

# Analysis of Core PCA drivers for Currency Rates

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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

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## 1. Introduction

The foreign exchange market is the largest financial market in the world, and it is extremely liquid. It provides investors with a lot of flexibility, since there are no restrictions on the total amount of money that one individual can use for investing. Furthermore, there is also no regulation of the market, implying that it operates on a 24-7 basis [Tanamarttayararat \(2018\)](#). However, investing in currency rates have often been overlooked as a potential resource of returns for a variety of reasons. One reason is that currency rates can be challenging to model. The underlying source of value of a currency rate is elusive [Pojarliev & Levich \(2013\)](#). An economic model for currency valuation often uses fundamental macroeconomic variables, such as real income or national money supply, to estimate the fair value of the currency rate. However, these models are often overly restrictive and account for country-specific macroeconomic variables, making it nearly impossible to replicate the results across currency rates. Therefore, an economic model that works well for a specific currency or period may not necessarily work well for other currencies or periods. There is also the risk of central bank intervention in currency rates which deters investors from investing. However, profit opportunities in the currency market are available but are subject to a high level of risk and are mostly suitable for specialist [Ponomareva, Sheen & Wang \(2019\)](#).

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Taking these shortcomings and strengths into account, this paper uses principal component analysis to analyse the relationship between currency rates and macroeconomic variables. By examining 33 emerging and developing market currency rates, the paper concludes that shocks to commodity prices, such as an oil price shock, political instability and the Asian economy are all important macroeconomic variables that account for most of the variation in currency rates.

The paper is structured as follows: Section 2 briefly discusses the data, methodology and some descriptive statistics of the principal component analysis. Section 3 provides an in-depth discussion about the core principal component drivers for currency rates. Section 4 forecasts the three most traded currency rates. Finally, section 5 concludes.

## 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 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.

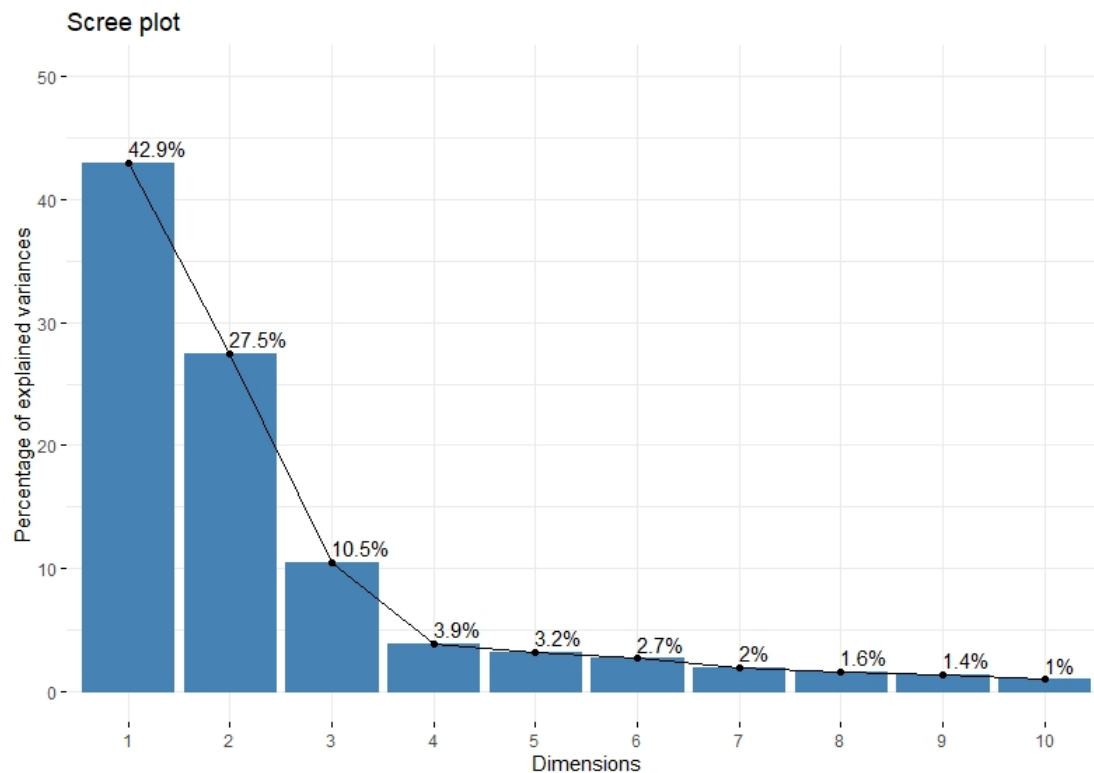


Figure 2.1: Scree plot

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.

