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On the co-movements among Stock prices and exchange rates cointegration: a VAR/VECM approach

Moussa Wajdi[1]

Abstract

In this paper, based on the cointegration test, the causality test and the VECM model, we have shown that there is a two-way causality and a long-term relationship between the stock market and the exchange rate of each country. Our results lead to important implications from the point of view of investors and policy makers. They are highly relevant to the financial decisions of international investors on the management of their risks exposed to fluctuations in exchange rates and stock prices and on the benefits of potential diversification opportunities that may arise due to the decline in dependence between exchange rates and stock prices.

JEL classification numbers: C1, C53, F37, G15
Keywords: Exchange rates, Stock Prices, VECM Model, Granger Causality.

1 Introduction

Over the last decade, an increasing number of works have emerged to model the relationship between exchange rates and stock prices. For example, Nieh and Lee (2001) examined the cointegration between stock prices and exchange rates for seven major countries during 1 October 1993 to 15 February 1996. They found that there is a long-term relationship between variables for all countries. Ayuso and Blanco (2001) examined if there is an increase in the integration of financial markets, and if so, to what degree this integration has occurred. They have extended their study to an international level by including the following stock markets: New York, London, Paris, Madrid, Frankfurt, Milan and Tokyo. Their study covers the period from 1990 to 1999. The authors use two methodologies: the use of standard measures of comovements, and the use of two alternative measures of market integration, methods based on Chen and Knez (1995) approach. Financial globalization has increased the funds flow into international financial markets, which has increased the interdependence between exchange rates and stock price returns (Dark et al 1999). Granger, Huang and Yang (2000) used daily data to analyze the cointegration between exchange rates and stock prices over the Asian

[1] University of Tunis, Higher Institute of Management of Tunis

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financial crisis (1997). They show that there is a strong cointegration between exchange rates and stock prices in most Asian countries (Hong Kong, Taiwan, Malaysia, Singapore, Thailand, etc.). Yang, Kolari and Min (2003) analyzed the effect of the Asian financial crisis of 1997-1998 on the Japanese stock markets, ten other Asian countries and the americain exchange market in long and short terms. Also, they performed a comparative analysis of the degree of integration of the series before, during and after the crisis. As a result, they concluded that integration between these markets existed before and during the crisis and intensified after this crisis. Additionally, they found a strong influence of the US market on the Asian markets throughout the study period and Japan, Taiwan and the Philippines appeared to be isolated. Phylaktis and Ravazzolo (2005) studied the cointegration between stock prices and exchange rates for five countries (Thailand, Malaysia, Philippines, Hong Kong and Malaysia). They found a cointegration and bidirectional causality between stock prices and exchange rates. Diamandis and Drakos (2011) examined the long-term relationship and short-term dynamics between exchange rates and stock prices as well as the impact of exogenous shocks on four countries (Argentina, Brazil, Chile and Mexico) using a multiple cointegration techniques and Granger causality test. They showed a non significant long-term relationship between stock prices and exchange rates for each country. However, after having integrated the American stock market, they found that these variables will positively correlated: the American stock pricefacilitates the transmission between these countries. Statistically, Chen-Yin Kuo (2016) proved that the VECM is the best model than the other three traditional forecasting models (VAR, OLS and GLS) over a long period of forecast. They also find that this model produces smaller errors and behaves much better than the VAR model, which suggests that the VEC model is more accurate than the VAR model in the longest forecast horizon.

2 Empirical Methodology

If the variables are non-stationary and they haven't any cointegration relationship, we will estimate the VAR model estimated as follows:

$$Y_t = \alpha_0 + \sum_{i=1}^{p} \beta_i Y_{t-i} + \varepsilon_t \qquad (1)$$

Where, $\beta_1, \beta_2 \ldots \beta_p$ are the estimated coefficients. First of all, we must identify the number of lags of the VAR (p) model above. The criteria for selecting include the probability test ratio (LR), Akaike information criteria (AIC) or Schwarz (SC). Once the VAR model is established, we would analyze the causal relationship between series (**Sims 1972**). From the previous equations, we consider the mean squared error (MSE) of Y_t :

$$MSE = \frac{1}{s} \sum_{i=1}^{s} (\hat{y}_{t+i} - y_{t+i})^2 \qquad (2)$$

If $MSE\left[\hat{E}(y_{t+s} | y_t, y_{t-1} \ldots)\right] = MSE\left[\hat{E}(y_{t+s} | y_t, y_{t-1} \ldots, x_t, x_{t-1} \ldots)\right]$ means that x do not causes y by the Granger causality test.

