Analysis of Core PCA drivers for Currencies

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Abstract

Using principal component analysis, I identify the core driving factors of emerging and developing market currency rates. I analyse 33 currencies from 1994-03-30 to 2021-10-29. I find that the first principal component is related to commodities, especially oil. The second principal component relates to political instability and the absence of violence/terrorism. The third principal component relates to some Asian factor. These factors can be used in further studies to make predictions about currency rates and determine whether they are under/overvalued. .

Keywords: PCA, Emerging Market, Developing Market

JEL classification L250, L100

1. Introduction

2. PCA Analysis

This paper analysis daily currency rates from the 30th of March 1990 till the 29th of October 2021. The currency rates are all relative to USD. The currency rates were split into emerging and developing markets according to the Morgan Stanley Capital International (MSCI) 2021 annual market classification. Frontier and standalone markets were not considered. Table 5.1 in appendix A displays the countries under consideration. Ultimately, 12 developing markets and 21 Emerging markets were analysed. Figure 5.1 in appendix A plots the rates of all 33 currencies.

Analysing 41 emerging and developing market currency rates result in very large datasets that need interpretation. Empirical techniques have been developed to decrease the dimensionality of a large dataset. One such empirical technique is principal component analysis (PCA), which is used to reduce the dimensionality of large datasets in an interpretable way while minimizing information loss. To achieve this, a new uncorrelated variable is created, known as the principal component, which maximizes the variance Jolliffe & Cadima (2016). The PCA yields 33 orthogonal principal

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components. To examine the relative importance of each principal component, I compare the scale of the eigenvalues of the variance-covariance matrix. The results are displayed in the scree plot in figure 2.1.

