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Forecasting Foreign Exchange Behavior – Eigenvector Scaling Model

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Interest and Relevance

Forecasting Currencies

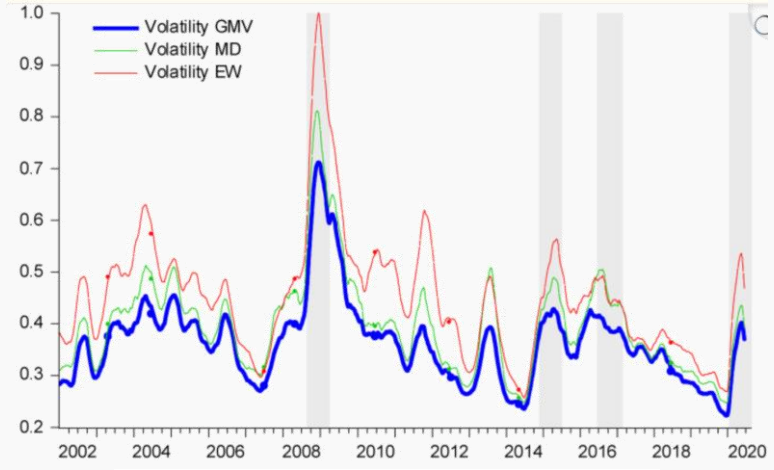
Forecasting Foreign Exchange Currencies

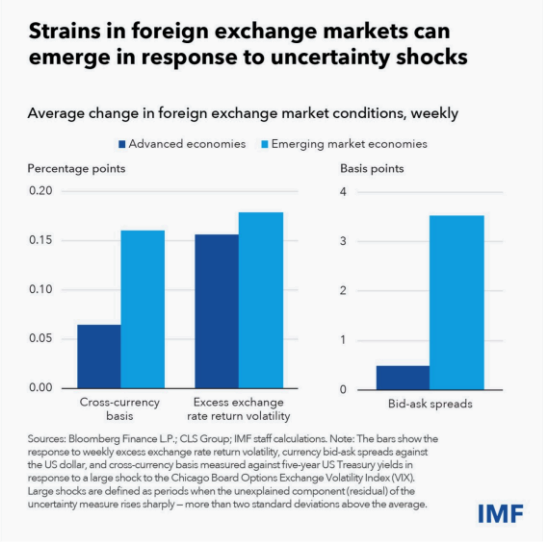
"Markets can remain irrational longer than you can remain solvent"
- John Meynard Keynes

The foreign exchange market is naturally sensitive to global shocks (i.e.recession, regulation), making forecasting a mounting challenge. Market sentiment and geopolitical events are what shape forex today.

For example, the Basel Committee responded to the 2008 financial crisis by changing the ratio between leverage and capital (Basel III – leverage ratio), causing changes in forex prices across the world (Cenedese et al.).

Left to Right: annualized average volatility series of GMV, MD, and EW increases during the 2008 financial crisis and COVID-19 (1). Balance sheets tighten in response to global shocks, in this case, COVID-19 (2).





Long-Term Forecasting vs. Short-Term Forecasting

- Although long-term forecasting is difficult given global shocks, finding market inefficiencies using short-term forecasting can be much more feasible.

- Because of the volatile nature of foreign exchange, having models that can be used in a high frequency setting. This can help in setting quicker adjustments in response to market movements and market noise.

- Shalishali & Ho (2010) demonstrates an eigenvector scaling model adapted from Saaty (1977) which was originally created to forecast short-term behavior in selected Asian currencies following the 2008 financial crisis.

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Literature Review

Reviewing Shalishali & Ho (2010)

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The Eigenvector Equation and It's Applications

The Eigenvector equation provides us a mechanism to model how currency prices are pulled.

