Exchange rate volatility spillovers and the South African currency

L Raputsoane[1]

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Abstract

This paper examines the volatility spillovers between the South African currency and the currencies of selected markets in developed and emerging Europe as well as Asia and Latin America. Additionally, the exchange rate volatility spillovers are examined over one year window samples to determine the evolution of volatility spillovers between these currencies overtime. The empirical results show statistically significant negative exchange rate volatility spillover effects between the South African currency and the currencies in developed and emerging European markets, while no spillover effects can be established for the currencies in the Asian and Latin American markets. Moreover, the one year window samples results confirm the hypothesis of changing exchange rate volatility spillovers across currency markets overtime.

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Corresponding author's e-mail address: leroi.raputsoane@resbank.co.za

[1] The views expressed are those of the author(s) and do not necessarily represent those of the South African Reserve Bank or Reserve Bank policy.

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1 Introduction

The international foreign exchange activity has accelerated in recent decades as a result of the rapid globalisation of financial markets. Consistent with globalisation, the rapid liberalisation of the goods and financial markets, together with the adoption of freely floating exchange rate regimes have made cross border capital flows swift and effortless. These developments have heralded an era of increased exchange rate volatility in global currency markets given the role exchange rates play in international transactions (Doong and Yang, 2004). They also imply increased likelihood of foreign exchange rate volatility spillovers and contagion across currency markets.

Exchange rate volatility spillovers or volatility co-movements between currencies imply that the currency markets in different economies have achieved some level of integration. It further suggests similarity in the underlying economic, institutional structures and that the shocks faced by these economies and the transmission of these shocks through the currency markets are analogous. It also insinuates market psychology amongst markets participants, which is the segmentation of currency markets in terms of their riskiness. As a result, common volatility across currency markets implies greater bandwagon and contagion effects across these markets (Pramor and Tamirasa, 2006).

This paper examines the exchange rate volatility spillovers between the South African currency and the currencies of selected developed and emerging economies. Of particular interest is the extent to which volatility in the selected currency markets are comparable to that of the South African currency. Further, the exchange rate volatility spillovers are examined over one year window samples to determine the evolution of these volatility spillovers between the South African currency and the currencies in the selected markets overtime. This study will enhance the understanding of foreign exchange activity in the South African currency market relative to the selected currency markets.

This paper is organised as follows: Section 2 is the literature review. Section 3 is methodology and data, which discusses the model together with the volatility spillover indexes. Section 4 is the empirical analysis and section 5 is the conclusion.

2 Literature review

Since the work of Engle, Ito and Lin (1990), there is limited empirical work on foreign exchange rate volatility spillovers. Using dollar exchange rates for French franc, Italian lira, German mark and British pound for the period 1974 to 1998, Black and McMillan (2000) found evidence of significant volatility spillovers across European currencies. McMillan (2001) went further to study the common trend and volatility in the Deutschemark and French franc per dollar exchange rates using a multivariate random walk stochastic volatility model. The study found high correlation between the volatility innovations and suggests that they follow a common trend so that, in essence, the volatilities are cointegrated.

Horvath (2005) analysed the exchange rate volatility for 20 Central and Eastern European Countries (CEECs) over the period 1989-1998. The study found that the CEECs encounter increased exchange rate volatility of approximately the same level as the euro area countries before they adopted the Euro so that the countries fulfilling the optimum currency area experience less exchange rate spillovers. Klassen (1999) studied the time-dependence of exchange rate correlations using a multivariate GARCH model for weekly data covering the period April 1974 to July 1997. Analysing the correlations between eight developed countries U.S. dollar exchange rates (the Canadian dollar, Japanese Yen, British pound, Belgian franc, French franc, German mark, Italian lira and the Dutch guilder) in post- Bretton-Woods era, the study found that the major U.S. dollar exchange rates have become more loosely instead of closely tied since the eighties.

Melvin and Melvin (2003) studied the volatility spillovers of the Deutschemark and Japanese yen per dollar exchange rates across regional markets in Asia, Europe and America. They found the evidence of statistically significant effects for both own-region and interregional spillovers, but that the magnitude of own-region spillovers are more important than interregional spillovers. Pramor and Tamirasa (2006) compared the long-run volatility trends in Central and East European as well as Euro zone currencies over the period 1993 to 2005 using Component GARCH (CGARCH) model. They find that the volatility trends are closely correlated and that the spillovers of volatility across regional markets have moderated over time, with the exception of the Hungarian forint.