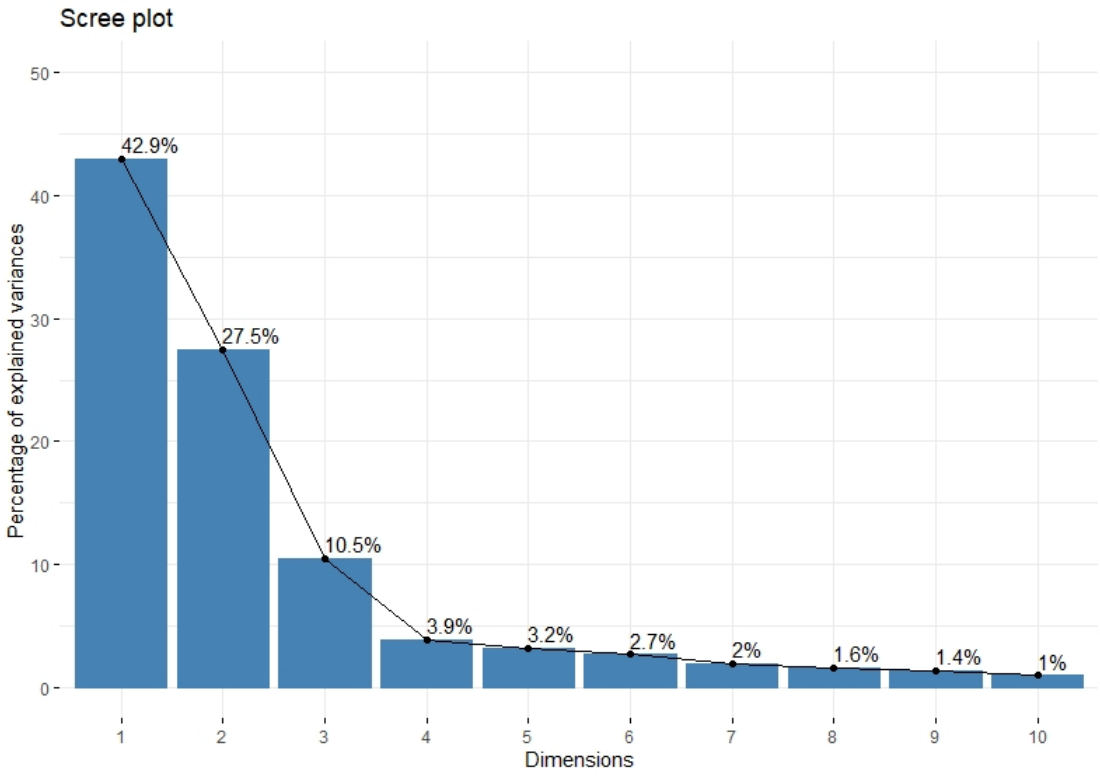

Figure 2.1: Scree plot

The scree plot indicates that the first principal component explains 42.9 percent of the variability, the second explains 27.5 percent and the third explains 10.5 percent. Therefore, the first three principal components explain 80.9 percent of the total variation. Figure 2.2 displays the first principal component. There is a drastic increase around 2008 during the financial crisis. This reflects the sharp appreciation of the USD against most currencies. The US dollar strengthens due to the global *flight to safety* into US Treasury bills as well as the reversal of carry trades McCauley & McGuire (2009). The same pattern can be seen during 2020 when the COVID_19 crisis was in full effect, however, the extent is much smaller.

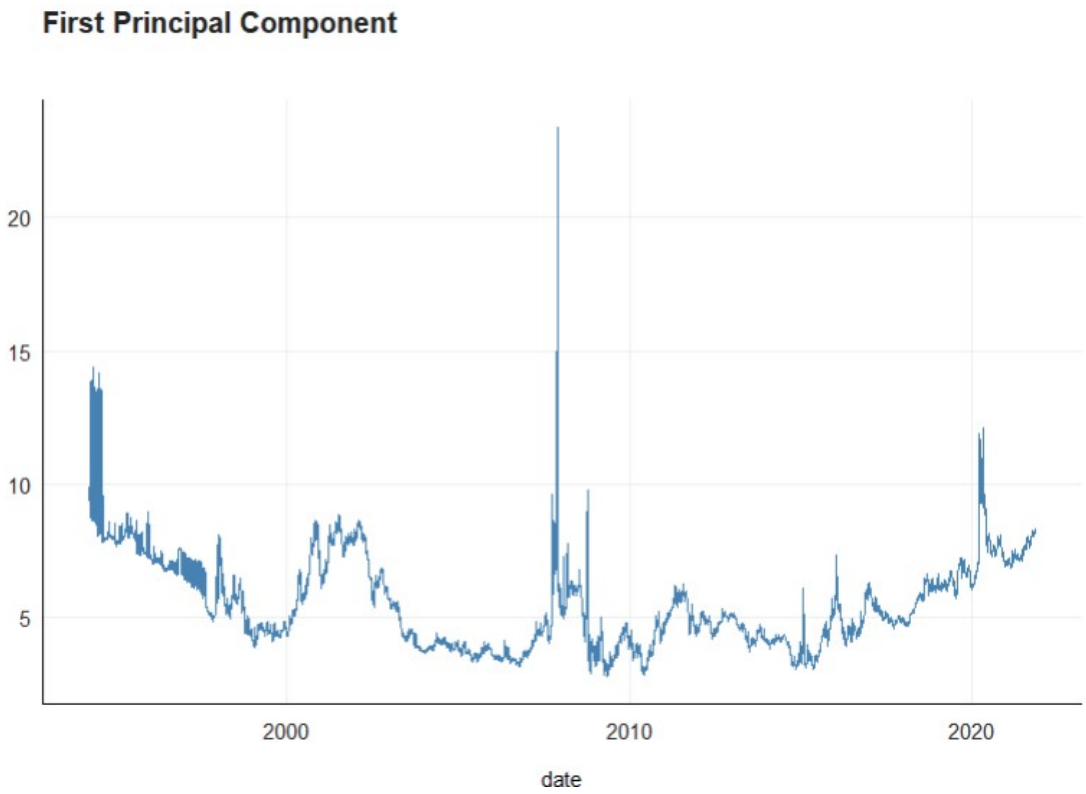

Figure 2.2: First Principal Component

3. Identifying Common Drivers

The principal component is used to analyse the driving forces. By comparing the eigenvalues of the variance-covariance matrix in the previous section, I determined that the first three principal components explain the majority of the total variance of the currency rates. In this section, I examine the correlation between the first three principal component and the currency rates, as well as provide economic interpretations around the core driving factors that affect currency rates.

