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Abstract

This paper examines the presence of nonlinear behavior in exchange rates of 31 countries, majority of which are less liquid in the foreign exchange market and maintain a floating exchange rate system. The results, based on formal test procedures, provide evidence of nonlinear behavior in the residuals from both structural and time series models of exchange rates. The results also indicate that standard serial correlation test alone may not be useful to validate correct model specification as it has low power against nonlinear behavior in the residuals.

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1. Introduction

Following Musa (1979), the stylized fact about exchange rates is that they follow a random walk. Meese and Rogoff (1983) demonstrate that a random walk model performs no worse than estimated time-series and variants of structural models. These phenomena have led to an intense interest in examining the idea of nonlinearities in the exchange rate adjustment process. In the last two decades, numerous studies have examined the possibility of nonlinear dependence in exchange rate returns behavior. While most authors provide support to nonlinear structure that appears consistent with the presence of conditional heteroskedasticity, adequate representation of the nonlinear dependence in exchange rate return still remains unresolved (see, for example, Sollis, 2008).

The objective of this study is to provide a systematic analysis of the nonlinear specification and identification of the parameters in exchange rate returns based on experiences of a cross-section of currencies in recent decades. The purpose here is to use an acceptable specification which will isolate linear components of the series consistent with a parsimonious representation of the data, rather than building a statistically adequate empirical model of exchange rate returns. Examination of the stochastic process that generates the exchange rate returns behaviour is important because it has important implications for tests exchange rate economics. If foreign exchange rates exhibit nonlinear dependence, then empirical analysis using linear modelling techniques, such as a simple random walk model, is more likely to be incorrect and consequently, any prediction or policy inferences from such models will be misleading.

This paper examines 31 floating exchange rates (all against US dollar), including four major currencies in the world. For test purposes, we start with a structural model based on purchasing power parity (PPP). Note that PPP is viewed as an anchor for exchange rate dynamics (see, for

example, Rogoff, 1996). To exploit the properties of a data generating process (DGP), an autoregressive moving average (ARMA) model is also used. To examine the presence of nonlinear dependence in exchange rate return, we use Breusch-Godfrey serial correlation Lagrange Multiplier (LM) and the Brock–Dechert–Scheinkman (BDS) tests. In general, the test results do not provide clear-cut evidence of the presence of nonlinearity in our sample. To explain the results, we turn to examining the impact of outliers and extreme observations, and this is done by a sample trimming method where the sizes of the aberrant observations have been reduced. Interestingly, the outliers are found to make important differences in results for some highly liquid currencies.

This paper has several attractions. First, we provide new evidence of nonlinear dynamics in exchange rate returns by extending our sample of major currencies to include a set of less liquid floating currencies. Note that, due to inherent structural rigidities, nonlinearity is likely to be more prevalent among the currencies of developing countries, but this area has largely been unexplored. A second attractive feature is that unlike most other studies, we start with a structural model side by side with a time series model. This approach is expected to exploit a better representation of the data for our test purposes. Finally, we use a novel technique to examine the role of outliers in explaining the nonlinearity in exchange rates. This method is considerably simpler than the existing alternatives, and intuitively more appealing.

The paper is organized as follows. Section 2 gives a brief reference to the existing literature on this topic, followed by data and descriptive statistics in Section 3. Methodology and statistical tests are discussed in Section 4. The next section gives the empirical results, and the last section concludes the paper.

2. A reference to literature

Existing literature points to at least three potential reasons why exchange rates would behave in a nonlinear manner. First, Rogoff (1996) and Obstfeld and Rogoff (2000) point out that transaction costs and other frictions, such as, tariffs and subsidies, in goods markets can, among other things, explain nonlinear behaviour in foreign exchange markets. According to Berka (2005), these costs can take the form of transportation or other transactions costs. Second, as suggested by Olsen *et al* (1997) and Kilian and Taylor (2003), nonlinearity in exchange rates may be explained by the interaction of agents with heterogeneous objectives that vary across geographical location, the various types of institutional constraints they face, and their individual degree of risk aversion. A third potential source of nonlinearity, suggested by Sarno and Taylor (2001) and Taylor (2004, 2005) arises from the influence of official intervention in the foreign exchange rate market.

Over the recent decades, several studies have examined the existence of nonlinear dependencies in exchange rate return series. Building on the work of Bolerslev (1987), Diebold (1988), Diebold and Nerlove (1986), among others, Hsieh (1989) is among the first to provide influential insights into this issue. His study examines the nonlinearity in daily exchange rates of five major currencies and reports the presence of substantial nonlinearity in a multiplicative rather than additive form, a large part of which is consistent with a generalized autoregressive conditional heteroskedasticity (GARCH) model. Similar results are reported in Emekter *et al* (2009), Abhyankar *et al.* (1995), Hsieh (1989b), Scheinkman and LeBaron (1989a, 1989b), and Mayfield and Mizrach (1992), among others. It is to be noted that GARCH-type models may work reasonably well for high-frequency data, but their applicability is limited for lower frequency data such as, monthly or quarterly.

PPP has occupied the centre stage of research in nonlinear dynamics of exchange rates, see

for example, Cuestas and Mourelle (2011), Kim and Moh, (2010), Yoon (2010), Lin et al (2010), Sollis (2008), Villavicencio (2008). Based on PPP, several studies have proposed nonlinear alternative models such as smooth transition autoregressive (see Liew et al., 2003; Alba and Park, 2005; Leon and Najarian, 2005), chaos (Hsieh, 1989), Markov switching model (see Engel and Hamilton, 1990; Laurini and Portugal, 2003; and Frömmel et al., 2005), and artificial networks (Gradojevic and Yang, 2006). In general, most studies detect the presence of nonlinear dependencies in exchange rate returns series. Nonparametric approaches have also been suggested in order to avoid making restrictive assumptions on the marginal distribution of the process. Nonparametric tests with results very similar to the parametric tests, for nonlinearities in exchange rates can be found, for example, in Diebold and Nason, (1990), Chan and Tran (1992), Delgado (1996) and Aparicio and Escribano (1998), Diks and Manzan (2002), among others.

Numerous tests have been developed for testing the presence of nonlinear dependence in financial time series. While different tests have different properties, the one proposed by Brock, Dechert, Scheinkman (1987), referred to as (BDS) test, appears to have gained a wide acceptance. This procedure tests the null hypothesis that the residuals are independently and identically distributed and has the power against both deterministic chaos and nonlinear stochastic system. Studies using BDS test includes, among others, Scheinkman et al (1989), Hsieh (1989, 1991), DeGrauwe et al. (1993), Brooks (1996), and Mahajan and Wagner (1999).

Overall, there appears to be strong evidence, consistent with economic interpretation, that nonlinearities may be present in exchange rate determination. However, given the underperformance of the class of nonlinear models in out-of-sample forecasting, significant new research is needed in this area. As it is argued that the apparent nonlinearity in exchange rates could simply be due to structural

breaks or outliers in the series (see, for example, Villavicencio, 2008), the role of outliers needs to be examined more carefully. It is to be noted that the issue of outlier is largely unexplored.