In a benchmark study, Engle, Ito and Lin (1990) tested two competing hypotheses on volatility clustering. These are the heat wave effects, which refer to volatility clustering at a regional level and the meteor shower effects, which refer to volatility clustering at a global level. Using the General autoregressive Conditional Heteroscedacity (GARCH) model to analyse intra-daily market segments for the US dollar per Japanese yen exchange rate for the period October 1985 to September 1986, their results generally support the hypothesis of the meteor shower suggesting cross-regional volatility clustering.

In general, empirical studies support the exchange rate spillover paradigm, particularly for currency markets in developed economies. In most cases, high frequency data particularly intra-day, daily and weekly closing spot exchange rates is used. The GARCH models are commonly used for analytical purposes, particularly the Exponential GARCH (EGARCH) model. The CGARCH and multivariate GARCH models are also popular to account for transitory and permanent effects as well as cross-currency spillovers, respectively. Moreover, there are instances where the long-run common volatility is tested, particularly in empirical works that estimate cointegration in foreign exchange rate volatility trends such as in Black and McMillan (2000) as well as Febrianm and Herwany (2007).

3 Data description and methodology

3.1 Data

The data set consists of daily closing spot exchange rates for 14 currency markets of South Africa, Euro Area, Japan, United Kingdom, Canada, Poland, Russia, Turkey, China, India, Korea, Argentina, Brazil and Mexico. Their selection is based on the countries' importance in terms of GDP size among the industrialised and emerging economies. All foreign exchange rate data series are expressed as domestic currency per US dollar. The sample covers period January 01, 1999 to April 25, 2008. This yields 2431 observations. The sample starting point coincides with the introduction of the Euro in January 1999. The exchange rate data series are sourced from the Bloomberg database.

The exchange rates data series is transformed into log differences, also referred to as continuously compounded returns in financial economics. The log differenced data series are computed as follows

$$y_t = \log x_t - \log x_{t-1} = \log\left(\frac{x_t}{x_{t-1}}\right) \qquad [1]$$

where, x_t are the nominal exchange rate data series. The exchange rates like other financial time series such as stock indices and share prices behave in a similar manner after this transformation. As a result, they are said to exhibit ergodicity. They also have the advantage that they can be modelled as a stationary stochastic process. These reasons make it possible to compare the different exchange rates.

Doong and Yang (2004) argue that high frequency data, denominated in daily and intraday frequencies, contains too much noise. Nevertheless, it captures information content of changes in exchange rates, while low frequency data, denominated in monthly or quarterly frequencies, does not. As a result, daily denominated data is appropriate for the purpose of this study. The descriptive statistics of the U.S. dollar denominated currencies are presented in table 1 and Table A1 in the appendix details the currencies descriptions. Based on the standard deviation, the Korean won and the Japanese yen are the most volatile, while the British pound and Euro are the least volatile given the level of the currencies. Considering the mean of the currencies, the Argentinean peso and the Turkish lira are the most volatile, while the Chinese renmimbi and the Indian rupee are the least volatile. Figure A1 in the appendix show the exchange rates indexes and log differences.

3.2 Model

The Exponential GARCH (EGARCH) model is used to estimate the volatility spillovers between the South African currency and the selected currency markets. This model is popularly used to estimate the conditional variance or volatility of high frequency financial assets, stock market indexes and exchange rate data. The EGARCH model was proposed Nelson (1991) as an extension of the Bollerslev's

(1986) GARCH model. The GARCH model is the generalisation of Engle's (1982) autoregressive Conditional Heteroscedacity (ARCH) model. These models posses useful properties for estimating volatility dynamics in a unified framework and are consistent with the stylised facts in foreign exchange rate dynamics such as volatility persistence and clustering (Guimaraes and Karacadag, 2004).

The mean and the conditional variance equations in the EGARCH(p,q) model are specified as follows

$$y_t = \theta + \varepsilon_t \qquad , \ \varepsilon_t \left| \Omega_{t-1} \sim N(0, \sigma_t^2) \right. \qquad [2]$$

$$\sigma_t^2 = \exp\left\{ \omega + \sum_{i=1}^{q} \left(\alpha_i \left| \frac{\varepsilon_{t-i}}{\sqrt{\sigma_{t-i}^2}} \right| + \gamma_i \frac{\varepsilon_{t-i}}{\sqrt{\sigma_{t-i}^2}} \right) + \sum_{i=1}^{p} \beta_i \ln \sigma_{t-i}^2 \right\} \qquad [3]$$

y_t is the dependent variable, in this case, the exchange rate data series. It is a function of the constant tem θ, which measures the average rate of accelerations and decelerations in the dependent variable or the equilibrium exchange rate and the error term ε_t. t is a time subscript. The conditional variance σ_t^2 is a one-period ahead forecast of variance based on the information set Ω at time $t-1$. It is a function of a constant term ω, the ARCH term $\frac{\varepsilon_{t-i}}{\sqrt{\sigma_{t-i}^2}}$, which caries information about volatility in the previous period and the GARCH term σ_{t-i}^2, which is the last period forecast variance.