Table 5.2 in appendix B shows the correlation and p-value for the first principal component (PC1). The country that has the highest positive correlation with PC1 is Hungary (HUF), which is a net importer of crude petroleum. Saudi Arabia (SAR) and the United Arab Emirates (AED) are two of the top exporting countries. China (CNY) is the only country with a negative correlation with PC1, with its top import being refined petroleum. Therefore, one would expect that the oil price is one of the core PCA drivers for currencies.

Oil is an extremely important, non-renewable resource. The demand and price for oil tend to drastically increase with world economic development Li & Ma (2015). Crude oil is quoted in the U.S dollar, therefore there is a direct relationship between the two. Theoretically, an appreciation in the US dollar

should cause a decrease in the price of oil. However, empirical research has found contradicting results, indicating a bi-directional causality relationship between oil and exchange rates Beckmann, Czudaj & Arora (2020). Fluctuations in the oil prices are diverse and unique, depending on whether a country is a net importing or net exporting country. For oil-importing countries, Castro & Jimenez-Rodriguez (2020) found that an oil price shock leads to depreciation of the home currency in the short run, however, the long-run effects are diverse.

For oil-exporting countries, it has been empirically proven that instability in the oil price does not have a significant effect on economic growth. Table 5.2 supports the results of Candila, Maximov, Mikhaylov, Moiseev, Senjyu & Tryndina (2021) who found a much stronger correlation for oil-importing countries. China is a unique case has it is one of the largest importers and exporters of oil. Li & Ma (2015) found a non-linear causality between the oil price and the RMB exchange rate. This indicates that movement in the price of oil can cause co-movement of RMB with a one-month lag. Since the relationship between the oil price and exchange rates are diverse and unique, policymakers should react with caution when examining exchange rate pressure.

Table 5.3 in appendix B displays the correlation and the p-value for the second principal component (PC2). The countries that have the highest correlation with PC2 are, amongst others, Singapore (SGD), New Zealand (NZD), Australia (AUD) and Canada (CAD), all developing market economies. The countries with the lowest correlation with PC2 are Turkey (TRY), Egypt (EGP) and Mexico (MXN). This suggest that the PC2 is related to political stability. Countries with a high political stability and absence of violence/terrorism ranking are highly correlated with PC2, whereas countries with a low ranking are often negatively correlated with PC2.

A country with a high political stability ranking offer much more safe and attractive investment opportunity for foreign investors. This implies that political stability has a significant effect on currency rates. Political unrest, such a serious allegation into government conduct can contribute to the destabilization of an economy, which will weaken currency rates. Changes in currency rates are known as *exchange rate risk* which accounts for uncertainty in movement in the exchange rate between the home and receiver country Higgins, Hysenbegasi & Pozo (2004).

Although the effect of political instability is profound, Levis (1979) found that the relationship between political instability in developed countries and foreign direct invest are highly significant in the short run, but not the long run. This would suggest that foreign investors adjust quickly to new developments and that political stability should be considered in conjunction with numerous other relevant factors.

The correlation and the p-value for the third principal component is represented in Table 5.4 in appendix B. The countries with the largest correlation all appear in Asia and the countries with the lowest correlation are all developed market. This implies that the third principal component is an Asia-specific factor. Over the past few areas, Asian countries have experienced phenomenal growth,

which has created profitable opportunities for foreign investors.