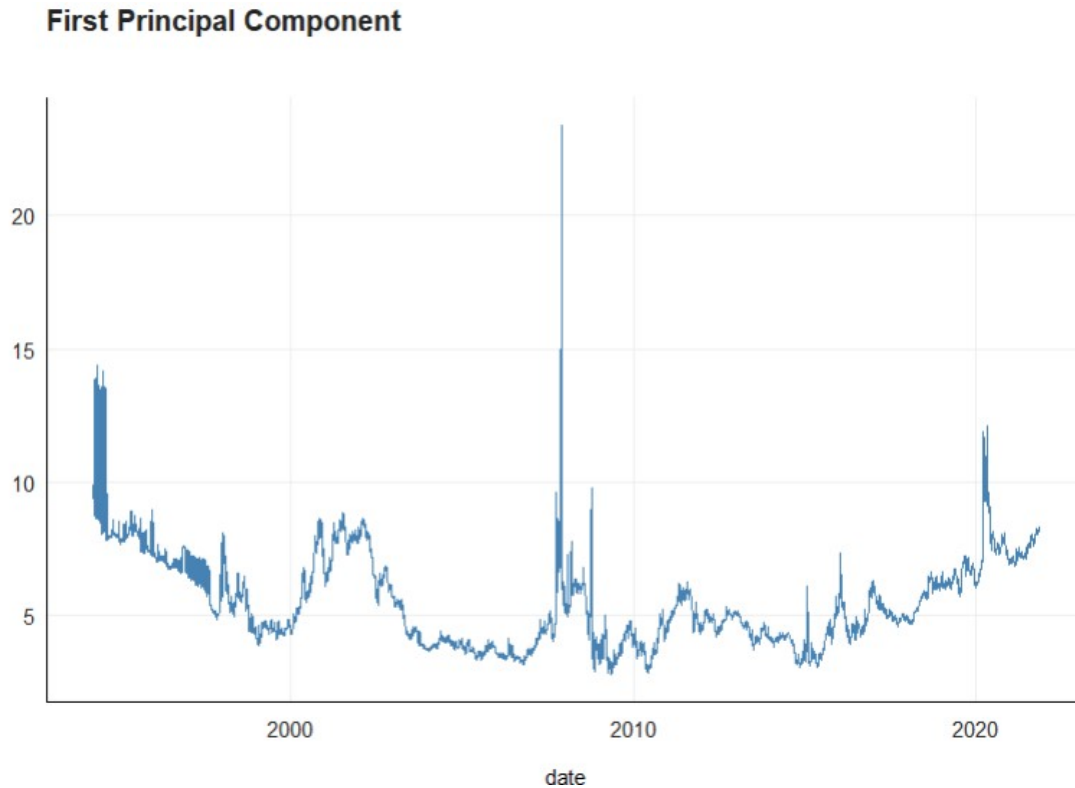


Figure 2.2: First Principal Component

### 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 as 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 developed market economies. The countries with the lowest correlation with PC2 are Turkey (TRY), Egypt (EGP) and Mexico (MXN). This suggests 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 offers 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 as 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 investment 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 years, 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.