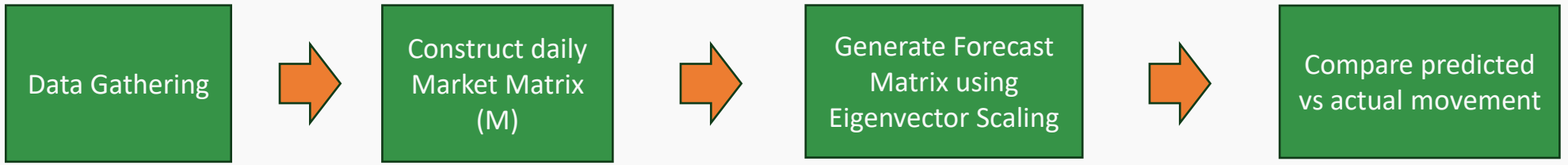
- In a noisy market like the forex market, the eigenvector equation can be implemented and become how we detect market mispricing/stress

$$A\mathbf{v} = \lambda\mathbf{v} \longrightarrow (M - \lambda I) = 0 \longrightarrow W\mathbf{q} = \lambda_{max}\mathbf{q}$$

Implementation Strategy

Implementation and modifications of Shalishali & Ho (2010)

Implementation Strategy (I)



Implementation Strategy(II)

1. Data Gathering
   - importing daily FX spot rates to create a clean, consistent input dataset for the forecasting pipeline
2. Construct Daily Market Matrix **(M)**
   - Transform raw spot data into a matrix that reflects real-world currency relationships

Matrix Table of Most Recent Cross-Rates of Currencies * (July, 2009)

	CNY	HKD	jpy	VDN	MYR	SGD	THB	IDR	inr	PKR	PHP	LKR	TWD
CNY	**1.000**	0.881	0.072	0.0004	0.521	1.916	0.201	0.0006	0.141	0.827	0.142	0.059	0.208
HKD	1.135	**1.000**	0.081	0.0004	2.196	5.365	0.228	0.0007	0.159	0.937	0.161	0.067	0.236
JPY	13.76	12.291	**1.00**	0.0055	26.99	65.94	2.803	0.0095	1.963	1.151	1.975	0.824	2.898
VDN	2,515	2,289	186.32	**1.000**	4,869	149.6	504.0	1.726	353.3	207.8	356.9	149.5	523.6
MYR	0.212	0.456	0.037	0.0002	**1.000**	2.441	0.103	0.0003	0.072	0.042	0.073	0.030	0.107
SGD	4.713	0.186	0.015	0.0066	0.409	**1.000**	0.042	0.0001	0.029	0.017	0.029	0.012	0.043
THB	5.004	4.406	0.358	0.0019	9.677	23.63	**1.000**	0.0034	0.697	0.410	0.704	0.295	1.034
IDR	1,461.3	1,286	104.68	0.579	1,825	6,902	293.3	**1.000**	203.8	119.916	206.0	86.31	302.1
INR	7.139	6.286	0.511	0.0028	13.80	33.722	1.433	0.0049	**1.000**	0.585	1.006	0.421	1.476
PKR	12.137	10.685	0.869	0.0048	23.47	57.332	2.436	0.0084	1.706	**1.000**	1.715	0.718	2.516
PHP	7.0656	6.220	0.506	0.0028	13.66	33.37	1.418	0.0048	0.993	0.582	**1.000**	0.416	1.457
LKR	16.863	14.845	1.208	0,0066	32.60	79.653	3.385	0.0115	2.371	1.391	2.401	**1.000**	3.492
TWD	4.916	4.240	0.345	0.0019	9.314	22.75	0.967	0.0033	0.677	0.397	0.685	0.286	**1.000**

*CNY=China Yuan Renminbi, HKD=Hong Kong Dollar, JPY=Japanese yen, VDM=Vietnamese Dong, MYR=Malaysia Ringgits, SGD=Singapore Dollars, THB=Thailand Baht, IDR=Indonesia Rupiahs, INR=Indian rupee, PKR=Pakistan Rupees, PHP=Philippines Pesos, LKR=Sri Lanka Rupees, TWD=Taiwan New Dollars

Implementation Strategy(III)

3. Eigenvector-Based Forecast (M*)

- compute the **principal eigenvector**, which represents relative currency values.

$$\mathrm{Wq} = \lambda_{\max}\mathrm{q}$$

- Using the eigenvector, we generate a **Forecast Matrix**

$$M_{ij}^{*} = \frac{r_j^{*}}{r_i^{*}}$$

Implementation Strategy(VI)

4. Performance Evaluation (H/NH)

- We compare the **direction** of predicted movement vs actual movement.
- Real movement:

$$\Delta M = M_{t+1} - M_t$$

- Predicted movement:

$$\Delta M^* = M_t^* \quad - M_t$$

- If both movements have the same sign → **H (Hit)**
- If signs differ → **NH (Not Hit)**
- Accuracy is computed across all time periods and all currency pairs.