4. Forecasting

Forecasting currency rates is important to many fields such as international business and monetary policy. However, it is challenging to obtain accurate forecasts due to the fluctuations caused by political instability, shocks to commodity prices and economic events. From an investing point of view, an accurate forecast reduces risk related to international investments as well as maximizes returns. Monetary policy also depends on an accurate forecast of currency rates, as changes in the interest rate can either appreciate or depreciate the home currency. Changes in currency rate affect trade, which affects economic growth. Therefore, an accurate currency forecast can assist authorities to implement effective policies that boost economic growth Shen, Lee, Liu, Chang & Yang (2021). In this section, I attempt to forecast the three most traded currencies: the Euro (EU), the Pound sterling (GBP) and the Japanese yen (JPY). Figure 4.1 displays the currency rate for the three currencies, all relative to USD.

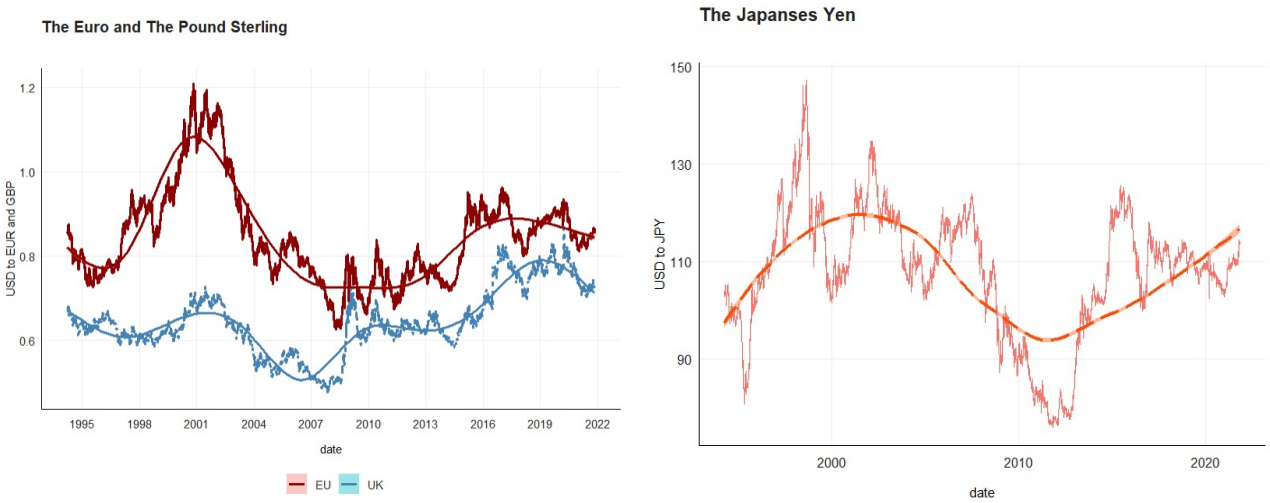

Figure 4.1: The three most traded currencies

I employ a 30 period ahead Autoregressive Integrated Moving Average (ARIMA) model to forecast currency rates. Akincilar, TEMIZ & Sahin (2011) found that the ARIMA model performs relatively well when compared to other forecasting methods. Figure 4.2 and figure 4.3 show the forecasting results for the selected currencies with a 95 per cent upper and lower bound. The forecast results indicate that the USD/GBP rate is forecasted to decrease, implying that the Pound sterling is going to strengthen. However, the actual data shows the opposite effect, the GBP currency rate weakened.

The forecast results indicate that the USD/EU rate is forecasted to increase slightly, implying that

the euro is going to decrease. Actual data support this forecast. The forecast results indicate that the USD/JPY rate is forecasted to decrease slightly, implying that the Pound sterling is going to strengthen. Actual data shows that the currency rate remained relatively stable, making the forecast results mostly accurate. The results should be further investigated to conclude on the forecast accuracy, however, this was out of the scope of this paper.