α_i are reaction coefficients, β_i measure persistence and γ_i measure the leverage effects. Large reaction coefficients mean that volatility reacts intensely to shocks and a large persistence term means that the shocks to volatility take a long time to die out. The presence of the leverage effects can be tested by the hypothesis that $\gamma < 0$. The impact is asymmetric if $\gamma \neq 0$ and symmetric if $\gamma = 0$. Volatility asymmetry implies that an unexpected depreciation increases volatility more than an analogous unexpected appreciation. p in EGARCH(p,q) refers to the presence of the pth order autoregressive GARCH term, while q refers to the qth order moving average ARCH term.

The EGARCH(p,q) model can be augmented by including the conditional variances of the exogenous variables in equation [3] so that the augmented EGARCH(p,q) model is specified by the following equation

$$\sigma_t^2 = \exp\left\{\omega + \sum_{i=1}^{q}\left(\alpha_i \left|\frac{\varepsilon_{t-i}}{\sqrt{\sigma_{t-i}^2}}\right| + \gamma_i \frac{\varepsilon_{t-i}}{\sqrt{\sigma_{t-i}^2}}\right) + \sum_{i=1}^{p}\beta_i \ln \sigma_{t-i}^2 + \sum_{j=1}^{p}\lambda_j \ln \vartheta_{t-j}^2\right\} \qquad [4]$$

Where σ_{t-i}^2 now becomes the conditional variance of the South African currency and ϑ_{t-j}^2 are the conditional variances of the selected currencies. As a result, λ_j measure the volatility spillovers between the South African currency and the selected currency markets. Therefore, statistically significant λ_j imply that developments in the selected currency markets spillover to the South African currency market. To account for cross-currency spillovers in the volatility equation, the multivariate GARCH model must be estimated. However, Pramor and Tamirasa (2006) argue that the GARCH model estimated in this manner comes at the cost that it is not robust to the ordering of the series and requires a lot of restrictions. As a result, estimating the univariate EGARCH model is consistent with the purpose of this study.

Empirical evidence supports the notion of the changing degree of foreign exchange volatility interdependence across currency markets over time. This evidence of evolving volatility spillovers can be found in the studies by Bollerslev (1990) and Klassen (1999), etc. To investigate whether or not the volatility spillovers between the currency market in South Africa and the selected basket of currencies have evolved over time, the spillovers are estimated over one year window samples. The spillover table is used to display the one year window samples volatility spillovers. The volatility Spillover Indexes SI are estimated as follows

$$SI_{ij} = \lambda_{ij} \qquad [5]$$

where λ is defined above. In this instance, i denotes the currency market and j refers to a particular one year window period.

Three distributions are usually assumed given that the EGARCH model is estimated using the maximum likelihood method. These are the Gaussian distribution, the Student's t distribution and the General Error Distribution (GED). Given a sample of T observations and assuming the Gaussian distribution or conditional normality for each of the variables series, the log-likelihood function for the EGARCH(p,q) model is given by

$$L_t(\Theta) = \frac{v}{\psi 2^{1+\frac{1}{v}} \Gamma(1/v)} \sum_{i=1}^{T} \frac{1}{2}\left[-\log \sigma_t^2 - \left| \frac{\varepsilon}{\sigma_t \psi} \right|^v \right] \qquad [6]$$

Where Θ is the parameter vector, $\psi \equiv \left[2^{(-2/v)} \Gamma(1/v) / \Gamma(3/v)\right]^{1/2}$, $\Gamma(.)$ is the gamma function and v is the thickness parameter where if $v = 2$, the error distribution is Gaussian. The rest of the variables are described as above. The Gaussian distribution is assumed in the estimation. In the event that Gaussian distribution is rejected, the robust standard errors detailed in Bollerslev and Wooldridge (1992) are used. The readers interested in the functional forms of the Student's t distribution and the General Error Distribution (GED) are referred to Anderson (2001).

4 Empirical results

The maximum likelihood estimates of the estimated EGARCH(1,1) models [3] and [4] are reported in table 2 and 3, respectively. The Argentinean peso, the Chinese renmimbi and the Turkish lira samples were from January 2002, August 2005 and March 2001, respectively. The reason for not using the samples from January 1999 is that these currencies exhibit little or no variability in the period before the above mentioned dates. All the estimated models were tested for the evidence of remaining ARCH effects using the ARCH LM test. This is because a correctly specified variance equation should exhibit no remaining ARCH in the residuals. The null hypothesis of no remaining ARCH effects is accepted for almost all the estimated models [3] and [4] except for the Polish zloty per US dollar for model [3]. Additionally, the quasi-maximum likelihood robust covariances and standard errors were estimated for all the models using the heteroscadasticity consistent covarience described in Bollerslev and Wooldridge (1992).