3. Data and summary statistics

Our sample has 31 floating exchange rate series (all against the US dollar), which can be categorized into three subgroups. Exchange rates of Australia, Canada, Japan and UK are in the first group, and these are among the most heavily-traded currencies in the world. Euro is not included in this group because of its relatively shorter period of existence and the complexity in common inflation. The second subgroup consists of Albania, Armenia, Colombia, Dominican Republic, Guatemala, Iceland, Israel, Madagascar, Malawi, New Zealand, Norway, Papua New Guinea, Poland, Sierra Leone, South Africa, South Korea, Sri Lanka, Sweden, Switzerland, Tanzania, Turkey and Uganda (these countries are listed as user of floating exchange rate arrangements according to the IMF classification of exchange rate arrangements and monetary policy framework). Third subgroup has five ASEAN countries: Indonesia, Malaysia, Singapore, Thailand and Philippines.

Data includes nominal exchange rates (US dollar price per unit of foreign currency) and consumer price index (CPI) which is used for inflation. All data are monthly except for Australia, New Zealand and Papua New Guinea because these countries report quarterly CPIs. An abbreviated version of all data are given in Appendix 1 (a full listing is available upon request). All data are from the International Financial Statistics (IFS) through datastream.

Descriptive statistics of the exchange rate data (in log-change form) are provided in Table 1 to Table 3 (presented by subgroups). As can be seen, the third and fourth moments describing the distribution of exchange rate return series offer some indication of a departure from normality. All 31

currencies' kurtosis coefficients are larger than that of standard normal distribution of 3.0. In the first sub-group of highly liquid currencies, Australia and Canada have much heavier tail than that of Japan and UK. Only Swiss Franc in the second sub-group has a kurtosis coefficient close to three. The same for ASEAN 5 currencies are well above standard normal. The Jarque-Bera test statistics confirm departure from normality in the exchange rate returns of 30 countries with the exception of Dominican Republic.

TABLE 1 Summary statistics of exchange rate log-changes: highly liquid currencies

	<i>Mean</i>	<i>Median</i>	<i>Std. Dev.</i>	<i>Skewness</i>	<i>Kurtosis</i>	<i>Jarque-Bera</i>
AUSTRALIA	-0.00186	-0.000202	0.048958	-1.390948	10.41921	6121.061 (0)
CANADA	-0.00012	-0.000144	0.014369	-0.6063	12.03252	6121.061 (0)
JAPAN	0.002802	-0.000215	0.027918	0.542562	3.826225	2472.276 (0)
UK	-0.000908	-0.000801	0.025067	-0.205318	4.67624	148.6969 (0)

Note: The p-values of the Jarque-Bera test are in parenthesis.

TABLE 2 Summary statistics of exchange rate log-changes: less liquid currencies

	<i>Mean</i>	<i>Median</i>	<i>Std. Dev.</i>	<i>Skewness</i>	<i>Kurtosis</i>	<i>Jarque-Bera</i>
ALBANIA	0.0005	0.0018	0.0315	-0.7739	6.7183	56.34140 (0)
ARMENIA	-0.0098	0.0000	0.0661	-6.3953	50.8261	940514.7 (0)
COLUMBIA	-0.0101	-0.0143	0.0302	-1.1378	27.4123	219.9162 (0)
DOMINICAN REPUBLIC	-0.0086	-0.0015	0.0411	-2.1907	13.4448	3.8330 (0.15)
GUATEMALA	-0.0042	-0.0014	0.0234	-3.6508	30.2313	116.3162 (0)
ICELAND	-0.0054	0.0000	0.0337	-1.8806	11.9544	3818.47 (0)
ISRAEL	-0.0171	-0.0040	0.0433	-2.4108	10.2871	211.8064 (0)
KOREA	-0.0019	-0.0009	0.0289	-6.1629	76.2335	12300.21 (0)
MADAGASCAR	-0.0103	-0.0055	0.0489	-5.7242	57.7395	22700.57 (0)
MALAWI	-0.0144	-0.0028	0.0421	-3.7874	24.5794	45.6010 (0)
NEW ZEALAND	-0.0034	-0.0027	0.0525	-0.7502	5.9165	67.6785 (0)
NORWAY	-0.0005	-0.0009	0.0256	-0.3618	4.2367	9581.43 (0)
PAPUA NEWGUINEA	-0.0078	-0.0030	0.0461	-0.6483	5.3594	7932.857 (0)
POLAND	-0.0165	-0.0048	0.0717	-4.9507	34.2946	85024.06 (0)
SIERRALEONE	-0.0171	0.0000	0.0580	-1.4402	17.0615	35.18767 (0)
SOUTH AFRICA	-0.0058	-0.0045	0.0379	-0.6316	8.6834	35188.18 (0)
SRILANKA	-0.0053	-0.0034	0.0118	-1.8335	18.3048	1312.734 (0)
SWEDEN	-0.0013	-0.0008	0.0271	-0.6659	5.4024	8445.331 (0)
SWITZERLAND	0.0013	-0.0004	0.0295	0.2411	3.1271	1453.961 (0)
TANZANIA	-0.0055	0.0000	0.0182	-0.6768	8.0938	9267.584 (0)
TURKEY	-0.0008	0.0006	0.0258	-2.1837	24.2196	395.0136 (0)
UGANDA	0.0015	0.0000	0.2479	15.7112	271.0050	20730.85 (0)

Note: The p-values of the Jarque-Bera test are in parenthesis.

TABLE 3 Summary statistics of exchange rate log-changes: ASEAN 5 currencies

	<i>Mean</i>	<i>Median</i>	<i>Std. Dev.</i>	<i>Skewness</i>	<i>Kurtosis</i>	<i>Jarque-Bera</i>
INDONESIA	-0.007994	-0.002262	0.060995	-4.607279	48.91994	522.5835 (0)
MALAYSIA	-0.000248	0.000000	0.019188	-1.042884	25.384	31.65186 (0)
PHILIPINES	-0.004082	-0.000318	0.022933	-4.172495	36.58204	45087.86 (0)
SINGAPORE	0.001655	0.000976	0.013831	0.081272	6.33853	1138.885 (0)
THAILAND	-0.000837	0.000628	0.025776	-2.18373	24.21961	1571.157 (0)

Note: The p-values of the Jarque-Bera test are in parenthesis.

4. Tests for nonlinearity

One of the simplest structural models for exchange rate is given by the purchasing power parity (PPP) theory. In its relative form, it states that any change in the differential rate of inflation between the two countries tends to be offset over the long run by an equal but opposite change in the spot exchange rate. Mathematically:

$$y_t = \pi_t^H - \pi_t^F$$

with

$$y_t = \ln S_t - \ln S_{t-1}$$

where, S_t , π_t^H and π_t^F are the spot rate, the home and foreign country inflation rates at time t respectively. This provides a convenient foundation to establish a structural model for exchange rate, namely:

$$\Delta y_t = \alpha + \beta(\Delta \pi_t^H - \Delta \pi_t^F) + \eta_t \quad (1)$$

where $\Delta y_t = y_t - y_{t-1}$ and $\eta_t \sim iid(0, \sigma_\eta^2)$ are assumed to be independently and identically distributed random variables with zero means and finite variances. Hence, testing the hypothesis

$$H_0 : \alpha = 0, \beta = 1$$

$$H_1 : \alpha \neq 0, \text{ or } \beta \neq 1$$

upon obtaining consistent estimates of the coefficients is equivalent to testing the PPP hypothesis. However, the underlying assumption of this model is that exchange rate returns are proportional to the inflation differential and that the residuals, η_t , should be an independent and identically distributed random variable. Therefore, if η_t exhibits nonlinear behavior, then it implies that the deviations from PPP contain systematic components that could not be explained by the PPP hypothesis alone.