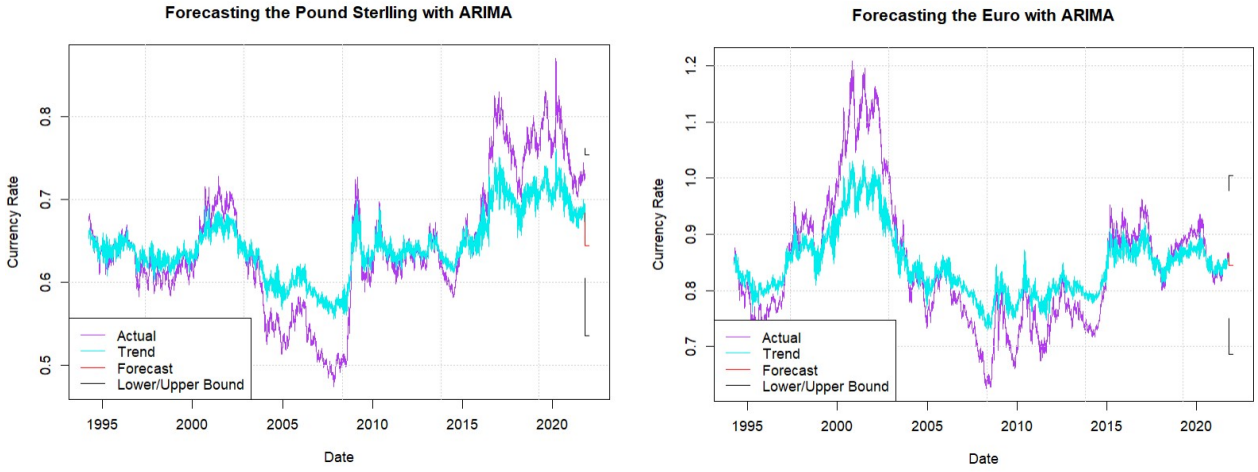

Figure 4.2: Forecasting Results (1)

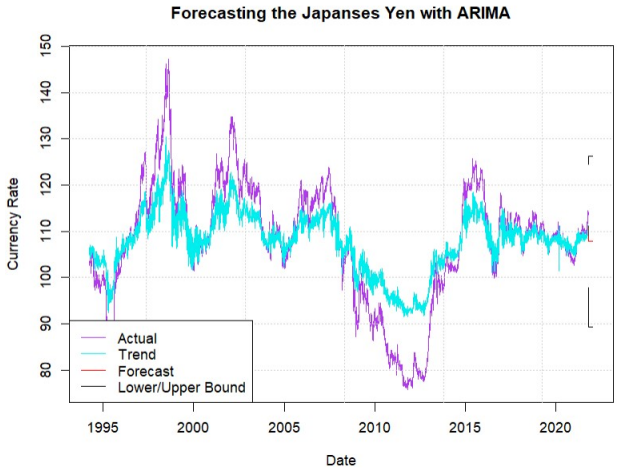

Figure 4.3: Forecasing Results (2)

5. Conclusion

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Appendix A

Emerging Market		Developed Market	
Currency	ISO Code	Currency	ISO Code
Sol	PEN	Japanese Yen	JPY
Saudi riyal	SAR	Hong Kong dollar	HKD
New Taiwan dollar	TWD	Canadian dollar	CAD
Czech koruna	CZK	Danish krone	DKK
South Korean won	KRW	Euro	EUR
Renminbi	CNY	Australian dollar	AUD
Indian rupee	INR	New Zealand dollar	NZD
Brazilian real	BRL	Singapore dollar	SGD
Turkish lira	TRY	Swedish Krona	SEK
Russian ruble	RUB	Norwegian krone	NOK
South African rand	ZAR	Isreali Shekel	ILS
Mexican peso	MXN	Pound sterling	GBP
Columbian peso	COP		
Egyptian pound	EGP		
Chilean peso	CLP		
Hungarian forint	HUF		
Malaysian ringgit	MYR		
Phillipine peso	PHP		
Thai bath	THB		
United Arab Emirates dirham	AED		
Polish złoty	PLN		