A VAR model with an explanatory variable of Y_t is represented by the following model:

$$y_t = \sum_{i=1}^{k} \alpha_i y_{t-i} + \sum_{i=1}^{k} \beta_i x_{t-i} + \varepsilon_{1t} \quad (3)$$

To test if x_t caused by y_t, H_0: $\beta 1 = \beta 2 = \ldots = \beta k = 0$.

The value of the F-test equals to : $$F = \frac{(SSE_y - SSE_u)/_k}{SSE_u/_{(T-kN)}} \quad (4)$$

If our variables are non-stationary and there is a cointegration relationship, we should add an error correction term in the VAR model and having a vector error correction (VEC) model.

The VEC model with two variables can be written as follows:

$$\Delta X_t = \alpha_1 + \beta_1 E_{t-1} + \sum_i \alpha_{11}(i) \Delta Y_{t-i} + \sum_i \alpha_{12} \Delta X_{t-i} + \varepsilon_{1t} \quad (5)$$

$$\Delta Y_t = \alpha_2 + \beta_2 E_{t-1} + \sum_i \alpha_{21}(i) \Delta Y_{t-i} + \sum_i \alpha_{22} \Delta X_{t-i} + \varepsilon_{2t} \quad (6)$$

Where, E_{t-1} is the error correction term, and it is the residual error of X_t and Y_t .

If α_{11} is statistically significant by the F-test, there is a short-term Granger relation of ΔY_t to ΔX_t. If β1 is statistically significant, there is a long-term Granger relationship from Y to X.

3 Empirical results

In this section, we exposed the cointegration of stock prices and exchange rates. First of all, we present the data. Secondly, we present the results of unit root, cointegration and Granger causality tests. Finally, we model the volatility before presenting our conclusion.

We use a daily market index and exchange rates data of five developing countries and two emerging countries: Canada, Japan, Denmark, Hong Kong, Singapore, Mexico and Brazil from 1/1/2000 to 31/12/ 2015. The sample consists of 87,600 observations. All data come from the Board of Governors of the Federal Reserve System and the following links (https://www.federalreserve.gov/) and (https://www.yahoo.finance.fr). The Skewness coefficients are negative for all series of returns indicating an asymmetric distribution tail on the left. The results of the Jarque-Bera test indicate the rejection of the normality assumption for all series suggesting a non-linear behavior. The Ljung-Box test for correlating series of 10 off sets allowed us to reject the null hypothesis of autocorrelation (see **table1**).

Table 1: Descriptive statistics

Variables	Mean	S.D	Skewness	Kurtosis	J.B	$Q^2(10)$
PANEL A						
R (BRL/USD)	0.0134	0.8598	-0.0889***	17.9220***	54227.51***	3050.04**
R (CAD/USD)	-0.0007	0.4816	-0.0663***	12.8099***	23437.58***	760.647*
R (SGD/USD)	-0.0027	0.2767	-0.1220***	11.2526***	16598.48***	414.958**
R (JPY/USD)	0.0027	0.5323	-0.3533***	10.3700***	13347.87***	162.484***
R (MXN/USD)	0.0101	0.5309	-0.8288***	24.4807***	113025.7***	2900.00***
R (HKD/USD)	-5.1363e-005	0.0253	-1.7546***	45.6287***	445489.6***	723.071***
R (DKK/USD)	-0.0012	0.5438	-0.2153***	10.4219***	13458.46***	416.170**
PANEL B						
R (BOVESPA)	0.0159	1.5047	-0.0611***	9.8335***	11374.36***	1576.64**
R (TSX)	0.0075	0.9556	-0.7631***	17.4570***	51434.14***	170.784**
R (STI)	0.0025	0.9747	-0.4003***	13.0116***	24563.06***	1410.69*
R (NIKKEI225)	8.96E-05	1.2669	-0.4820***	13.6162***	27669.88***	2444.19**
R (IPC)	0.0307	1.1173	-0.0740***	11.5084***	17633.08***	1079.40**
R (HSI)	0.0043	1.2651	-0.0866***	16.0561***	41515.27***	1892.45***
R (OMXC20)	0.0235	1.0854	-0.2613***	11.9096***	19396.17***	2072.85***

Notes: ***, ** and * denote statistical significance at 1%, 5% and 10%, respectively.

We check the correlations between each pair of exchange rates and stock prices within four months, eight months, one year, two years, respectively (see **Appendix 1**). Thus, the correlation analysis identifies the level of correlation at different scales and the transmission of volatility between stock pricereturns and exchange rate returns. Therefore, we find that the correlation fluctuations are downward between each pair of stocks and exchange rates for all countries, especially after 2007. Moreover, we detect decreases in the correlations between each pair of stocks and exchange rates for all countries since 2010.