A structural model, such as equation (1), is not always convenient from a forecasting perspective. A natural choice for forecasting exchange rate would be the Auto Regressive Moving Average (ARMA):

$$y_t = \alpha_0 + \sum_{i=1}^p \theta_i y_{t-i} + \sum_{j=1}^q \phi_j \varepsilon_{t-j} + \varepsilon_t \quad (2)$$

where, $\varepsilon_t \sim iid(0, \sigma_\varepsilon^2)$ are assumed to be an independently identically distributed random variables with zero means and finite variances under the assumption that the Least Squares (LS) estimator is consistent for the coefficients in equation (1) and (2). The iid assumption on the residuals can be tested using standard diagnostic tests. In this paper the Breusch-Godfrey LM test for serial correlation have been conducted on the estimated residuals for both equations (1) and (2). The null hypothesis of the LM test is that there is no serial correlation up to a pre-specified lag order. However, the lack of serial correlation alone cannot be used to validate the correct model specification. This is because the standard LM test assumes linear dependence in the residuals, that is, current residual is linearly related to the past residuals. Therefore, the test has low power if the residual is non-linearly related to its past values. Given its popularity (see, for example, Scheinkman and LeBaron, 1989; Hsieh, 1989, 1991; De

Grauwe *et al.*, 1993; Steurer, 1995; Abhyankar *et al.*, 1995, 1997; Brooks, 1996; Barkoulas and Travlos, 1998; Opong *et al.*, 1999; Mahajan and Wagner, 1999), this paper utilises the Brock-Dechert-Scheinkman test (henceforth refer to BDS test) to detect potential nonlinear dependence in the residuals. Let $y_t^m = (y_t, y_{t-1}, \dots, y_{t-m+1})$, the BDS test statistic is calculated as:

$$BDS_m(\varepsilon) = \frac{\sqrt{T} \left[C_{m,T}(\varepsilon) - (C_{m,1}(\varepsilon))^m \right]}{\sigma_m(\varepsilon)} \quad (4)$$

where

$$C_{m,T}(\varepsilon) = \frac{2}{T_m(T_m - 1)} \sum_{m \leq s \leq T} \sum_{m \leq t \leq T} I(y_t^m, y_s^m; \varepsilon)$$

with $T_m = T - m + 1$ and

$$I(y_t^m, y_s^m; \varepsilon) = \begin{cases} 1, & |y_{t-i} - y_{s-i}| < \varepsilon, i = 0, 1, \dots, m-1 \\ 0, & \text{otherwise} \end{cases}.$$

The idea behind the BDS test is to estimate the frequency in which temporal patterns are repeated in the data. This is done by examining the number of times that y_t^m and y_s^m are within the ε neighbourhood of each other. Under certain conditions, the BDS test statistic is asymptotically normal.

Finally, to identify the contribution of outliers in explaining the nonlinearity, the above tests are repeated on the residuals after the impacts of outliers and extreme observations have been minimized by a sample trimming algorithm. Essentially, any observation that is more than 3 standard deviations away will be reduced to exactly 3 standard deviations. Any observation that is more than 2 standard deviations but less than 3 standard deviations will be reduced to 2 standard deviations. We stop at 2 standard deviations because any further trimming would affect more than 20% of the data,

which may not be justifiable. Note that these sample trimming procedure does not involve omission or removal of outliers and hence no loss of information.

5. Empirical results

Before estimating equation (1), we employ standard tests to check for the stationarity of the series. Both Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests cannot reject the null of a unit root in levels, but the series tend to be stationary in their first differences (results are available in Appendix). Regression results of equation (1) reject PPP for all currencies on a bi-lateral basis (for brevity, these results are not reported here, but available on request). To run the ARMA model, optimal lags have been chosen based on the lowest Schwarz Information Criterion (SIC). We then run tests to determine the applicability of the residual series of the structural and time series models. We have checked for ARCH effect in the residuals of both the models to test the heteroscedasticity. The test results reject the null hypothesis of having homoscedasticity for all the 62 cases (31 time series, 31 structural)¹. As can be seen in Tables 4, 5 and 6, the LM test on the residual of the PPP model failed to reject the null hypothesis of no serial correlation up to order two for only three countries namely Colombia and Sri Lanka and Uganda. Similarly, ARMA model failed to reject the null hypothesis of no serial correlation for twenty five countries. The LM test indicates that the residuals are serially correlated and the equation should be re-specified before using it for hypothesis tests and forecasting. On the other hand as can be seen, BDS test fail to reject the null hypothesis in 3 cases when conducted on the residuals of structural model and in 7 cases when conducted on ARMA model residuals. In the literature of nonlinearity it is quite common that, after fitting the data in the linear models, supporters

¹ Results of ARCH effects are presented in the third column of appendix 2 to 7

of LM test use it as a diagnostic tool to substantiate the reliability of the model and upon getting the confirmation of having no serial correlation in the residuals of the model they tend to move on in proposing new alternative nonlinear model. What we find here is that serial correlation alone could not be used to validate correct model specification. In what follows, we discuss the results by subgroups.

In the case of first subgroup (Table 4), for PPP model, both tests confirm the presence of multi-colinearity and that the residual are not iid. However, from the test results of ARMA residuals, we can see that there is no serial correlation for any of the four major countries. This result indicates that the ARMA model used to test the linearity tends to be the correct specification for testing the presence of nonlinearity. Note that the BDS test rejects iid for Canada and Japan.

Table 4: BDS and LM tests: highly liquid developed currencies

<i>Exchange Rate</i>	<i>Time series Model</i>	<i>Serial Correlation (LM) test for Structural Model</i>	<i>Serial Correlation (LM) test for Time Series Model</i>	<i>BDS Test for Structural Model residuals</i>	<i>BDS Test for Time Series Model Residuals</i>
USD/AUD	ARMA (1,1)	0.0062	0.7630	0.0003	0.8807
USD/CAD	ARMA(1,1)	0.0000	0.9653	0.0000	0.0000
USD/JPY	ARMA(3,2)	0.0000	0.9953	0.0003	0.0857
USD/GBP	ARMA(1,1)	0.0000	0.9974	0.0000	0.0010

Note: BDS results are not sensitive qualitatively to the choice of dimension results reported. It is based on dimension equals to 2. The structural model $(S_{t+1}-S_t)/S_t = \pi^H - \pi^F$ used for every pair where H is always USD and F is the respective countries inflation. The numbers reported in the table are the associated p-values for each test.

The results for the second subgroup (with 22 currencies) are given in Table 5. For PPP model, it can be seen that serial correlation is present in the residuals for South Korea, Madagascar and Switzerland and at the same time they are iid by the BDS test. Opposite is the case for Colombia, Sri Lanka and Uganda, that is, absence of serial correlation with no iid. In case of ARMA, we have at

least 12 cases where the LM test confirms that there is no serial correlation but the BDS test implies that the residuals are not iid. On the whole, the results are very mixed.