Implementation Strategy(V)

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Summary Tables

Period *t*	Date	M	M*	M_t-M_{t+1}	M^*_t-M_{t+1}	H/NH
1	01/05/09	0.0732	0.0690	0.0024	0.0060	H
2	01/19/09	0.0756	0.0750	-0.0013	-0.0054	H
3	02/16/09	0.0743	0.0696	-0.0047	-0.0193	H
4	03/27/09	0.0696	0.0503	-0.0005	0.0208	NH
5	05/06/09	0.0691	0.0711	0.0019	-0.0022	H
6	06/16/09	0.0710	0.0733	n/a	n/a	n/a

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Results

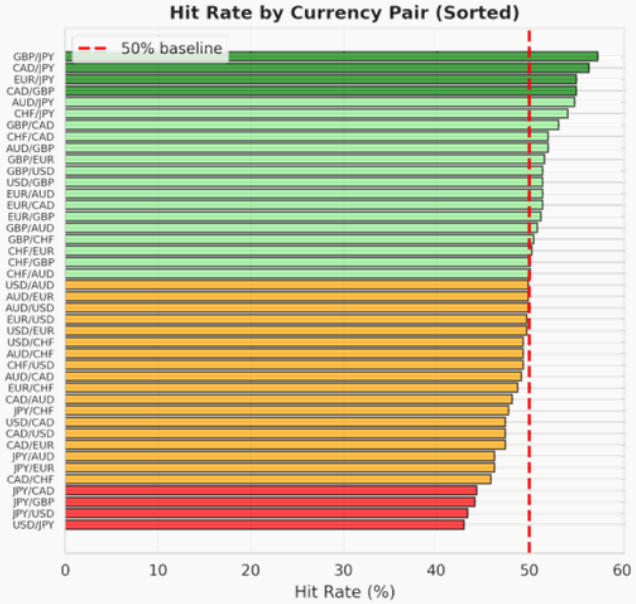
Hit Rate Visualization and Model Accuracy

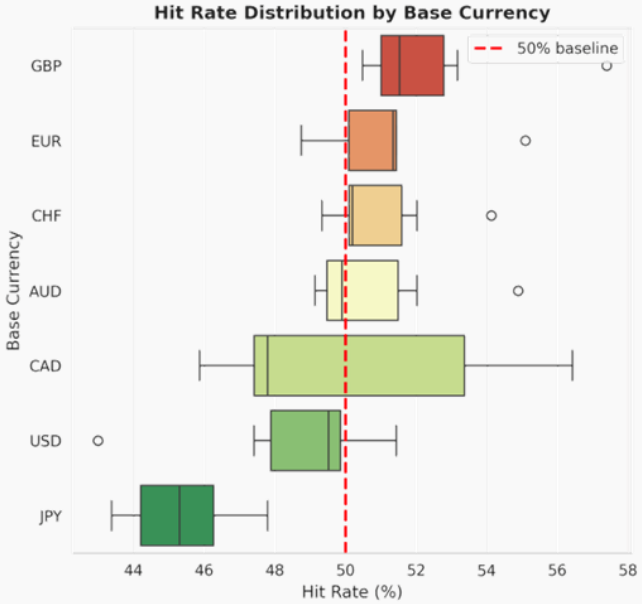
Currency Pair Predictions from five years ago to present.