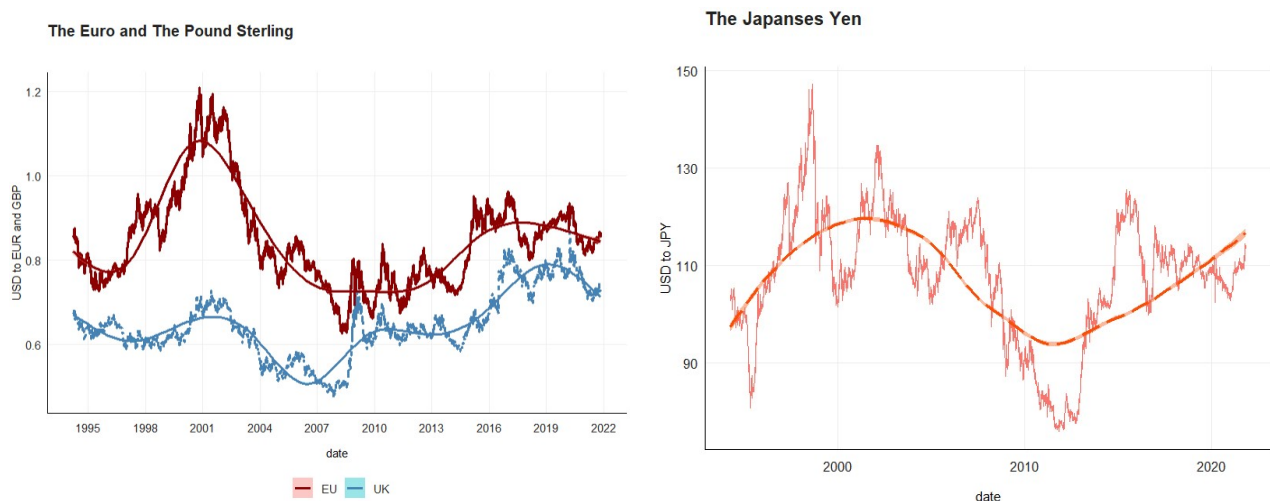


Figure 4.1: The three most traded currencies

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.

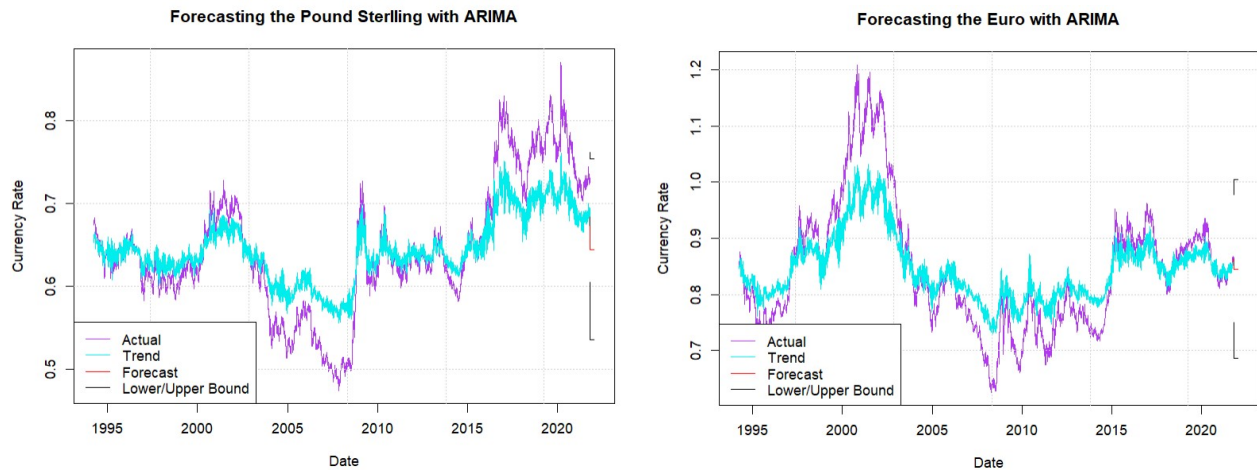


Figure 4.2: Forecasting Results (1)

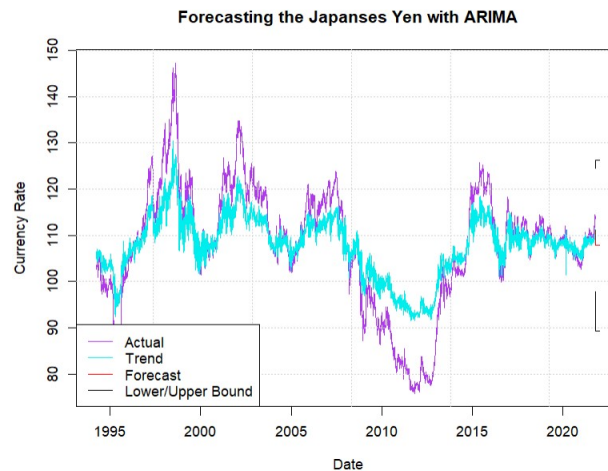


Figure 4.3: Forecasting Results (2)

## 5. Conclusion

This paper uses 33 emerging and domestic market currency rates to determine which macroeconomic variables are most important when analysing currency rates. Since economic models are accompanied

with many short comings, such as being overly restrictive, this paper uses a principal component analysis technique to reduce the dimensionality of the datasets in an interpretable way while minimizing information loss. The paper concludes that shocks to commodity prices, such as an oil price shock, political instability and the growth of Asian markets should all be used to build prediction models of sport returns.