Table 2 The Exponential GARCH(1,1) volatility results

Currencies	Mean equation	Variance Equation			
	θ	ω	α	γ	β
USDARS	0.000 (0.000)	-0.050 (0.004)**	0.073 (0.011)**	-0.057 (0.008)**	0.998 (0.000)**
USDBRL	0.000 (0.000)	-0.467 (0.061)**	0.277 (0.025)**	0.059 (0.015)**	0.973 (0.006)**
USDCAD	0.000 (0.000)*	-0.092 (0.027)**	0.065 (0.012)**	-0.018 (0.008)**	0.996 (0.002)**
USDCNY	0.000 (0.000)	-0.021 (0.007)**	2.296 (0.363)**	2.231 (0.352)**	1.005 (0.001)**
USDINR	0.000 (0.000)	-0.666 (0.085)**	0.433 (0.043)**	0.036 (0.022)*	0.968 (0.006)**
USDJPY	0.000 (0.000)	-0.336 (0.086)**	0.100 (0.021)**	-0.034 (0.012)**	0.975 (0.008)**
USDKRW	0.000 (0.000)**	-0.604 (0.114)**	0.233 (0.030)**	0.031 (0.017)*	0.960 (0.010)**
USDMXN	0.000 (0.000)	-0.747 (0.152)**	0.141 (0.025)**	0.097 (0.018)**	0.941 (0.013)**
USDPLN	0.000 (0.000)**	-0.767 (0.190)**	0.156 (0.027)**	0.036 (0.015)**	0.936 (0.018)**
USDRUB	0.000 (0.000)	-0.212 (0.032)**	0.282 (0.056)**	-0.044 (0.019)**	0.993 (0.002)**
USDTRY	0.000 (0.000)**	-0.293 (0.040)**	0.148 (0.017)**	-0.014 (0.012)	0.981 (0.003)**
USDGBP	0.000 (0.000)	-0.197 (0.072)**	0.065 (0.015)**	0.001 (0.009)	0.986 (0.006)**
USDEUR	0.000 (0.000)**	-0.089 (0.032)**	0.059 (0.013)**	-0.009 0.007	0.996 (0.003)**
USDZAR	0.000 (0.000)	-0.212 (0.041)**	0.163 (0.021)**	0.011 (0.012)	0.991 (0.004)**

Notes: Standard errors in parentheses,
** and * statistical significance at 5 and 10 percent, respectively.

According to the results for model [3], all the currencies show statistically significant reaction and persistence to shocks as shown by α and β. This means that volatility reacts intensely to shocks in all the selected currencies and that the shocks to volatility in these currencies take relatively long to die out. The Argentinean peso, Canadian dollar, Japanese yen and the Russian rubble show significant leverage effects as shown by the negative and statistically significant γ. This means that depreciations in these currencies increase volatility more than the appreciations.

Additionally, most of the currencies do not display any statistically significant equilibrium rates except for the Korean won, Polish zloty, the Turkish lira and the Euro as shown by the statistically insignificant θ.

To examine the exchange rate volatility spillovers, the augmented Exponential GARCH(1,1) model [4] is estimated for the full sample as well as over one year rolling window periods for all the selected currencies. The estimated spillover indexes are presented in table 3. For the full sample, the estimated results show statistically significant negative spillover indexes between the South African rand and the euro, Japanese yen, Polish zloty, Russian rubble and the British pound. This implies an inverse volatility co-movement between the selected currencies and the South African currency.

The results further show no statistically significant volatility spillover effects between the South African rand and the currencies in selected emerging Asian and Latin American markets. It is not surprising that the east European currencies have the similar spillover effects on the South African currency as does the developed European currencies. Horvath (2005) argues that the central and east European currency markets are relatively well aligned with those in the euro area in relation to openness and similar export commodity structures.

Over the one year window samples, there is evidence of common volatility in at least one window period between the South African rand and all the currencies excluding the Chinese renmimbi. Consistent with the full sample results, the common volatility spillovers are mostly frequent between the South African rand and the Russian rubble as well as the British pound, while they are less frequent between the South African rand and the Brazilian real and the Korean won. The common volatility spillovers are prevalent between 2004 and 2005 window periods and less prevalent in the 2003 and 2006 rolling windows.