Table 2 indicates that all the exchange rates returns are stationary in order of integration equal to 0 and the exchange rates in level are stationary. In order of integration equal to 1 with the exception of MXN / USD rate which is integrated in order two (see **Panel A**) and Panel B shows that all the stock prices series are stationary in level in order of integration equal to 1 and stationary in first difference in order of integration equal to 0.

Table 2: ADF unit root test results

Variables	ADF test	Probability	Critical Value (5%)	I (d)
PANEL A				
BRL/USD	-75.97064	0.0001	-3.410573	I(1)
R (BRL/USD)	-76.41278	0.0001	-3.410573	I(0)
CAD/USD	-77.11061	0.0001	-3.410573	I(1)
R (CAD/USD)	-77.25916	0.0001	-3.410573	I(0)
SGD/USD	-78.46198	0.0001	-3.410573	I(1)
R (SGD/USD)	-78.44433	0.0001	-3.410573	I(0)
JPY/USD	-78.03436	0.0001	-3.410573	I(1)
R (JPY/USD)	-77.96752	0.0001	-3.410573	I(0)
MXN/USD	-24.52884	0.0000	-3.410577	I(2)
R (MXN/USD)	-75.98413	0.0001	-3.410573	I(0)
HKD/USD	-57.22170	0.0000	-3.410573	I(1)
R (HKD/USD)	-57.22249	0.0000	-3.410573	I(0)
DKK/USD	-78.47106	0.0001	-3.410573	I(1)
R (DKK/USD)	-77.48348	0.0001	-3.410573	I(0)
PANEL B				
BOVESPA	-78.69462	0.0001	-3.410573	I(1)
R (BOVESPA)	-76.40613	0.0001	-3.410573	I(0)
TSX	-74.18284	0.0001	-3.410574	I(1)
R (TSX)	-74.81707	0.0001	-3.410574	I(0)
STI	-75.63863	0.0001	-3.410573	I(1)
R (STI)	-75.17447	0.0001	-3.410573	I(0)
(NIKKEI225)	-79.16906	0.0001	-3.410573	I(1)
R (NIKKEI225)	-79.08102	0.0001	-3.410573	I(0)
IPC	-72.39650	0.0000	-3.410573	I(1)
R (IPC)	-70.97170	0.0000	-3.410573	I(0)
HSI	-78.91835	0.0001	-3.410573	I(1)
R (HSI)	-78.98292	0.0001	-3.410573	I(0)
OMXC20	-76.20924	0.0001	-3.410573	I(1)
R (OMXC20)	-74.10668	0.0001	-3.410573	I(0)

Then, we focus on the bivariate cointegration methodology proposed by Engle and Granger (1987). This methodology study the dynamic aspects between variables. Technically, if the estimated residuals are cointegrated: it is a long-term relationship and the estimate is based on VEC model and if the residuals are not cointegrated: it is a short-term relationship and the estimate is based on VAR model. Table 3 indicates that there is a significant cointegration for the entire sample (at 1%, 5%, and 10% levels) which means that there is a long-term relationship between stock prices and exchange rates in each country. Also, we note that DKK / OMXC20, HKD /HSI, SGD / STI causality is significant at 1%, the causality of MXN/ IPC and HKD/ HSI is significant at 10% and BRL/Bovespa and CAD/ TSX causality is significant at 5%.

Table 3: Cointegration and causality results: exchange rates vs prices

Series			**Cointegration**		**Causality**	
Returns	**ADF test**	**C.value 5%**	**Prob**	**Decision**	**F-Statistic**	**Prob**
BRL/Bovespa	-77.0652	-3.41057	0.0001	yes	2.62168	0.0993
CAD/TSX	-77.80145	-3.410574	0.0001	yes	2.81078	0.0937
SGD/STI	-79.56212	-3.410573	0.0001	yes	13.3949	0.0003
JPY/ NIKKEI	-80.37257	-3.410573	0.0001	yes	15.445	0.0035
MXN/IPC	-79.90004	-3.410573	0.0001	yes	1.36512	0.0427
HKD/HSI	-57.5504	-3.410573	0.0000	yes	4.12458	0.0423
DKK/OMEX	-77.52351	-3.410573	0.0001	yes	6.42702	0.0135

Table 4 shows that there is a significant cointegration relationship for all variables and that there is a bidirectional causality between each couple of series. These results show the long-term dynamic relationship justified by the VECM model.