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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      | Israeli 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 zloty                | PLN      |                    |          |

Table 5.1: Description of currencies

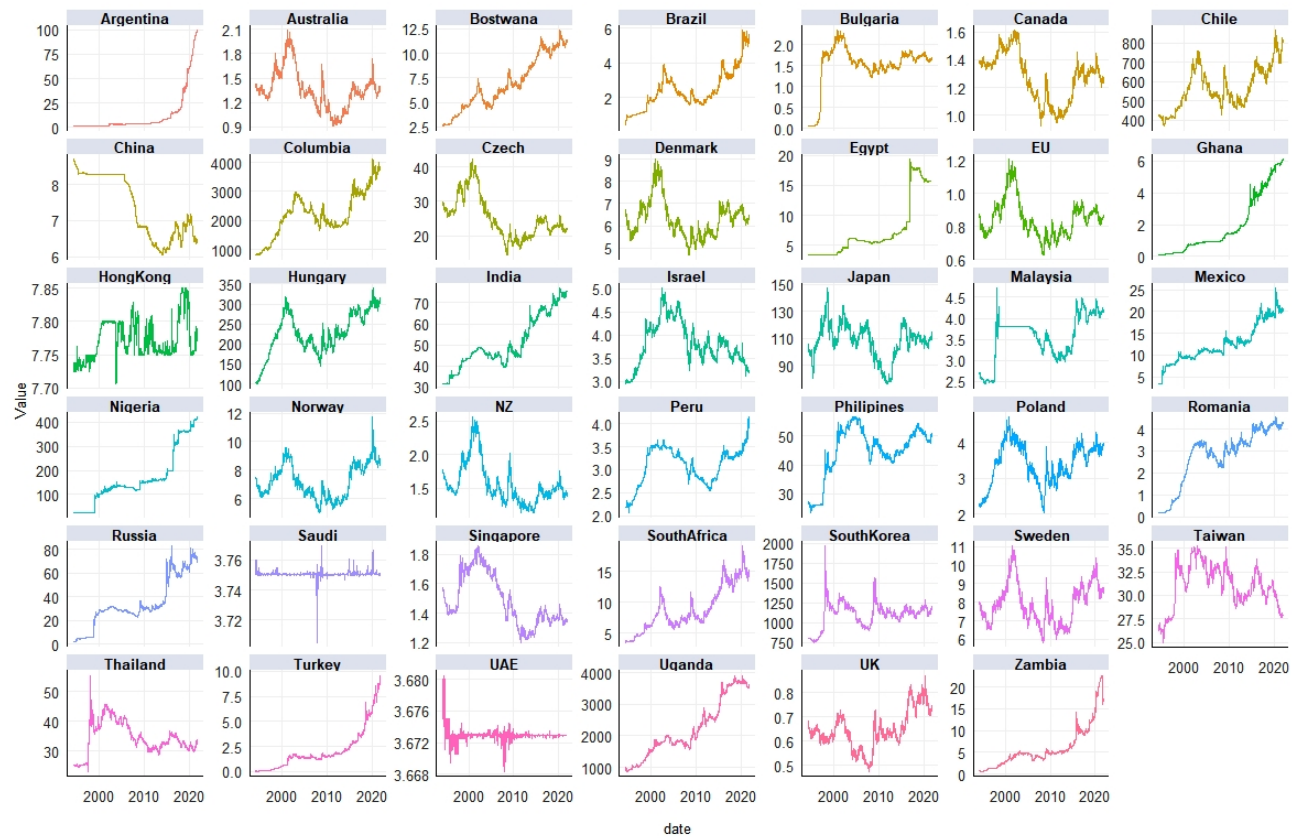


Figure 5.1: Currency rates of all 33 emerging and developing market countries

## Appendix 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