These results confirm the hypothesis of the changing degree of exchange rate volatility spillovers across currency markets overtime. However, it is not clear from the results whether or not the spillover effects have intensified overtime. Moreover, the spillovers are random, unstable and change signs between successive window periods. Generally, the spillovers are more prevalent between the South African rand

and the currencies in advanced economies and the east European currency markets than they are for the emerging Asian and Latin American currency markets. The results contradict the findings in other studies, particularly Horvath (2005), Melvin and Melvin (2003) as well as McMillan (2001), for advanced countries' currency markets where positive volatility spillovers are found. As a result, there are implications for the transmission of shocks and hence for portfolio because the shocks to foreign exchange markets may be caused by the information about economic fundamentals and market psychology etc.

Table 3 The Exponential GARCH (1,1) volatility spillovers results

Currencies	1999	2000	2001	2002	2003	2004	2005	2006	2007	Full sample
USDARS				-0.043 (0.163)	-0.017 (0.093)	0.228 (0.117)**	0.685 (0.665)	-0.264 (0.226)	0.326 (0.149)**	0.006 (0.003)*
USDBRL	0.151 (0.142)	0.012 (0.008)	-0.014 (0.007)**	-0.226 (0.154)	0.041 (0.087)	0.022 (0.070)	-0.027 (0.063)	0.267 (0.141)*	0.088 (0.064)	-0.004 (0.003)
USDCAD	0.777 (0.386)**	0.044 (0.050)	-0.043 (0.038)	-1.427 (0.812)*	-0.155 (0.134)	0.330 (0.197)*	0.008 (0.128)	1.258 (0.481)**	0.206 (0.103)**	-0.001 (0.008)
USDCNY								0.118 (0.097)	-0.017 (0.132)	0.012 (0.011)
USDEUR	-0.016 (0.034)	0.228 (0.085)**	-0.004 (0.011)	-0.642 (0.612)	-0.095 (0.231)	0.054 (0.020)**	-2.077 (1.690)	0.713 (0.464)	0.650 (0.309)**	-0.012 (0.006)**
USDINR	0.022 (0.012)*	0.002 (0.004)	0.030 (0.021)	0.173 (0.079)*	-0.041 (0.071)	-0.036 (0.050)	-0.038 (0.013)**	0.218 (0.139)	-0.091 (0.054)*	0.000 (0.002)
USDJPY	0.065 (0.070)	-0.014 (0.004)**	-0.127 (0.124)	0.087 (1.153)	0.240 (0.177)	-0.180 (0.199)	-0.030 (0.011)**	0.489 (0.521)	0.371 (0.192)*	-0.028 (0.008)**
USDKRW	0.607 (0.370)*	0.005 (0.006)	-0.005 (0.009)	-0.042 (0.377)	0.097 (0.072)	0.038 (0.009)**	0.616 (0.446)	0.190 (0.255)	0.127 (0.189)	-0.001 (0.005)
USDMXN	1.689 (0.334)**	0.029 (0.014)**	0.020 (0.022)	-0.866 (0.510)*	-0.155 (0.140)	-0.182 (0.274)	-0.059 (0.007)**	-0.142 (0.373)	-0.013 (0.115)	-0.011 (0.008)
USDPLN	0.020 (0.104)	0.210 (0.153)	-0.009 (0.008)	0.341 (0.344)	-0.286 (0.151)*	1.327 (0.602)**	0.042 (0.011)**	0.164 (0.318)	0.941 (0.716)	-0.022 (0.011)**
USDRUB	1.238 (0.157)**	-0.010 (0.004)**	0.004 (0.006)	0.614 (0.168)**	-0.116 (0.081)	0.019 (0.008)**	-0.058 (0.024)**	0.149 (0.257)	0.143 (0.033)**	-0.007 (0.002)**
USDTRY				1.333 (0.416)**	-0.033 (0.071)	1.565 (0.281)**	0.875 (0.950)	0.244 (0.147)*	0.190 (0.130)	-0.004 (0.003)
USDGBP	-0.133 (0.151)	0.031 (0.023)	0.083 (0.038)**	0.240 (0.644)	-0.757 (0.390)**	-0.112 (0.381)	-0.354 (0.076)**	1.412 (0.577)**	0.760 (0.314)**	-1.223 (0.470)**

Notes: Standard errors in parentheses,
** and * statistical significance at 5 and 10 percent, respectively.

The absence of volatility spillover linkages between the South African currency market and the currency markets in emerging Asian and Latin America means that the exchange rate shocks affect these currency markets independently. On the flipside, the presence of negative volatility spillover linkages between the South African currency market and the currency markets in advanced economies and eastern Europe means that high volatility in the South African currency market coincides with low volatility in the these currency markets. Since foreign exchange volatility is associated with risk, this is desirable for portfolio diversification and investors' risk aversion. Investors in these currency markets can rebalance their portfolios in favour of less risky currency markets as implied by the inversely related volatility dynamics.

