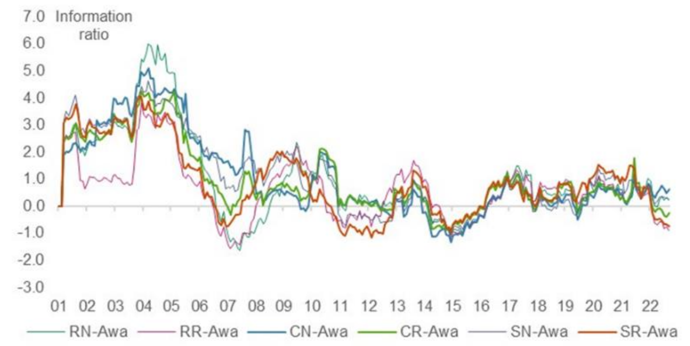
REER discount, symmetrical or conditional REER discount:

Also, EM currencies have generally depreciated and models with conditional REER performed better as they have helped avoid falling into "value traps", such as the TRY in 2018.

2-year rolling information ratio for agnostic models



2-year rolling information ratio for β-aware models

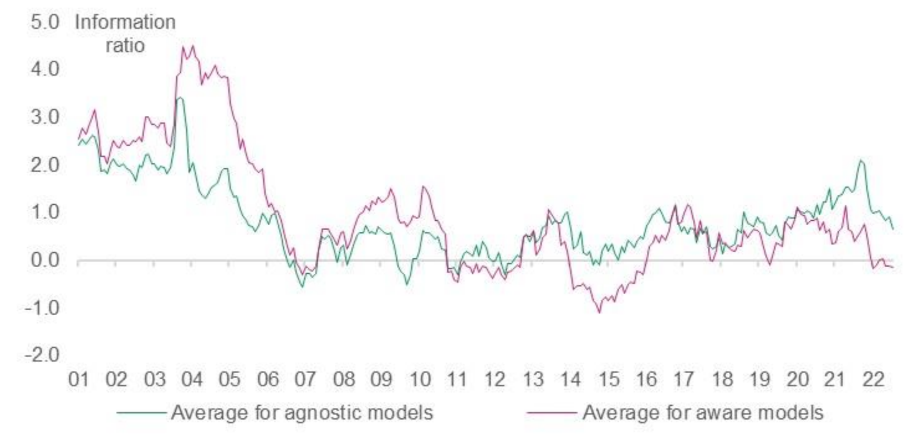


Source: Credit Agricole CIB

β-Agnostic or β-Aware convictions

As for the chosen between agnostic or aware convictions, the decision is not obvious. While the aware model was clearly the best performer until 2011, the lead has been less clear over the past 10 years, when agnostic models have been more consistent. And yet, the idea of a conviction that adapts to market risk made more sense to us.

Average 2-year rolling information ratio for β-aware and agnostic models



Source: Credit Agricole CIB

That said, we still need to find a way to choose between our different models and improve overall portfolio performance. The idea is first to understand which variables determine portfolio performance. What makes one model outperform the other during a given period, or vice versa? Can we find a way to determine automatically what would be the best model as a function of financial and economic variables?

SELECTING THE MODEL

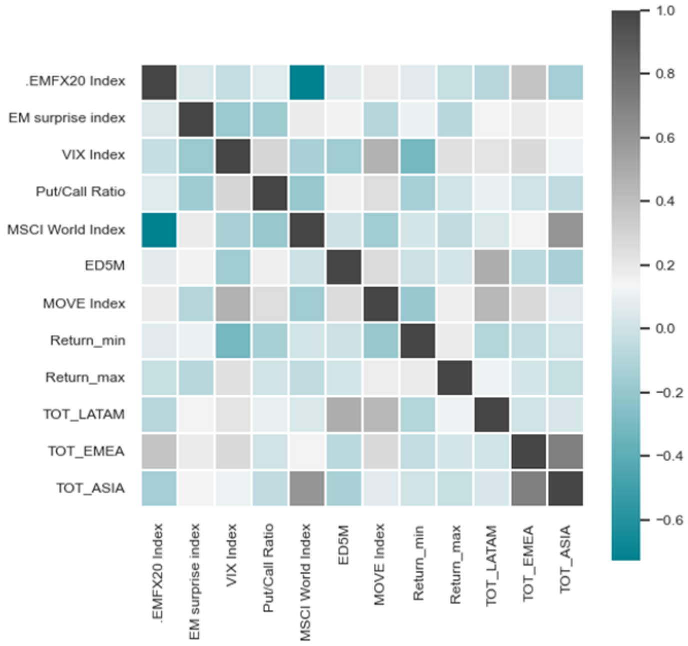
We decided to train an algorithm to our backtest data, going back to 2003 on a daily basis. According to endogenous and exogenous features, we want the algorithm to choose the best model to apply. The idea is to improve the portfolio performance by adapting the choice of the model to the economic environment.