Table 5: BDS and LM tests: less liquid currencies

<i>Exchange Rate²</i>	<i>Time series Model</i>	<i>Serial Correlation (LM) test for Structural Model</i>	<i>Serial Correlation (LM) test for Time Series Model</i>	<i>BDS Test for Structural Model residuals</i>	<i>BDS Test for Time Series Model Residuals</i>
USD/ALL	ARMA(1,1)	0.0000	0.2945	0.0000	0.0000
USD/AMD	ARMA(6,4)	0.0000	0.1243	0.0000	0.9413
USD/COP	ARMA(1,1)	1.0000	0.3594	0.0000	0.0000
USD/DOP	ARMA(1,4)	0.0023	1.0000	0.0000	0.0000
USD/GTQ	ARMA(12,9)	0.0050	1.0000	0.0000	0.0000
USD/ISK	ARMA(5,1)	0.0000	1.0000	0.0000	0.0000
USD/ILS	ARMA(1,2)	0.0000	1.0000	0.0000	0.0000
USD/KRW	ARMA(1,1)	0.0000	0.6023	0.9563	0.9579
USD/LKR	ARMA(1,2)	1.0000	0.0033	0.0000	0.0000
USD/MGA	ARMA(1,2)	0.0093	0.0000	0.8927	0.8943
USD/MWK	ARMA(1,2)	0.0000	0.6264	0.0000	0.0000
USD/NOK	ARMA(0,1)	0.0000	0.6870	0.0000	0.7560
USD/NZD	ARMA(1,1)	0.0001	0.5418	0.0000	0.0103
USD/PGK	ARMA(1,1)	0.0510	1.0000	0.0001	0.0011
USD/PLN	ARMA(5,3)	0.0000	0.0000	0.0000	0.0000
USD/ZAR	ARMA(2,1)	0.0000	0.0000	0.0000	0.0001
USD/SEK	ARMA(1,2)	0.0000	0.7074	0.0000	0.9727
USD/SLL	ARMA(7,4)	0.0000	0.0322	0.0000	0.0000
USD/CHF	ARMA(1,1)	0.0000	0.0654	0.8017	0.4099
USD/YTL	ARMA(1,1)	0.0274	0.1662	0.0000	0.0000
USD/TZS	ARMA(1,1)	0.0155	1.0000	0.0000	0.0092
USD/UGX	ARMA(4,4)	1.000	1.0000	0.0001	0.0050

Note: BDS results are not sensitive qualitatively to the choice of dimension results reported. It is based on dimension equals to 2. The structural model $(S_{t+1}-S_t)/S_t = \pi^H - \pi^F$ used for every pair where H is always USD and F is the respective countries inflation. The numbers reported in the table are the associated p-values for each test.

In the case of ASEAN 5 countries (Table 6), the test results on the residuals under the PPP model reject the null of no serial correlation under the LM test and BDS test supports the findings. However, the tests on ARMA residuals indicate that LM test has low power against nonlinear behavior in the residuals. For all the 5 countries it is found that there is no serial correlation and at the same time they are not iid.

² Countrywide currency codes are in appendix 7

Table 6: BDS and LM tests: ASEAN 5 currencies

<i>Exchange Rate</i>	<i>Time series Model</i>	<i>Serial Correlation (LM) test for Structural Model</i>	<i>Serial Correlation (LM) test for Time Series Model</i>	<i>BDS Test for Structural Model residuals</i>	<i>BDS Test for Time Series Model Residuals</i>
USD/IDR	ARMA(2,2)	0.0006	0.7226	0.0000	0.0000
USD/MYR	ARMA(3,1)	0.0000	0.9545	0.0000	0.0000
USD/SGD	ARMA(4,2)	0.0000	0.9957	0.0000	0.0065
USD/THB	ARMA(1,1)	0.0000	0.6969	0.0000	0.0000
USD/PHP	ARMA(1,1)	0.0000	0.9909	0.0000	0.0000

Note: BDS results are not sensitive qualitatively to the choice of dimension results reported. It is based on dimension equals to 2. The structural model $(S_{t+1}-S_t)/S_t = \pi^H - \pi^F$ used for every pair where H is always US inflation and F is the respective country's inflation. The numbers reported in the table are the associated p-values for each test.

In Tables 4, 5 and 6 above, test results on time series residuals indicate that twenty out of thirty one countries do not suffer from serial correlation but at the same time they are not identically or independently distributed as well. In such a scenario, the next question of interest is whether these residual structures are influenced by the presence of the outliers in the exchange rate data or not. To identify the contribution of outliers in explaining the above results, the above tests are repeated on the residuals after the impacts of outliers and extreme observations have been minimized by a sample trimming algorithm. In this procedure, any observation that is more than 3 standard deviations away will be reduced to exactly 3 standard deviations. Any observation that is more than 2 standard deviations but less than 3 standard deviations will be reduced to 2 standard deviations. We stop at 2 standard deviations because any further trimming would affect more than 20% of the data, which may not be justifiable. Note that these sample trimming procedure does not involve omission or removal of outliers and hence no loss of information.

The sample trimming algorithm is run on a set of currencies chosen randomly from our sample. Table 7 gives the results. As can be seen, the results for Japan and Canada have now changed, the BDS tests fails to reject the null of iid. We find no significant changes in the results for other currencies.

Table 7: A comparison of BDS test statistic before and after adjusting outliers

Exchange Rate	Before adjusting Outlier			Standard deviation adjusted	After adjusting Outlier		
	Time series Model	BDS Statistics	P Value		Time series Model	BDS Statistics	P Value
USD/CAD	ARMA(1,1)	0.0151	0.0000	3.00	ARMA(1,1)	0.0122	0.0001
				2.50	ARMA(2,1)	0.0057	0.0660
				2.00	ARMA(1,1)	0.0000	0.9621
USD/JPY	ARMA(3,2)	0.0057	0.0857	3.00	ARMA(1,1)	0.0002	0.9431
USD/NZD	ARMA(1,1)	0.0174	0.0103	3.00	ARMA(1,1)	0.0185	0.0037
				2.50	ARMA(1,1)	0.0203	0.0011
				2.00	ARMA(1,1)	0.0162	0.0071
USD/PLN	ARMA(5,3)	0.0391	0.0000	3.00	ARMA(3,2)	0.0356	0.0000
				2.00	ARMA(1,1)	0.0337	0.0000
USD/LKR	ARMA(1,2)	0.0445	0.0000	3.00	ARMA(2,1)	0.0276	0.0000
				2.00	ARMA(1,2)	0.0363	0.0000
USD/IDR	ARMA(2,2)	0.0836	0.0000	3.00	ARMA(1,1)	0.1067	0.0000
				2.50	ARMA(1,2)	0.0999	0.0000
				2.00	ARMA(2,4)	0.0944	0.0000
USD/SGD	ARMA(4,2)	0.0113	0.0065	3.00	ARMA(1,1)	0.0108	0.0062
				2.50	ARMA(2,3)	0.0082	0.0145
				2.00	ARMA(1,1)	0.0122	0.0007

Note: BDS results are not sensitive qualitatively to the choice of dimension results reported. It is based on dimension equals to 2.