Table 4: Cointegration and causality results: stock priceprices vs exchange rates

Series			**Cointegration**		**Causality**	
Returns	**ADF test**	**C.value 5%**	**Prob**	**Decision**	**F-Statistic**	**Prob**
Bovespa/BRL	-77.06200	-3.410573	0.0001	yes	418.175	0.0590
TSX/CAD	-75.37400	-3.410574	0.0001	yes	232.119	0.0151
STI/SGD	-76.24450	-3.410573	0.0001	yes	1.86394	0.0722
NIKKEI/JPY	-81.52416	-3.410573	0.0001	yes	0.86803	0.0515
IPC/MXN	-70.97157	-3.410573	0.0000	yes	158.329	0.0364
HSI/HKD	-79.44633	-3.410573	0.0001	yes	9.00585	0.0027
OMXC20/DKK	-74.14490	-3.410573	0.0001	yes	0.00055	0.0814

If it exist a cointegration relationship between two variables, we estimate the VECM model and its cointegration parameter and if there isen't t any cointegration relationship we estimate the VAR model. In **table 5**, the coefficients are significant and all the absolute values of t-student are higher than 1.96 with the exception of Denmark (0.32). Thus, we conclude that there is a long-term dynamic between the stock prices and the exchange rates.

Table 5: VAR/VECM results: exchange rate vs stock prices

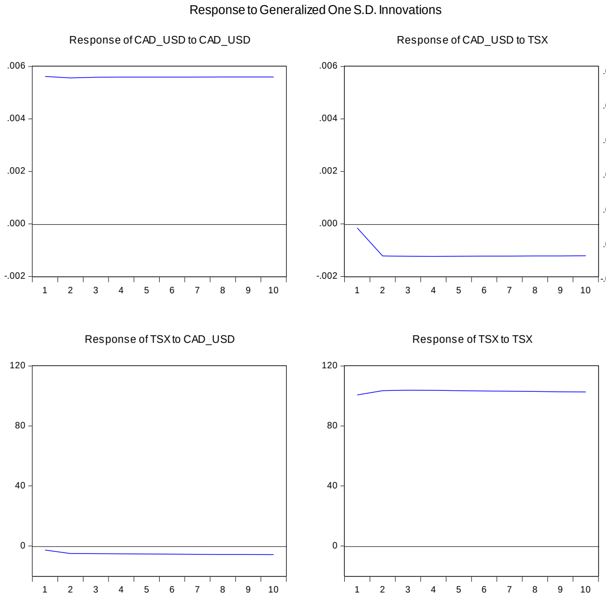
Series	VECM		VAR	
	Coint Eq	t-student	Coint Eq	t-student
BRL/Bovespa	-393,3996	[-1,0830]	-	-
CAD/TSX	-382.3891	[-1.65600]	-	-
SGD/STI	-312.2629	[-4.12126]	-	-
JPY/ NIKKEI225	43.58178	[11.9255]	-	-
MXN/IPC	-134.6353	[-2.58035]	-	-
HKD/HSI	-2804.128	[-1.82607]	-	-
DKK/OMEXC20	-0.548877	[-0.32102]	-	-

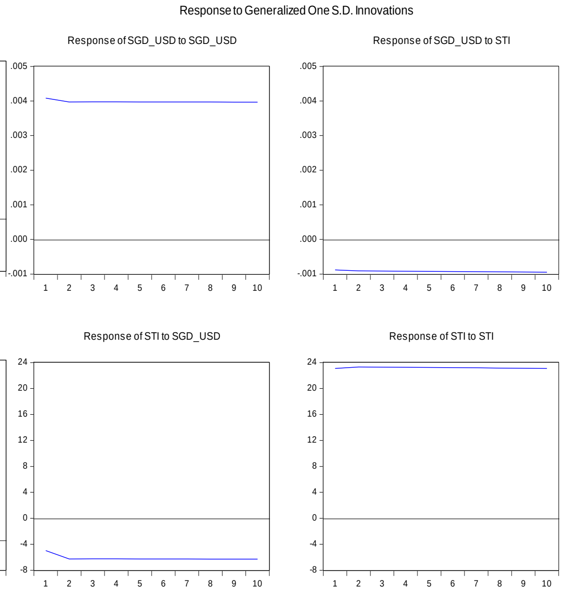
In **table 6**, the coefficients are statistical significant, all the absolute values of t-student are higher than 1.96 and we can conclude the long-term dynamics between the series.