5 Conclusion

This paper examined the exchange rate volatility spillovers or the co-movemetnt in volatility of the South African currency and the currencies of selected developed and emerging economies. The augmented EGARCH model was estimated for daily closing spot exchange rates of the South African currency and the selected currency markets in developed and emerging Europe as well as Asia and Latin America. Additionally, one year window samples were estimated to examine whether volatility spilllovers between the currencies have evolved overtime. The full sample results show statistically significant negative exchange rate volatility spillover effects between the South African currency and the currencies in developed and East European currency markets, on the one hand.

On the other hand, the results do not show any statistically significant volatility spillover effects between the South African currency and the currencies in emerging Asian and Latin American currency markets. This result is further reinforced when analysing the volatility spillovers over the one year window samples. The volatility spillovers are more frequent between the South African currency and the currencies in developed and east European currency markets, while they are less frequent for the currencies in emerging Asian and Latin American currency markets. Moreover, the results confirm the hypothesis of changing exchange rate volatility spillovers across currency markets overtime.

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Appendix

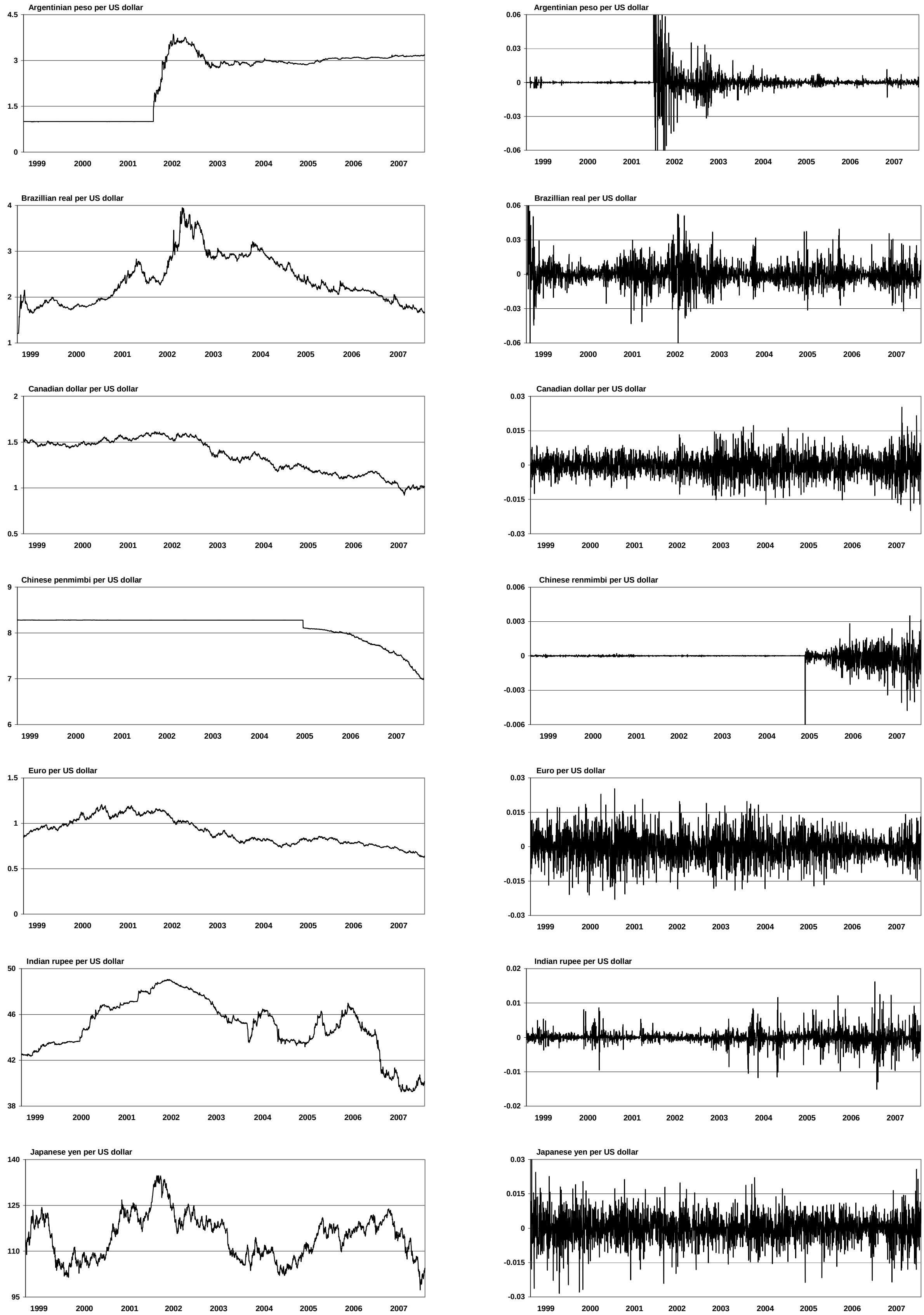
Table A1 Currencies' description