6. Conclusion

This paper has investigated the possibility of nonlinear dependence in exchange rate returns for a cross-section of 31 currencies, including major currencies and those from the emerging countries. PPP model is used as a linear structural model and ARMA is used as linear time series model. Both LM test for serial correlation and BDS tests are conducted on the residuals of both the models. Tests using structural model confirmed the existence of nonlinear parameters in the exchange rate return while tests using time series model give mixed results. Further investigation on time series model are done after adjusting the outliers from raw data. The results have changed for highly liquid developed currencies

like Japanese yen and Canadian dollar but remained unchanged for relatively less liquid currencies like Sri Lankan rupees, Indonesian rupees, Singapore dollar, New Zealand dollar or Polish zlotych.

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Appendix 1

Sample description

Country	Currency	Currency Code	Sample*
Australia	Dollar	USD/AUD	1973(1) - 2010(3)
Canada	Dollar	USD/CAD	1973(1) – 2010(10)
Japan	Yen	USD/JPY	1973(1) – 2010(10)
United Kingdom	Pound Sterling	USD/GBP	1973(1) – 2010(10)
Albania	Leke	USD/ALL	1992(8) – 2010(10)
Armenia	Drams	USD/AMD	1994(1) - 2010(10)
Colombia	Peso	USD/COP	1980(2) – 2010(9)
Dominican Republic	Pesos	USD/DOP	1985(2) - 2010(10)
Guatemala	Quetzal	USD/GTQ	1989(9) - 2010(10)
Iceland	Kronur	USD/ISK	1983(2) - 2010(10)
Israel	Shekels	USD/ILS	1981(2) -2010(10)
South Korea	Won	USD/KRW	1980(2) - 2010(10)
Sri Lanka	Rupees	USD/LKR	1980(2) - 2010(10)
Madagascar	Ariary	USD/MGA	1982(1) - 2010(10)
Malawi	Kwachas	USD/MWK	1982(2) - 2010(5)
Norway	Krone	USD/NOK	1980(2) - 2010(10)
New Zealand	Dollar	USD/NZD	1973(1) - 2010(3)
Papua New Guinea	Kina	USD/PGK	1973(1) - 2010(2)
Poland	Zoltych	USD/PLN	1988(2) - 2010(10)
South Africa	Rand	USD/ZAR	1980(2) - 2010(10)
Sweden	Kronor	USD/SEK	1980(2) - 2010(10)
Sierra Leone	Leones	USD/SLL	1986(11) - 2010(9)
Switzerland	Francs	USD/CHF	1980(2) - 2010(10)
Turkey	Lira	USD/TRY	1995(1) - 2010(10)
Tanzania	Shillings	USD/TZS	1995(1) - 2010(10)
Uganda	Shillings	USD/UGX	1988(1) - 2010(10)
Indonesia	Rupees	USD/IDR	1978(11) - 2010(10)
Malaysia	Ringgit	USD/MYR	1973-1998, 2005-2010
Singapore	Dollar	USD/SGD	1973(1) – 2010(10)
Thailand	Baht	USD/THB	1984(11) - 2010(10)
Philippines	Pesos	USD/PHP	1973(1) – 2010(10)

*Data for Australia, New Zealand and Papua New Guinea are quarterly. All other data are monthly.

Appendix 2

Unit Root test results of exchange rate returns and ARCH and LM test results of ARMA residuals: highly liquid currencies

	<i>ADF</i>	<i>PP</i>	<i>ARCH</i>	<i>LM</i>
AUSTRALIA	-9.5953*	-9.4185*	0.8502	0.2256
CANADA	-16.6889*	-16.7878*	0.8124	0.0706
JAPAN	-15.8007*	-15.6424*	3.7540**	0.0000
UK	-14.6673*	-14.5511*	8.0593*	0.0000

Note: The reported values are the test statistics. *, ** and *** are the level of significance at 1%, 5% and 10% level respectively.

Appendix 3

Unit Root test results of exchange rate returns and ARCH and LM test results of ARMA residuals: less liquid currencies

	<i>ADF</i>	<i>PP</i>	<i>ARCH</i>	<i>LM</i>
ALBANIA	-9.6578*	-9.6180*	26.3146*	2.4450
ARMENIA	-12.6267*	-18.8952*	0.0004	3.3429
COLUMBIA	-18.1297*	-18.1891*	53.8110*	2.0467
DOMINICAN REPUBLIC	-5.5073*	-13.3470*	2.9368***	0.0000
GUATEMALA	-14.3184*	-14.4092*	55.8144*	0.0000
ICELAND	-11.9256*	-11.8955*	13.7333*	0.0000
ISRAEL	-4.9746*	-9.2792*	41.3638*	0.0000
KOREA	-13.4912*	-10.9562*	9.1081*	1.0139
MADAGASCAR	-15.3110*	-15.3227*	0.5233	23.9091*
MALAWI	-8.7373*	-11.3909*	8.0832*	0.9356
NEW ZEALAND	-8.4077*	-8.0859*	0.0248	1.2257
NORWAY	-13.1910*	-12.9272*	1.2997	0.7509
PAPUA NEWGUINEA	-9.5594*	-9.6776*	1.4318	0.0000
POLAND	-7.4305*	-7.5499*	34.4559*	39.1195*
SIERRALEONE	-7.4025*	-10.7403*	11.4347*	6.8702**
SOUTH AFRICA	-13.9545*	13.5858*	4.4332**	27.0513*
SRILANKA	-16.1484*	16.1085*	49.8752*	11.4485*
SWEDEN	-11.9931*	12.5355*	0.0422	0.6921
SWITZERLAND	-14.4265*	14.1945*	2.4479	5.4556***
TANZANIA	-10.1230*	9.7271*	0.0009	0.0000
TURKEY	-13.2205*	13.1593*	9.0420*	3.5888
UGANDA	-17.6008*	17.6101*	2.1158	0.0000

Note: The reported values are the test statistics. *, ** and *** are the level of significance at 1%, 5% and 10% level respectively.

Appendix 4

Unit Root test results of exchange rate returns and ARCH and LM test results of ARMA residuals: ASEAN 5 Currencies

	<i>ADF</i>	<i>PP</i>	<i>ARCH</i>	<i>LM</i>
INDONESIA	-15.4653*	-15.4692*	49.6249*	0.6499
MALAYSIA	-16.3984*	-16.5072*	62.2699*	0.0930
PHILIPINES	-15.7478*	-16.1178*	2.8303***	0.0183
SINGAPORE	-13.9672*	-15.49960*	24.0876*	0.0000
THAILAND	-13.2205*	-13.1593*	27.5072*	0.7222

Note: The reported values are the test statistics. *, ** and *** are the level of significance at 1%, 5% and 10% level respectively.

Appendix 5

Unit Root test results of inflation differential with USA and ARCH and LM test results of PPP residuals: highly liquid developed currencies

	<i>ADF</i>	<i>PP</i>	<i>ARCH</i>	<i>LM</i>
AUSTRALIA	-3.4292**	-10.2047*	0.1596	10.1642*
CANADA	-21.7742*	-21.9429*	4.0751**	25.2993*
JAPAN	-3.0962	-18.6779*	15.0571*	34.8919*
UK	-4.0807*	-18.4472*	25.5046*	61.1769*

Note: The reported values are the test statistics. *, ** and *** are the level of significance at 1%, 5% and 10% level respectively.