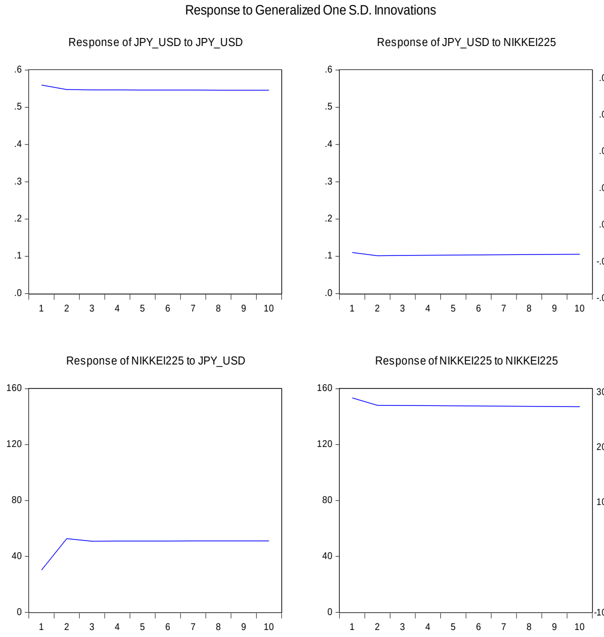
Table 6.:VAR/ VECM Results: Stock Prices vs. Foreign Exchange Rates

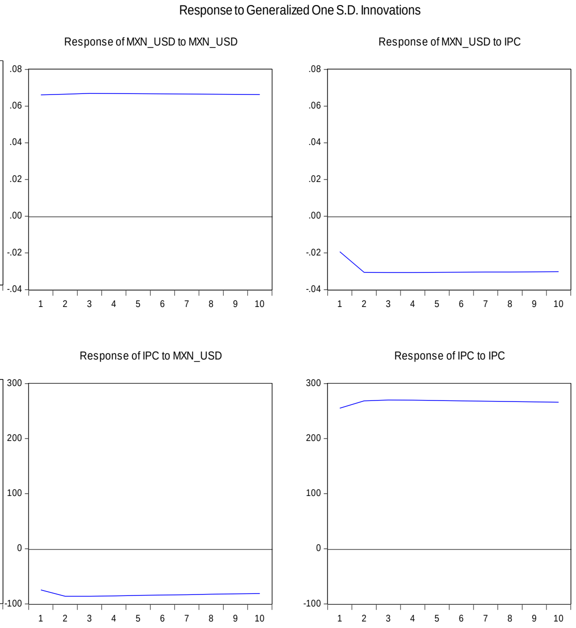
Series	VECM		VAR	
	Coint Eq	t-student	Coint Eq	t-student
Bovespa/BRL	-7.52E-06	[-16.2989]	-	-
TSX/CAD	-1.07E-05	[-14.5998]	-	-
STI/SGD	-2.14E-06	[-2.90369]	-	-
NIKKKIE225/JPY	-4.59E-05	[-3.95517]	-	-
IPC/MXN	-4.78E-05	[-13.4960]	-	-
HSI/HKD	-3.77E-07	[-3.34945]	-	-
OMXC20/DKK	4.84E-05	[7.48298]	-	-

The Granger causality test showed a direct or indirect causal link between the variables. This result supposes that there would be a dynamic interaction between series and each market could react to a shock on another market. The question now is what would be the magnitude of the shock reactions? and how long a market will take to cushion the effect of a random shock ? The study of IRF will provide answers. The impulse response is the output that is obtained when the input is a pulse, that is to say a sudden and brief variation of the signal. Indeed, when a pulse is the input of a linear system, the output is in general no longer a pulse, but a signal having an exact duration. **Figure 1** presents respectively the impulse response function of the exchange rate to a positive shock on the stock price for a period ranging from 0 to 10 months and the impulse response function of the stock price to a positive exchange rate shock. Therefore, we notice that the two markets react following a positive shock on one of them which confirms the results of the Granger causality test.