Table 5.1: Description of currencies

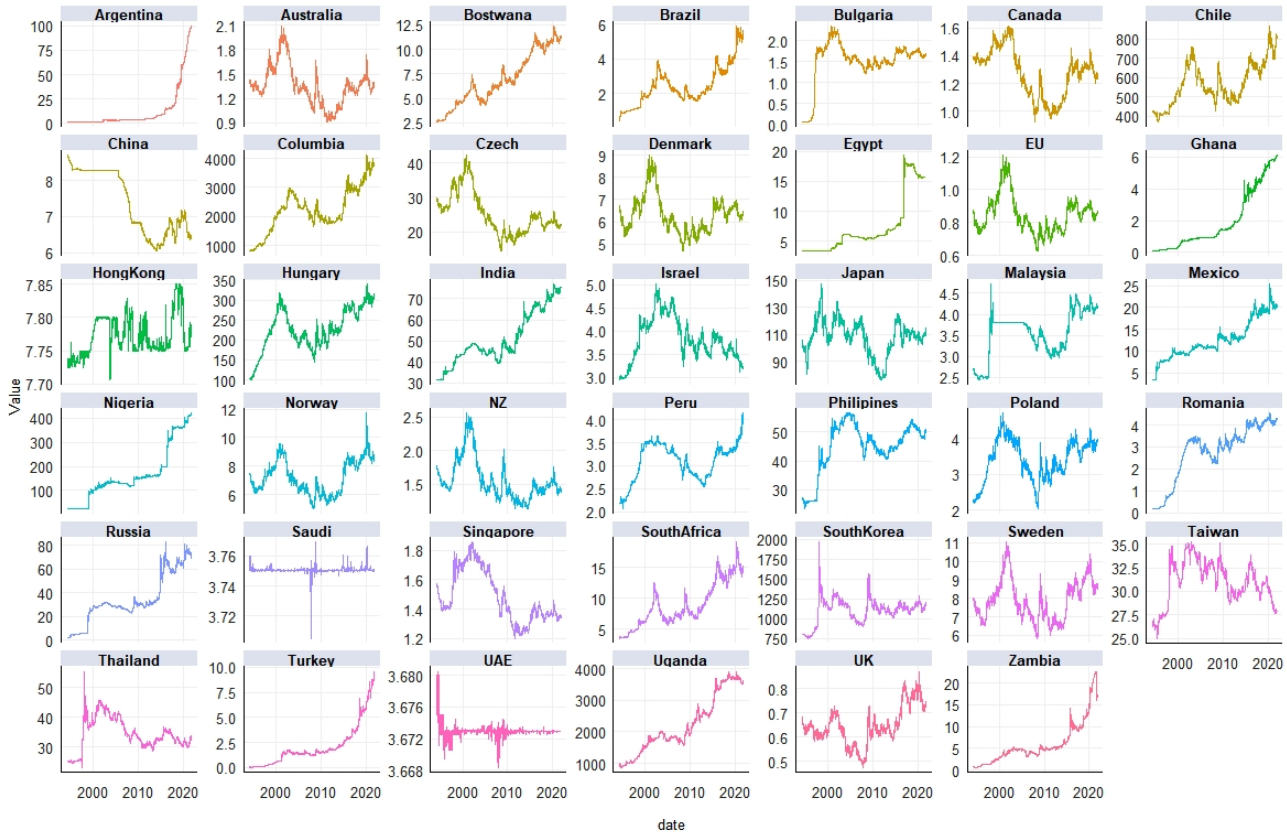

Figure 5.1: Currency rates of all 33 emerging and developing market countries

Apprendix B

	Correlation	P-value
HUF	0.9262878	0.000000e+00
MYR	0.9114497	0.000000e+00
CLP	0.9065261	0.000000e+00
PEN	0.8988561	0.000000e+00
PLN	0.8780890	0.000000e+00
COP	0.8751020	0.000000e+00
NOK	0.8378328	0.000000e+00
SEK	0.8330755	0.000000e+00
BRL	0.8263736	0.000000e+00
RUB	0.7871421	0.000000e+00
ZAR	0.7857282	0.000000e+00
INR	0.7411845	0.000000e+00
PHP	0.7307233	0.000000e+00
MXN	0.6843628	0.000000e+00
TRY	0.6753067	0.000000e+00
EUR	0.6577914	0.000000e+00
DKK	0.6479256	0.000000e+00
KRW	0.6422958	0.000000e+00
GBP	0.6259090	0.000000e+00
EGP	0.6216001	0.000000e+00
AUD	0.5593268	0.000000e+00
THB	0.5319724	0.000000e+00
HKD	0.5177139	0.000000e+00
TWD	0.4758927	0.000000e+00
CAD	0.4283742	3.557371e-319
JPY	0.4241386	2.822415e-319
NZD	0.3989511	3.069525e-273
ILS	0.3742421	4.183071e-238
SGD	0.2588114	1.665786e-110
CZK	0.2551624	2.320584e-107
AED	0.2038677	2.137731e-68
SAR	0.1573449	3.994842e-41
CNY	-0.1710389	2.206939e-48

Table 5.2: Correlation and P-value for the first principal component

	Correlation	P-value
SGD	0.90321526	0.000000e+00
CZK	0.87653914	0.000000e+00
CNY	0.86382354	0.000000e+00
NZD	0.83337067	0.000000e+00
AUD	0.75831445	0.000000e+00
CAD	0.71356174	0.000000e+00
DKK	0.63254705	0.000000e+00
EUR	0.62951387	0.000000e+00
THB	0.59809540	0.000000e+00
JPY	0.53230115	0.000000e+00
ILS	0.48051271	0.000000e+00
TWD	0.42403389	4.168569e-312
SEK	0.35444999	4.308577e-212