Appendix 6

Unit Root test results of inflation differential with USA and ARCH and LM test results of PPP residuals: less liquid currencies

	<i>ADF</i>	<i>PP</i>	<i>ARCH</i>	<i>LM</i>
ALBANIA	-19.5668*	-19.3925*	48.8902*	44.2356*
ARMENIA	-16.9658*	-10.5220*	23.1798*	39.9702*
COLUMBIA	-3.3110***	-19.1035*	41.9054*	0.0000
DOMINICAN REPUBLIC	-9.2055*	-9.7553*	21.8374*	12.1810*
GUATEMALA	-7.9095*	-8.6605*	34.4104*	10.5788*
ICELAND	-6.7959*	-9.7557*	79.7597*	38.1256*
ISRAEL	-3.5029**	-19.2502*	17.8933*	82.3544*
KOREA	-14.5280*	-14.4260*	14.4135*	90.5195*
MADAGASCAR	-14.1081*	-14.1806*	0.0649	9.3635*
MALAWI	-3.0307	-17.9221*	40.3352*	52.7894*
NEW ZEALAND	-6.9097*	-7.1435*	2.4587	19.6230*
NORWAY	-3.5800*	-16.0743*	18.3410*	45.6490*
PAPUA NEWGUINEA	-5.0711*	-9.6069*	3.0222***	5.9519**
POLAND	-3.6982**	-11.0282*	40.6919*	34.1545*
SIERRALEONE	-12.1976*	-14.0236*	16.3123*	34.6423*
SOUTH AFRICA	-8.6366*	-18.2738*	5.8324**	33.8240*
SRILANKA	-7.8736*	-13.6801*	21.3380*	0.0000
SWEDEN	-16.5352	-16.3649*	20.7628*	61.7297*
SWITZERLAND	-4.5291*	-17.0040*	0.9684	33.2991*
TANZANIA	-2.7377	-7.3129*	2.7198***	8.3323**
TURKEY	-8.8514*	-8.9544*	7.7852*	7.1919**
UGANDA	-20.6030*	-20.1495*	0.0017	0.0000

Note: The reported values are the test statistics. *, ** and *** are the level of significance at 1%, 5% and 10% level respectively.

Appendix 7

Unit Root test results of inflation differential with USA and ARCH and LM test results of PPP residuals: ASEAN 5 Currencies

	<i>ADF</i>	<i>PP</i>	<i>ARCH</i>	<i>LM</i>
INDONESIA	-14.0788*	-15.2306*	43.4919*	14.8571*
MALAYSIA	-16.5383*	-16.5044*	131.6069*	23.3516*
PHILIPINES	-4.2002*	-16.2316*	0.7217	28.1109*
SINGAPORE	-8.3018*	-16.5044*	49.0578*	36.8059*
THAILAND	-18.1601*	-18.5374*	102.5058*	32.9663*

Note: The reported values are the test statistics. *, ** and *** are the level of significance at 1%, 5% and 10% level respectively.

Appendix 8a

Exchange rates: 1-14 of 31 Countries, Monthly, 1973(1) – 2010(12)

Date	Canada	Japan	UK	Albania	Armenia	Colombia	Dominican Republic	Iceland	Israel	South Korea	Sri Lanka	Madagascar	Malawi	Norway
15/01/1973	1.0009	0.0033	2.3560	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1974	1.0087	0.0033	2.2240	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1975	1.0053	0.0033	2.3624	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1976	0.9935	0.0033	2.0280	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1977	0.9893	0.0034	1.7134	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1978	0.9082	0.0041	1.9341	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1979	0.8406	0.0051	2.0051	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1980	0.8592	0.0042	2.2640	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1981	0.8398	0.0050	2.4049	-	-	0.0197	-	-	-	0.0015	0.0557	-	-	0.1910
--														
15/01/1982	0.8386	0.0045	1.8868	-	-	0.0169	-	-	61.8517	0.0014	0.0486	-	-	0.1706
--														
15/01/1983	0.8141	0.0043	1.5738	-	-	0.0142	-	-	28.7911	0.0013	0.0467	0.0134	1.1027	0.1420
--														
15/01/1984	0.8011	0.0043	1.4085	-	-	0.0111	-	0.0341	8.6087	0.0013	0.0397	0.0100	1.3362	0.1271
--														
15/01/1985	0.7554	0.0039	1.1291	-	-	0.0087	-	0.0244	1.5063	0.0012	0.0379	0.0075	1.6008	0.1090
--														
15/01/1986	0.7110	0.0050	1.4249	-	-	0.0058	0.3395	0.0236	0.6718	0.0011	0.0364	0.0080	1.6959	0.1325
--														
15/01/1987	0.7352	0.0065	1.5063	-	-	0.0045	0.3255	0.0251	0.6354	0.0012	0.0350	0.0066	1.9044	0.1395
--														
15/01/1988	0.7781	0.0078	1.8032	-	-	0.0038	0.1983	0.0273	0.6378	0.0013	0.0325	0.0040	2.2693	0.1576
--														
15/01/1989	0.8394	0.0079	1.7760	-	-	0.0029	0.1553	0.0203	0.5508	0.0015	0.0302	0.0032	2.6231	0.1501