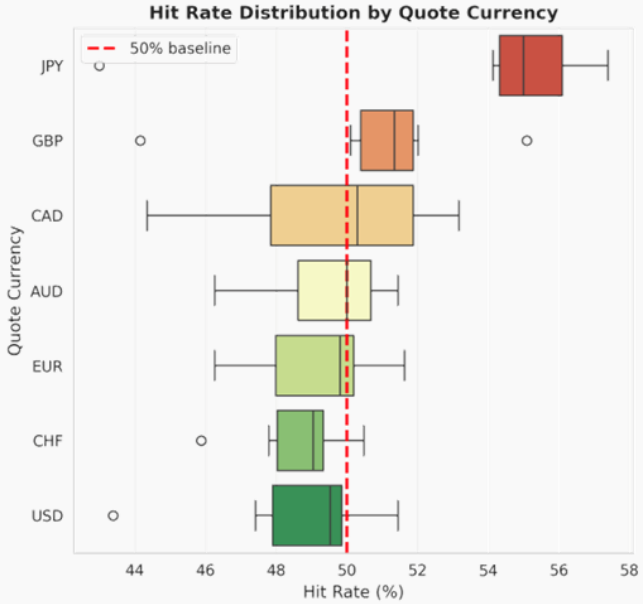
- The model is inconsistent as the overall mean for the hit rate 49% when we looked at data from two years ago. We expanded the data to five years ago to see if our model could be more accurate
- However, outside factors must be considered i.e. unexpected events within the global market or wars happening or any sort of intervention.

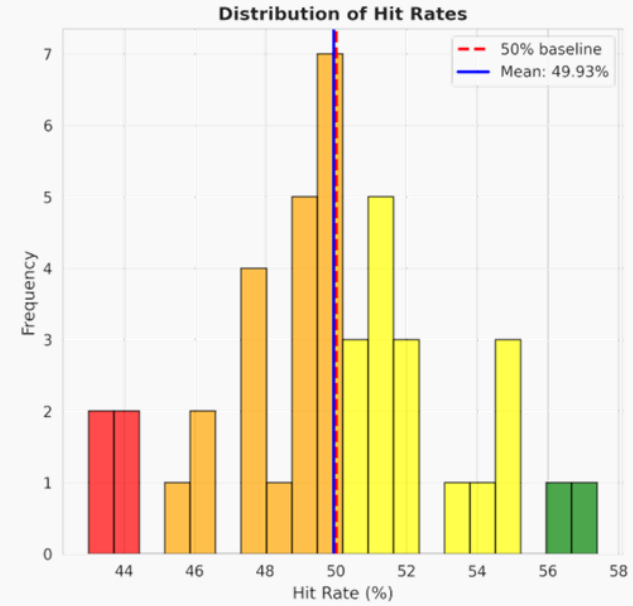
Metric	Value
Overall Mean	49.93%
Overall Median	49.90%
Std Deviation	3.34%
Min Hit Rate	42.99%
Max Hit Rate	57.39%
Pairs > 50%	20 / 42
Pairs > 55%	4 / 42
Best Pair	GBP/JPY
Worst Pair	USD/JPY

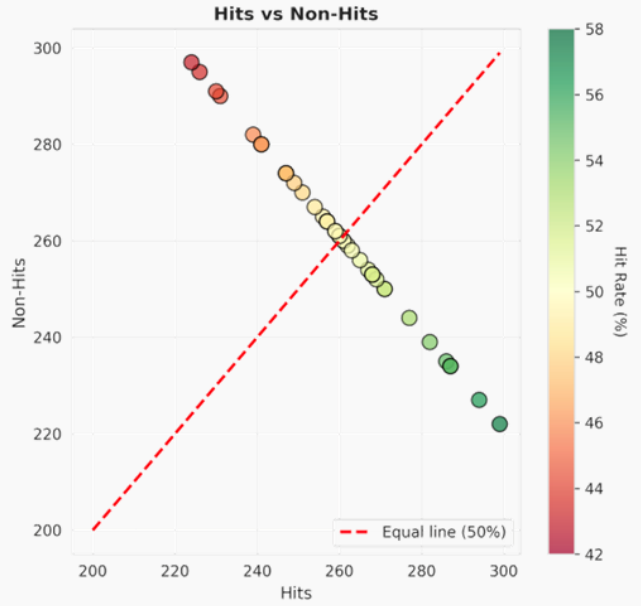
Hit Rate Analysis - Currency Pair Predictions











Performance Statistics

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Best Pair	GBP/JPY
Worst Pair	USD/JPY

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Augmented Dickey Fuller Test

The Augmented Dickey Fuller test is a regression model that measures whether a time series is stationary or in this case are your individual currency pairs stationary.