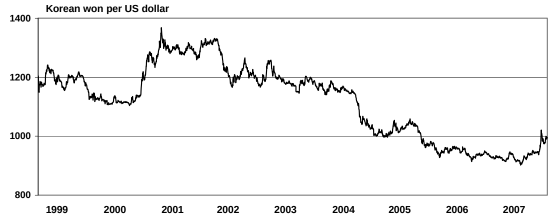
Currency	Description
USDARS	Argentinean peso per US dollar
USDBRL	Brazilian real per US dollar
USDCAD	Canadian dollar per US dollar
USDCNY	Chinese renmimbi per US dollar
USDEUR	Euro per US dollar
USDINR	Indian rupee per US dollar
USDJPY	Japanese yen per US dollar
USDKRW	Korean won per US dollar
USDMXN	Mexican peso per US dollar
USDPLN	Polish zloty per US dollar
USDRUB	Russian rubble per US dollar
USDTRY	Turkish lira per US dollar
USDGBP	British pound per US dollar
USDZAR	South African rand per US dollar

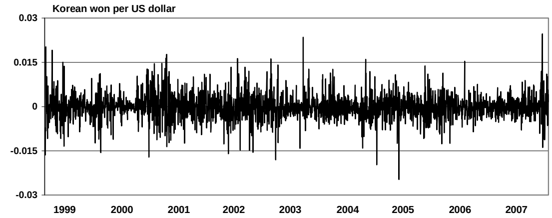
Table A2 Descriptive statistics

Currencies	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	No. of obs.
USDARS	2.38	3.86	1.00	0.98	-0.60	1.55	2431
USDBRL	2.36	3.95	1.21	0.53	0.67	2.73	2431
USDCAD	1.34	1.61	0.92	0.19	-0.35	1.78	2431
USDCNY	8.12	8.28	6.98	0.29	-2.07	6.60	2431
USDINR	44.97	49.05	39.25	2.43	-0.46	2.72	2431
USDJPY	114.81	134.71	97.33	7.20	0.23	2.56	2431
USDKRW	1117.19	1368.00	902.10	124.53	-0.18	1.79	2431
USDMXN	10.33	11.67	8.97	0.78	-0.24	1.54	2431
USDPLN	3.63	4.71	2.13	0.57	-0.56	2.32	2431
USDRUB	28.09	31.96	20.62	2.22	-0.30	2.52	2431
USDTRY	1.20	1.77	0.32	0.39	-1.02	2.63	2431
USDGBP	0.60	0.73	0.47	0.07	0.12	1.77	2431
USDEUR	0.90	1.21	0.63	0.15	0.31	1.90	2431
USDZAR	7.38	12.45	5.62	1.41	1.50	4.67	2431

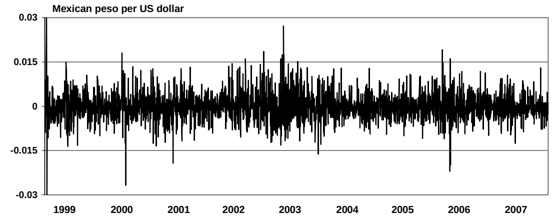
Figure A1 Exchange rates indexes and log differences

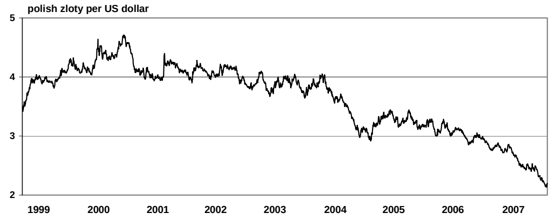


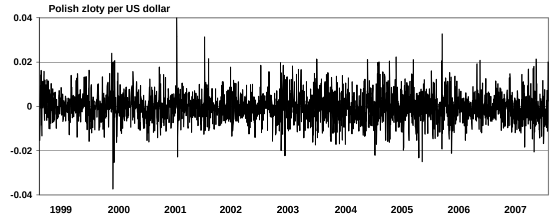

Korean won per US dollar
1400
1200
1000
800
1999 2000 2001 2002 2003 2004 2005 2006 2007