Date	Canada	Japan	UK	Albania	Armenia	Colombia	Dominican Republic	Iceland	Israel	South Korea	Sri Lanka	Madagascar	Malawi	Norway
--														
15/01/1990	0.8538	0.0069	1.6515	-	-	0.0023	0.1553	0.0165	0.5141	0.0015	0.0250	0.0033	2.6793	0.1529
--														
15/01/1991	0.8651	0.0075	1.9337	-	-	0.0017	0.0844	0.0181	0.4930	0.0014	0.0248	0.0031	2.6300	0.1694
--														
15/01/1992	0.8648	0.0080	1.8120	-	-	0.0014	0.0793	0.0175	0.4351	0.0013	0.0234	0.0027	2.7200	0.1615
--														
15/01/1993	0.7828	0.0080	1.5321	0.0095	-	0.0012	0.0794	0.0157	0.3596	0.0013	0.0203	0.0026	4.3844	0.1454
--														
15/01/1994	0.7591	0.0090	1.4927	0.0100	-	0.0011	0.0779	0.0137	0.3351	0.0012	0.0201	0.0025	4.5017	0.1331
--														
15/01/1995	0.7078	0.0100	1.5749	0.0105	0.0025	0.0012	0.0754	0.0147	0.3320	0.0013	0.0200	0.0013	15.2628	0.1492
--														
15/01/1996	0.7318	0.0094	1.5303	0.0105	0.0025	0.0010	0.0736	0.0152	0.3195	0.0013	0.0185	0.0013	15.3000	0.1559
--														
15/01/1997	0.7416	0.0085	1.6603	0.0090	0.0022	0.0010	0.0704	0.0147	0.3052	0.0012	0.0176	0.0011	15.3237	0.1551
--														
15/01/1998	0.6941	0.0077	1.6353	0.0066	0.0020	0.0008	0.0692	0.0138	0.2796	0.0006	0.0163	0.0009	21.3219	0.1336
--														
15/01/1999	0.6583	0.0088	1.6511	0.0071	0.0019	0.0006	0.0627	0.0144	0.2451	0.0009	0.0146	0.0009	43.5426	0.1342
--														
15/01/2000	0.6902	0.0095	1.6415	0.0073	0.0019	0.0005	0.0619	0.0139	0.2436	0.0009	0.0137	0.0008	46.5056	0.1248
--														
15/01/2001	0.6653	0.0085	1.4784	0.0071	0.0018	0.0005	0.0592	0.0118	0.2428	0.0008	0.0120	0.0008	80.1067	0.1139
--														
15/01/2002	0.6249	0.0075	1.4324	0.0071	0.0018	0.0004	0.0578	0.0098	0.2204	0.0008	0.0107	0.0008	67.6892	0.1115
--														
15/01/2003	0.6490	0.0084	1.6163	0.0076	0.0017	0.0003	0.0442	0.0126	0.2068	0.0008	0.0103	0.0008	87.8643	0.1447
--														
15/01/2004	0.7718	0.0094	1.8218	0.0094	0.0018	0.0004	0.0209	0.0144	0.2261	0.0008	0.0102	0.0008	108.6320	0.1468
--														
15/01/2005	0.8156	0.0096	1.8838	0.0103	0.0020	0.0004	0.0328	0.0160	0.2284	0.0010	0.0100	0.0005	108.9430	0.1597
--														
15/01/2006	0.8640	0.0087	1.7663	0.0098	0.0022	0.0004	0.0286	0.0160	0.2165	0.0010	0.0098	0.0005	124.9040	0.1506
--														
15/01/2007	0.8504	0.0083	1.9594	0.0104	0.0028	0.0004	0.0294	0.0143	0.2365	0.0011	0.0092	0.0005	139.4430	0.1570
--														
15/01/2008	0.9878	0.0093	1.9697	0.0120	0.0033	0.0005	0.0294	0.0156	0.2666	0.0011	0.0092	0.0006	140.3920	0.1848

Date	Canada	Japan	UK	Albania	Armenia	Colombia	Dominican Republic	Iceland	Israel	South Korea	Sri Lanka	Madagascar	Malawi	Norway
--														
15/01/2009	0.8155	0.0111	1.4422	0.0106	0.0033	0.0004	0.0281	0.0081	0.2552	0.0007	0.0088	0.0005	140.5780	0.1437
--														
15/01/2010	0.9588	0.0110	1.6172	0.0103	0.0027	0.0005	0.0276	0.0079	0.2694	0.0009	0.0087	0.0005	147.1310	0.1745
--														
15/12/2010	0.9916	0.0120	1.5621	0.0095	0.0028	0.0005	0.0267	0.0086	0.2775	0.0009	0.0090	0.0005	150.8000	0.1672

Note: All the exchange rates are quoted as US dollar price per unit of foreign currency. One sample from each period is reported. The full sample is available upon request.

Appendix 8b

Exchange rates: 15-28 of 31 Countries, Monthly, 1973(1) – 2010(12)

Date	Poland	South Africa	Sweden	Sierra Leone	Switzerland	Turkey	Tanzania	Uganda	Guatemala	Indonesia	Malaysia	Singapore	Thailand	Philippines
15/01/1973	-	-	-	-	-	-	-	-	-	-	0.3558	0.3565	-	0.1475
--														
15/01/1974	-	-	-	-	-	-	-	-	-	-	0.4005	0.3976	-	0.1486
--														
15/01/1975	-	-	-	-	-	-	-	-	-	-	0.4332	0.4333	-	0.1415
--														
15/01/1976	-	-	-	-	-	-	-	-	-	-	0.3869	0.4024	-	0.1337
--														
15/01/1977	-	-	-	-	-	-	-	-	-	-	0.3971	0.4068	-	0.1355
--														
15/01/1978	-	-	-	-	-	-	-	-	-	-	0.4224	0.4281	-	0.1355
--														
15/01/1979	-	-	-	-	-	-	-	-	-	0.0016	0.4525	0.4613	-	0.1354
--														
15/01/1980	-	-	-	-	-	-	-	-	-	0.0016	0.4585	0.4643	-	0.1347
--														
15/01/1981	-	1.3362	0.2250	-	1.3362	-	-	-	-	0.0016	0.4502	0.4807	-	0.1309
--														
15/01/1982	-	1.0351	0.1780	-	1.0351	-	-	-	-	0.0015	0.4430	0.4855	-	0.1210
--														
15/01/1983	-	0.9387	0.1366	-	0.9387	-	-	-	-	0.0014	0.4380	0.4815	-	0.1076
--														
15/01/1984	-	0.7970	0.1224	-	0.7970	-	-	-	-	0.0010	0.4272	0.4694	-	0.0714
--														
15/01/1985	-	0.4635	0.1103	-	0.4635	-	-	-	-	0.0009	0.4032	0.4544	0.0366	0.0529
--														
15/01/1986	-	0.4252	0.1318	-	0.4252	-	-	-	-	0.0009	0.4085	0.4705	0.0375	0.0525
--														
15/01/1987	-	0.4790	0.1515	0.0263	0.4790	-	-	-	-	0.0006	0.3882	0.4648	0.0385	0.0489
--														
15/01/1988	-	0.5069	0.1676	0.0434	0.5069	-	-	0.0167	-	0.0006	0.3937	0.4938	0.0396	0.0480
--														
15/01/1989	19.7691	0.4190	0.1599	0.0232	0.4190	-	-	0.0061	-	0.0006	0.3676	0.5154	0.0395	0.0469
--														