PLN	0.26203282	2.533385e-113
NOK	0.19878697	4.705671e-65
KRW	0.14350307	1.991097e-34
PEN	0.11407789	2.773568e-22
AED	-0.03178834	6.993189e-03
MYR	-0.03679994	1.792246e-03
HKD	-0.04911994	3.056982e-05
PHP	-0.11881763	4.754379e-24
HUF	-0.13573551	6.020449e-31
CLP	-0.21440682	1.272391e-75
GBP	-0.27266672	6.567991e-123
COP	-0.36995837	2.561588e-232
BRL	-0.43981305	0.000000e+00
ZAR	-0.55307034	0.000000e+00
RUB	-0.58376817	0.000000e+00
INR	-0.62851292	0.000000e+00
TRY	-0.64001397	0.000000e+00
EGP	-0.64775485	0.000000e+00
MXN	-0.69994979	0.000000e+00

Table 5.3: Correlation and P-value for the second principal component

	Correlation	P-value
ILS	0.69659804	0.000000e+00
TWD	0.68427216	0.000000e+00
PHP	0.61977923	0.000000e+00
THB	0.53049506	0.000000e+00
HKD	0.30858474	1.310000e-158
KRW	0.28839441	6.692788e-138
PEN	0.28634486	6.840019e-136
SGD	0.22758825	3.214148e-85
MYR	0.22365740	2.722457e-82
COP	0.17404390	4.636722e-50
AED	0.09417778	1.179695e-15
CLP	0.08433068	7.709335e-13
RUB	-0.02629516	2.568733e-02
PLN	-0.04475238	1.458206e-04
HUF	-0.07070644	1.909999e-09
CNY	-0.08335190	1.413117e-12
INF	-0.09077720	1.198224e-14
ZAR	-0.10617861	1.681325e-19
NZD	-0.14852069	8.807498e-37
TRY	-0.15874418	7.742415e-42
EGP	-0.18399169	7.806200e-56
AUD	-0.20033914	4.582160e-66
SAR	-0.25871186	2.032612e-110
EUR	-0.29838703	6.100743e-148
DKK	-0.31163124	7.020576e-162
SEK	-0.32101610	3.342782e-172
CZK	-0.34533690	1.002528e-200
CAD	-0.44548362	0.000000e+00
NOK	-0.47271370	0.000000e+00
GBP	-0.61500908	0.000000e+00

Table 5.4: Correlation and P-value for the third principal component