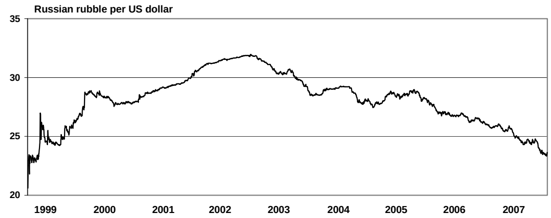

Korean won per US dollar
0.03
0.015
0
-0.015
-0.03
1999 2000 2001 2002 2003 2004 2005 2006 2007

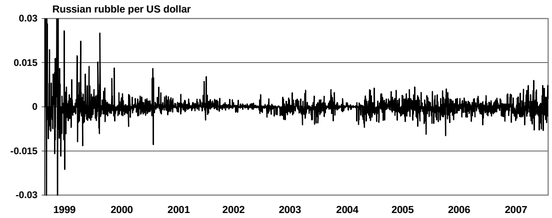

Mexican peso per US dollar
13
11
9
7
1999 2000 2001 2002 2003 2004 2005 2006 2007

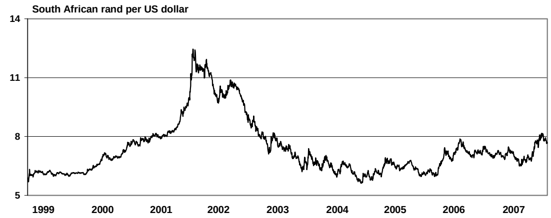

Mexican peso per US dollar
0.03
0.015
0
-0.015
-0.03
1999 2000 2001 2002 2003 2004 2005 2006 2007

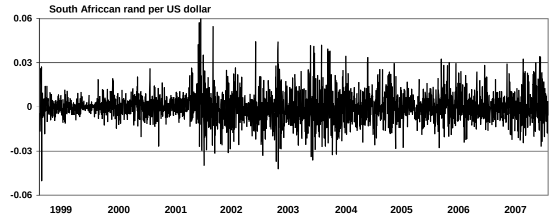

polish zloty per US dollar
5
4
3
2
1999 2000 2001 2002 2003 2004 2005 2006 2007

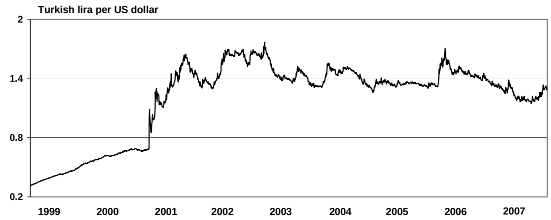

Polish zloty per US dollar
0.04
0.02
0
-0.02
-0.04
1999 2000 2001 2002 2003 2004 2005 2006 2007

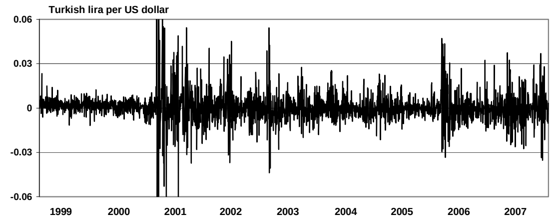

Russian rubble per US dollar
35
30
25
20
1999 2000 2001 2002 2003 2004 2005 2006 2007


Russian rubble per US dollar
0.03
0.015
0
-0.015
-0.03
1999 2000 2001 2002 2003 2004 2005 2006 2007

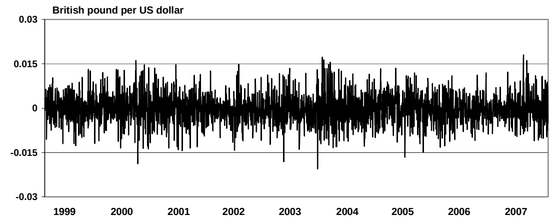

South African rand per US dollar
14
11
8
5
1999 2000 2001 2002 2003 2004 2005 2006 2007


South Africcan rand per US dollar
0.06
0.03
0
-0.03
-0.06
1999 2000 2001 2002 2003 2004 2005 2006 2007


Turkish lira per US dollar
2
1.4
0.8
0.2
1999 2000 2001 2002 2003 2004 2005 2006 2007


Turkish lira per US dollar
0.06
0.03
0
-0.03
-0.06
1999 2000 2001 2002 2003 2004 2005 2006 2007


British pound per US dollar
0.85
0.7
0.55
0.4
1999 2000 2001 2002 2003 2004 2005 2006 2007


British pound per US dollar
0.03
0.015
0
-0.015
-0.03
1999 2000 2001 2002 2003 2004 2005 2006 2007