- We compute the regression from this equation
  $\Delta Pt = \alpha + \beta Pt-1 + i=1 \sum p \gamma i \Delta Pt-i + \epsilon t$
- The P value represents the price and the β value is the test statistic

and to compute if the currency pair is stationary or non-stationary

we check if β < 5% Critical Value

Results: Only 4/42 Currency pairs are stationary

	Pair	Test Statistic	P-value	5% Critical Value	Lags Used	Conclusion
2	AUDCAD	-2.33	0.1625	-2.8671	1	Non-Stationary (Fail to Reject H0)
3	AUDCHF	-2.0122	0.2812	-2.8671	0	Non-Stationary (Fail to Reject H0)
4	AUDEUR	-2.5639	0.1007	-2.8671	1	Non-Stationary (Fail to Reject H0)
5	AUDGBP	-1.7846	0.3881	-2.8671	1	Non-Stationary (Fail to Reject H0)
6	AUDJPY	-2.041	0.2689	-2.8671	0	Non-Stationary (Fail to Reject H0)
7	AUDUSD	-2.1765	0.2149	-2.8671	1	Non-Stationary (Fail to Reject H0)
8	CADAUD	-2.3229	0.1647	-2.8671	1	Non-Stationary (Fail to Reject H0)
9	CADCHF	-1.7876	0.3866	-2.8671	0	Non-Stationary (Fail to Reject H0)
10	CADEUR	-2.9694	0.0379	-2.8671	0	Stationary (Reject H0)
11	CADGBP	-1.4912	0.5379	-2.8671	0	Non-Stationary (Fail to Reject H0)
12	CADJPY	-2.1477	0.2258	-2.8671	0	Non-Stationary (Fail to Reject H0)
13	CADUSD	-1.2783	0.6391	-2.8671	0	Non-Stationary (Fail to Reject H0)
14	CHFAUD	-2.0574	0.262	-2.8671	0	Non-Stationary (Fail to Reject H0)
15	CHFCAD	-1.78	0.3904	-2.8671	0	Non-Stationary (Fail to Reject H0)
16	CHFEUR	-1.8988	0.3326	-2.8671	0	Non-Stationary (Fail to Reject H0)
17	CHFGBP	-2.9979	0.0351	-2.8671	0	Stationary (Reject H0)
18	CHFJPY	-1.9286	0.3187	-2.8671	0	Non-Stationary (Fail to Reject H0)
19	CHFUSD	-2.2842	0.1771	-2.8671	0	Non-Stationary (Fail to Reject H0)
20	EURAUD	-2.5918	0.0947	-2.8671	1	Non-Stationary (Fail to Reject H0)
21	EURCAD	-2.9587	0.0389	-2.8671	0	Stationary (Reject H0)
22	EURCHF	-1.8688	0.3469	-2.8671	0	Non-Stationary (Fail to Reject H0)
23	EURGBP	-1.6668	0.4483	-2.8671	0	Non-Stationary (Fail to Reject H0)
24	EURJPY	-2.0368	0.2707	-2.8671	0	Non-Stationary (Fail to Reject H0)
25	EURUSD	-2.6457	0.0839	-2.8671	0	Non-Stationary (Fail to Reject H0)
26	GBPAUD	-1.7005	0.4308	-2.8671	1	Non-Stationary (Fail to Reject H0)
27	GBPCAD	-1.4113	0.5769	-2.8671	0	Non-Stationary (Fail to Reject H0)
28	GBPCHF	-3.0135	0.0337	-2.8671	0	Stationary (Reject H0)
29	GBPEUR	-1.648	0.4581	-2.8671	0	Non-Stationary (Fail to Reject H0)
30	GBPJPY	-1.8524	0.3548	-2.8671	0	Non-Stationary (Fail to Reject H0)

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