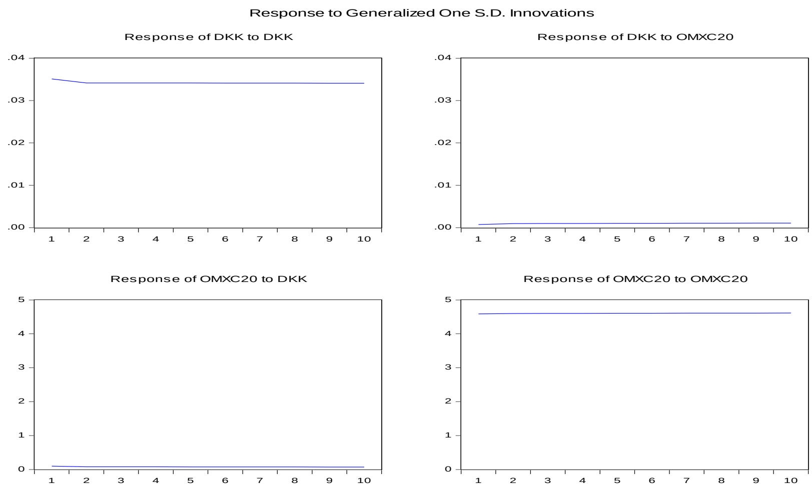


Figure1: Impulse response functions

However, we confirm the study of impulse response functions by decomposing variance of the forecast errors. It is a technique that measure the share of the variance of the forecast error of returns of a market, which is explained by the innovations of another market. Thus, for each of our stock price index, we performed this test by considering a horizon of 10 periods. The decomposing variance tables (see **Appendix 2**) report the results of exchange rate forecast errors following a random shock on its conditional volatility for a 10-months horizon. We find that, as the forecast period increases, the exchange rate innovations decrease suggesting that the foreign exchange market is a very volatile market. These results following a random shock show the share of conditional volatility fluctuations of the stock price index at the exchange rates. This result explains a strong interdependence between these two markets.

4 Conclusion

We obtain a result of significant stationaries for all stock market returns and exchange rate returns. Using the cointegration test, we can detect that there is a long-term linear combination of stock prices and exchange rates and that there is a bidirectional causal relationship between these two prices. The inspection of these reported results clearly shows that the managed float regime and the managed float exchange regime exhibit a very significant causality than the independent float regime and regardless of the independent floating exchange rate regimes. Floating directed, floating administered, both markets may react positively or negatively. Thus the results of Branson and Frankel (1983) and Nieh and Lee (2001) do not confirm our study.