Collecting macro variables

We introduced new variables to understand what could be the key movers in terms of performance of our models. In what kind of economical or financial circumstances would a model outperforms the others, or vice versa ? Here is the list of variables we came with:

- **Geographic indicator** : average Terms of Trade per region (Latam, Asia, EMEA)
- **Endogenous variables**:
  - Prior period maximal spot return across currencies
  - Prior period minimum spot return across currencies
- **Financial markets:**
  - Call/Put Ratio
  - MSCI World Index
  - VIX Index
  - MOVE Index
- **EM:**
  - Oil Price
  - Commodity Index
  - EM FX Index
  - EM surprise Index
- **US Economy:**
  - 10Y Treasury yields
  - US Citi Surprise Index
  - US CPI
  - Recession probability
  - 2-10 T slope
  - Fed Reserve balances
  - US TGA balance
  - ED5M

Alpha, predicted versus real



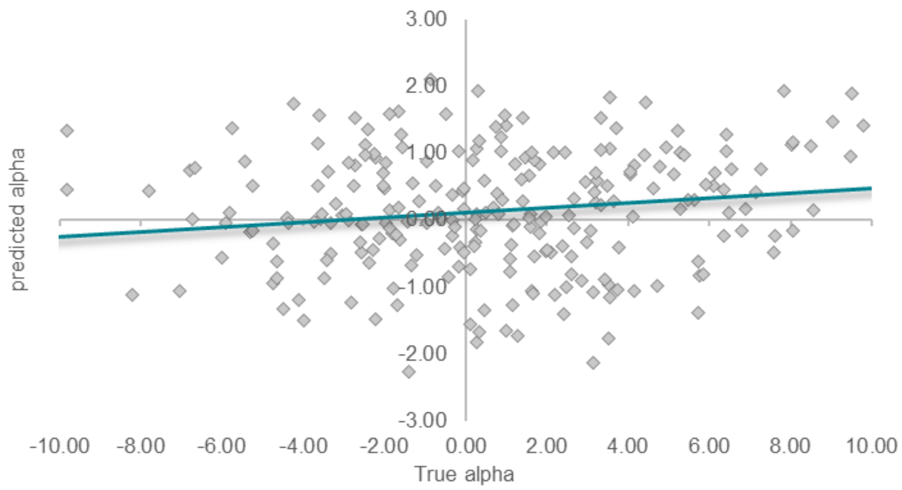
Source: Credit Agricole CIB

Note: the correlation matrix represents the historical correlation between the endogenous and exogenous variables used in the algorithm (discussed in the following pages).

Implementing a machine learning algorithm

We implemented a Random Forest Regressor algorithm for each one of our 12 models to predict the alpha score on a daily basis according to market and macroeconomic variables.

Alpha, predicted versus real, tested on 2023 dataset

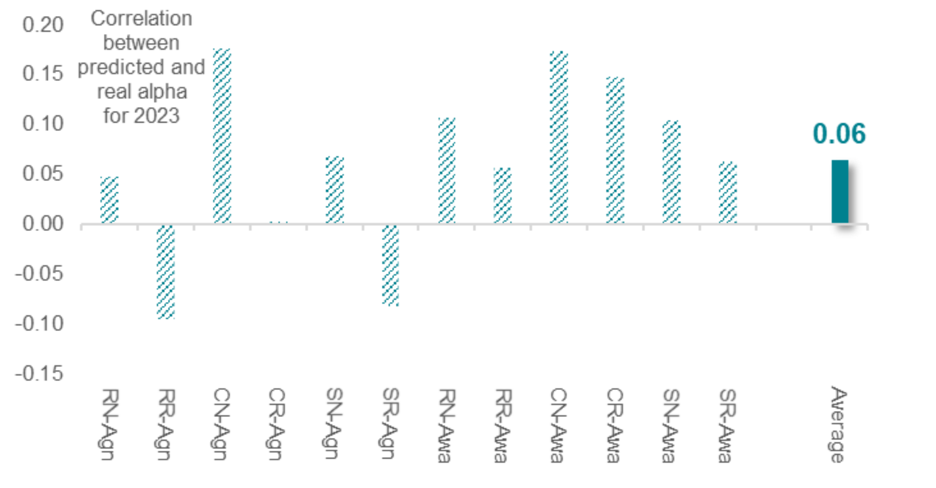


Source: Credit Agricole CIB

Note: example of taken from the algorithm related to CN Agnostic model

In the context of inherently unpredictable markets, a positive slope between predicted and true alpha indicates that the algorithm adds information.

Predictive ability of the algorithm by EMFX portfolio model, tested on 2023 dataset.