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APPENDIX 1

Figure 2: Rolling correlation at 4 months

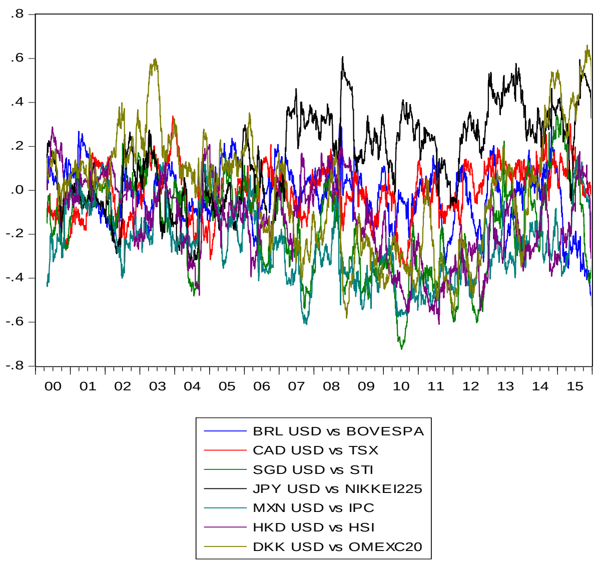


Figure 3: Rolling correlation at 8 months

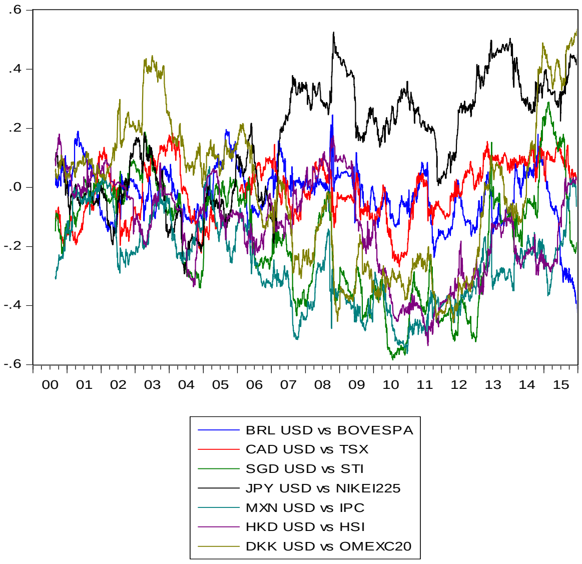


Figure 4: Rolling correlation at 12 months

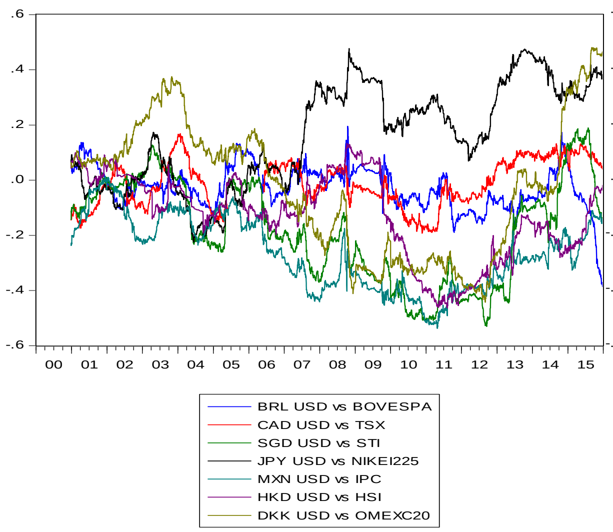
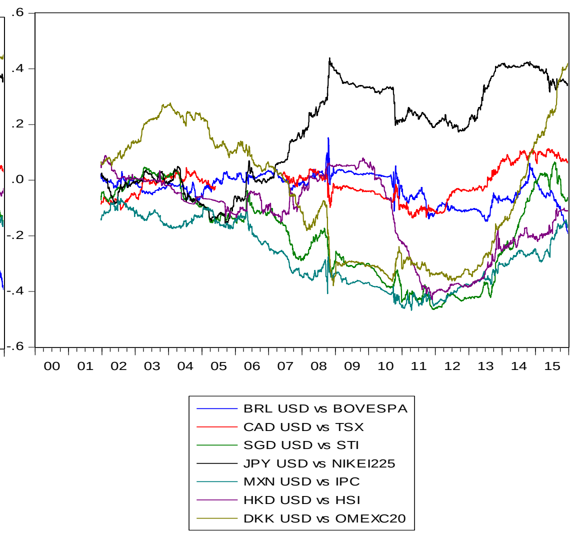


Figure 5: Rolling correlation at 24 months



APPENDIX 2

Table 7: Variance decomposing results: BRL / USD vs Bovespa

	BRL/USD			BOVESPA		
	SE	BRL/USD	BOVESPA	SE	BRL/USD	BOVESPA
time						
1	0.8761	100.00	0.0000	1.7004	3.4877	96.5122
2	0.9867	81.6615	18.3384	1.8172	9.0604	90.9396
3	1.1183	71.3154	28.6845	2.0610	18.8665	81.1334
4	1.2101	67.2839	32.7160	2.2266	21.3086	78.6913
5	1.3060	63.6822	36.3177	2.4022	24.1145	75.8855
6	1.3913	60.8831	39.1168	2.5550	26.0609	73.9391
7	1.4733	58.7377	41.2622	2.7039	27.6678	72.3321
8	1.5502	57.0092	42.9907	2.8431	28.9183	71.0816
9	1.6238	55.5822	44.4177	2.9766	29.9723	70.0276
10	1.6941	54.3874	45.6126	3.1039	30.8487	69.1512

Table 8: Variance Decomposing results: CAD / USD vs TSX

	CAD/USD			TSX		
	SE	CAD/USD	TSX	SE	CAD/USD	TSX
time						
1	0.5079	100.0000	0.0000	1.0736	4.0888	95.9111
2	0.5604	86.35782	13.6421	1.1557	11.1758	88.8246
3	0.6449	76.53734	23.4626	1.2979	21.1886	78.8113
4	0.6989	72.55230	27.4477	1.3992	24.6490	75.3509
5	0.7571	69.27611	30.7238	1.5059	28.0639	71.9360
6	0.8078	66.78871	33.2112	1.5996	30.4685	69.5314
7	0.8570	64.86351	35.1364	1.6907	32.4666	67.5333
8	0.9028	63.32316	36.6768	1.7760	34.0416	65.9584
9	0.9468	62.06086	37.9391	1.8579	35.3651	64.6348
10	0.9886	61.0070	38.9929	1.9361	36.4713	63.5286

Table 9: Variance decomposing results: SGD / USD vs STI

	SGD/USD			STI		
	SE	**SGDUSD**	**STI**	**SE**	**SGD/USD**	**STI**
time						
1	0.2964	100.0000	0.0000	1.1486	12.8856	87.1143
2	0.3099	94.0367	5.9632	1.2746	19.2054	80.7946
3	0.3376	84.6485	15.3514	1.5205	25.9064	74.0935
4	0.3558	80.4135	19.5864	1.6695	28.5035	71.4964
5	0.3766	76.1889	23.8110	1.8339	30.5991	69.4009
6	0.3946	73.0566	26.9433	1.9717	32.0101	67.9898
7	0.4126	70.3138	29.6861	2.1066	33.1139	66.8860
8	0.4294	68.0567	31.9432	2.2304	33.9633	66.0366
9	0.4458	66.0987	33.9012	2.3491	34.6513	65.3486
10	0.4615	64.4148	35.5851	2.4614	35.2143	64.7856

Table 10: Variance decomposing results: JPY / USD vs NIKKEI225

	JPY/USD			NIKKEI225		
	SE	**JPY/USD**	**NIKKEI225**	**SE**	**NIKKEI225**	**JPY/USD**
time						
1	1.3500	0.0000	0.0000	0.6259	12.9597	87.0402
2	1.4847	86.3428	13.657	0.6786	17.7658	82.2341
3	1.6632	71.4403	21.559	0.7969	26.5001	73.4998
4	1.7942	73.6290	26.370	0.8676	29.0067	70.9932
5	1.9297	69.8510	30.149	0.9467	31.7759	68.2240
6	2.0502	67.0058	32.994	1.0134	33.4135	66.5864
7	2.1667	64.7373	35.262	1.0788	34.8291	65.1708
8	2.2760	62.8991	37.100	1.1391	35.8849	64.1150
9	2.3809	61.3765	38.6234	1.1970	36.7695	65.2304
10	2.48108	60.0950	39.9050	1.2520	37.4902	62.5097

Table 11: Variance decomposing results: MXN / USD vs IPC

	MXN/USD			IPC		
	SE	**MXN**	**IPC**	**SE**	**MXN**	**IPC**
time						
1	0.06627	100.0000	0.0000	0.1144	6.7816	93.2183
2	0.09454	88.7117	13.2882	0.1172	16.8009	83.1001
3	0.11639	88.2586	21.7413	1.2177	14.1918	81.1542
4	1.13474	78.0358	30.9641	1.5173	20.8921	75.2001
5	1.15088	67.9035	32.0964	1.6181	23.7559	67.8284
6	2.16544	65.8158	2.1841	1.7107	28.0004	66.5551
7	2.17883	65.7533	36.2466	1.8101	32.5997	65.4587
8	2.19128	64.7066	37.2933	1.8179	34.8999	63.7701
9	2.20296	64.6704	39.3295	1.8832	36.5207	62.7881
10	2.21402	62.6414	39.8585	1.9678	37.9012	61.8997

Table 12: Variance decomposing results: HKD / USD vs HSI

	HKD/USD			HSI		
	SE	**HKD/USD**	**HSI**	**SE**	**HKD/USD**	**HSI**
time						
1	0.0263	100.0000	0.0000	1.5106	5.0859	94.9140
2	0.0273	93.8306	6.1693	1.6575	19.0045	90.9954
3	0.0290	84.7925	15.207	1.9834	23.7747	86.2251
4	0.0302	80.1778	19.8221	2.1692	35.4545	84.5454
5	0.0315	75.5473	24.4526	2.1692	36.8404	83.1595
6	0.0327	71.8671	28.1328	2.3832	37.7774	82.2225
7	0.0339	68.5479	31.4520	2.7327	38.5158	81.4841
8	0.0350	65.7191	34.2808	2.8914	39.0835	80.9164
9	0.0361	63.1992	36.8007	3.0443	39.5447	80.4552
10	0.0372	60.9777	39.0222	3.1887	39.9226	80.0774

Table 13: Variance decomposing results: DKK / USD vs OMXC20

	DKK/USD			OMEXC20		
	SE	DKK/USD	OMXC20	SE	DKK/USD	OMXC20
time						
1	0.5851	100.0000	0.0000	1.2419	1.8352	98.1647
2	0.6121	94.8536	5.1463	1.3566	7.7346	92.2653
3	0.6783	84.3191	15.6808	1.5618	16.7059	83.2941
4	0.7185	79.5855	20.4144	1.6953	20.3801	79.6198
5	0.7654	75.0730	24.9269	1.8406	23.5683	76.4316
6	0.8054	71.7967	28.2039	1.9651	25.7333	74.2666
7	0.8454	68.9799	31.0200	2.0869	27.5023	72.4976
8	0.8827	66.6891	33.3108	2.1998	28.8795	71.1205
9	0.9189	64.7279	35.2721	2.3081	30.0195	69.9804
10	0.9536	63.0566	36.9433	2.4111	30.9625	69.0374