Source: Credit Agricole CIB

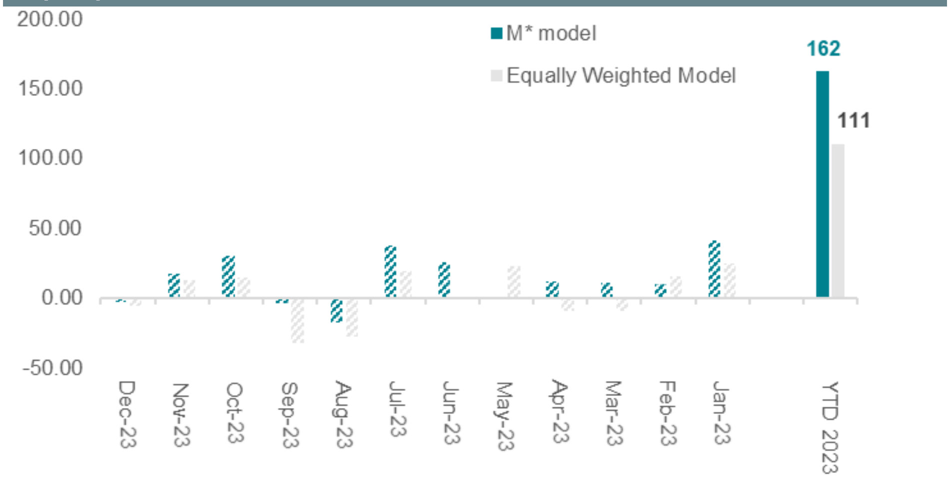
Now that we have a predicted alpha score for each model, we need to find a way to select the best model, or the one that is good enough taking into consideration the cost of switching.
We initiate the algorithm with the best performer for the first date. As long as this model performs relatively well compared to the best performer of the day, we continue to apply the original model. If the difference between the predicted alpha of the chosen model and the one of the best model becomes too wide, we change. The idea is to reduce the costs associated with changing models.

Let M_t^* be the chosen model and $\mathrm{alpha}_{\mathrm{M}_t^*,t}$ its predicted alpha score of the day t.

If t =1/1/2023, $\mathrm{M}_t^* = \Sigma_M(\mathrm{M}\, \mathbb{I}_{\{\mathrm{alpha}_{\mathrm{M},t}=\max_{\mathrm{M}}(\mathrm{alpha}_{\mathrm{M},t})\}})$

If t >1/1/2023, $\mathrm{M}_t^* = \begin{cases} \mathrm{M}_{t-1}^* & \text{If } \max_{\mathrm{M}}(\mathrm{alpha}_{\mathrm{M},t}) - \mathrm{alpha}_{\mathrm{M}_{t-1}^*,t} < 2\mathrm{bp} \\ \Sigma_M\left(\mathrm{M}\, \mathbb{I}_{\{\mathrm{alpha}_{\mathrm{M},t}=\max_{\mathrm{M}}(\mathrm{alpha}_{\mathrm{M},t})\}}\right) & \mathit{elsewhere} \end{cases}$

Alpha performance of the new Machine, tested on 2023 dataset



Source: Credit Agricole CIB

Global Markets Research contact details

Jean-François Paren Head of Global Markets Research +33 1 41 89 33 95

	Asia (Hong Kong, Singapore & Tokyo)		Europe (London & Paris)		Americas (New York)
Macro Strategy	Takuji Aida Chief Economist Japan +81 3 4580 5360	Arata Oto Japan Market Economist +81 3 4580 5337	**Louis Harreau** **Head of Developed Markets Macro & Strategy** **+33 1 41 89 98 95**	Valentin Giust Global Macro Strategist +33 1 41 89 30 01	Nicholas Van Ness ** US Economist +1 212 261 7601
Interest Rates			**Bert Lourenco** **Head of Rates Research** **+44 (0) 20 7214 6474** Matthias Loise Inflation Strategist +33 1 41 89 20 06	Guillaume Martin Interest Rates Strategist +33 1 41 89 37 66 Riccardo Lamia Interest Rates Strategist +33 1 41 89 63 83	Alex Li ** Head of US Rates Strategy +1 212 261 3950
Emerging Markets	Xiaojia Zhi Chief China Economist Head of Research, Asia ex-Japan +852 2826 5725 Eddie Cheung CFA Senior Emerging Market Strategist +852 2826 1553	Jeffrey Zhang Emerging Market Strategist +852 2826 5749 Yeon Jin Kim Emerging Market Analyst +852 2826 5756	**Sébastien Barbé** **Head of Emerging Market Research & Strategy** **+33 1 41 89 15 97**		Olga Yangol ** Head of Emerging Market Research & Strategy, Americas +1 212 261 3953
Foreign Exchange	David Forrester Senior FX Strategist +65 6439 9826		**Valentin Marinov** **Head of G10 FX Research & Strategy** **+44 20 7214 5289**	Alexandre Dolci FX Strategist +44 20 7214 5064	
Quant Research			Alexandre Borel Data Scientist +33 1 57 87 34 27		

*** employee(s) of Crédit Agricole Securities (USA), Inc.*

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Olga Yangol, Eddie Cheung

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MiFID II Research contact details

Andrew Taylor MiFID II Research contact andrew.taylor@ca-cib.com	Please send your questions on MiFID II to: research.mifid2@ca-cib.com

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