Date	Poland	South Africa	Sweden	Sierra Leone	Switzerland	Turkey	Tanzania	Uganda	Guatemala	Indonesia	Malaysia	Singapore	Thailand	Philippines
15/01/1990	1.0526	0.3913	0.1618	0.0114	0.3913	-	-	0.0027	0.2949	0.0006	0.3698	0.5293	0.0389	0.0445
--														
15/01/1991	1.0526	0.3902	0.1773	0.0051	0.3902	-	-	0.0018	0.1984	0.0005	0.3683	0.5730	0.0396	0.0357
--														
15/01/1992	0.8891	0.3595	0.1740	0.0023	0.3595	-	-	0.0010	0.1966	0.0005	0.3713	0.6127	0.0395	0.0377
--														
15/01/1993	0.6298	0.3258	0.1380	0.0018	0.3258	-	-	0.0008	0.1892	0.0005	0.3847	0.6049	0.0392	0.0396
--														
15/01/1994	0.4632	0.2933	0.1231	0.0017	0.2933	-	-	0.0009	0.1705	0.0005	0.3687	0.6238	0.0392	0.0361
--														
15/01/1995	0.4108	0.2826	0.1339	0.0016	0.2826	25.0000	0.0019	0.0011	0.1743	0.0005	0.3914	0.6885	0.0399	0.0406
--														
15/01/1996	0.3982	0.2746	0.1488	0.0011	0.2746	16.0000	0.0018	0.0010	0.1639	0.0004	0.3911	0.7036	0.0395	0.0382
--														
15/01/1997	0.3416	0.2155	0.1416	0.0011	0.2155	9.0000	0.0017	0.0010	0.1652	0.0004	0.4014	0.7112	0.0389	0.0380
--														
15/01/1998	0.2826	0.2024	0.1249	0.0007	0.2024	5.0000	0.0016	0.0009	0.1598	0.0001	0.2265	0.5705	0.0186	0.0235
--														
15/01/1999	0.2824	0.1672	0.1279	0.0007	0.1672	3.0000	0.0015	0.0007	0.1433	0.0001	-	0.5959	0.0273	0.0260
--														
15/01/2000	0.2437	0.1633	0.1179	0.0004	0.1633	2.0000	0.0013	0.0007	0.1269	0.0001	-	0.5977	0.0268	0.0247
--														
15/01/2001	0.2431	0.1285	0.1056	0.0006	0.1285	1.5000	0.0012	0.0006	0.1282	0.0001	-	0.5759	0.0232	0.0196
--														
15/01/2002	0.2460	0.0864	0.0958	0.0005	0.0864	0.7321	0.0011	0.0006	0.1247	0.0001	-	0.5438	0.0227	0.0195
--														
15/01/2003	0.2610	0.1151	0.1158	0.0005	0.1151	0.6299	0.0010	0.0005	0.1282	0.0001	-	0.5762	0.0234	0.0187
--														
15/01/2004	0.2669	0.1436	0.1380	0.0004	0.1436	0.7420	0.0009	0.0005	0.1233	0.0001	-	0.5887	0.0256	0.0180
--														
15/01/2005	0.3222	0.1692	0.1450	0.0004	0.1692	0.7405	0.0009	0.0006	0.1288	0.0001	0.2632	0.6105	0.0258	0.0179
--														
15/01/2006	0.3165	0.1641	0.1300	0.0003	0.1641	0.7516	0.0009	0.0006	0.1312	0.0001	0.2665	0.6124	0.0253	0.0190
--														
15/01/2007	0.3352	0.1395	0.1432	0.0003	0.1395	0.7029	0.0008	0.0006	0.1302	0.0001	0.2851	0.6502	0.0278	0.0204
--														
15/01/2008	0.4075	0.1426	0.1560	0.0003	0.1426	0.8535	0.0009	0.0006	0.1298	0.0001	0.3060	0.6986	0.0302	0.0244
--														

Date	Poland	South Africa	Sweden	Sierra Leone	Switzerland	Turkey	Tanzania	Uganda	Guatemala	Indonesia	Malaysia	Singapore	Thailand	Philippines
15/01/2009	0.3153	0.1010	0.1234	0.0003	0.1010	0.6271	0.0008	0.0005	0.1272	0.0001	0.2804	0.6720	0.0287	0.0212
--														
15/01/2010	0.3507	0.1341	0.1400	0.0003	0.1341	0.6791	0.0008	0.0005	0.1195	0.0001	0.2963	0.7163	0.0303	0.0217
--														
15/12/2010	0.3312	0.1462	0.1460	0.0002	0.1462	0.6595	0.0007	0.0004	0.1254	0.0001	0.3197	0.7650	0.0332	0.0228

Note: All the exchange rates are quoted as US dollar price per unit of foreign currency. One sample from each period is reported. The full sample is available upon request.

Appendix 9a

Consumer Price Index (CPI): 1-14 of 31 Countries Monthly, 1973(1) – 2010(12)

Date	Canada	Japan	UK	Albania	Armenia	Colombia	Dominican Republic	Iceland	Israel	South Korea	Sri Lanka	Madagascar	Malawi	Norway
15/01/1973	21.20	37.50	11.80	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1974	23.10	45.80	13.20	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1975	25.90	53.80	15.80	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1976	28.40	58.50	19.50	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1977	30.10	64.00	22.80	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1978	32.80	66.90	25.00	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1979	35.70	69.30	27.30	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1980	39.10	73.90	32.40	-	-	-	-	-	-	-	-	-	-	-
--														
15/01/1981	43.80	79.30	36.60	-	-	1.60	-	-	-	31.77	8.52	-	-	37.60
--														
15/01/1982	48.80	81.80	41.00	-	-	2.00	-	-	0.20	35.72	10.02	3.70	-	42.20
--														
15/01/1983	52.80	83.60	43.00	-	-	2.50	-	-	0.40	37.55	10.61	5.10	1.00	46.50
--														
15/01/1984	55.70	85.20	45.20	-	-	2.90	-	16.70	1.30	38.22	12.91	5.60	1.10	49.50
--														
15/01/1985	57.70	87.50	47.50	-	-	3.40	-	20.50	6.40	39.12	13.91	6.20	1.30	52.30
--														

Date	Canada	Japan	UK	Albania	Armenia	Colombia	Dominican Republic	Iceland	Israel	South Korea	Sri Lanka	Madagascar	Malawi	Norway
15/01/1986	60.30	88.80	50.10	-	-	4.20	4.70	27.50	17.10	40.39	14.46	7.20	1.50	55.50
--														
15/01/1987	62.60	87.80	52.10	-	-	5.10	4.80	31.00	21.20	40.83	15.57	7.80	1.60	60.70
--														
15/01/1988	65.20	88.60	53.80	-	-	6.40	6.20	39.10	24.50	43.37	17.61	10.50	2.40	65.00
--														
15/01/1989	68.00	89.60	57.80	-	-	8.10	9.50	46.20	29.40	46.31	19.39	11.30	2.80	68.30
--														
15/01/1990	71.70	92.50	62.20	-	-	10.30	12.80	57.20	34.30	49.05	23.12	12.70	3.10	71.20
--														
15/01/1991	76.60	96.20	67.80	-	-	13.60	22.60	61.40	40.40	54.25	26.68	13.60	3.60	74.10
--														
15/01/1992	77.90	97.90	70.60	-	-	17.30	24.40	65.80	47.10	58.43	29.92	15.70	4.00	75.90
--														
15/01/1993	79.40	99.10	71.80	31.90	-	21.60	25.90	67.40	52.10	61.07	34.37	17.70	5.30	77.80
--														
15/01/1994	80.50	100.40	73.60	40.00	4.90	26.50	26.50	69.50	57.70	64.95	37.89	20.30	6.40	78.80
--														
15/01/1995	81.00	100.90	76.10	46.20	51.80	32.10	30.60	70.70	65.70	68.33	38.81	31.40	11.00	80.90
--														
15/01/1996	82.30	100.40	78.20	49.10	68.20	38.60	32.90	71.80	71.50	71.61	43.15	42.80	18.90	81.80
--														
15/01/1997	84.00	101.00	80.40	57.40	71.80	46.50	35.20	73.30	78.70	74.97	50.37	46.30	20.20	84.30
--														
15/01/1998	85.00	102.90	83.10	83.00	88.30	54.80	37.10	74.90	84.10	81.18	57.01	48.40	23.90	86.00
--														
15/01/1999	85.50	103.10	85.10	88.00	87.10	64.20	39.80	75.90	90.70	82.37	59.18	51.50	37.20	88.00
--														
15/01/2000	87.40	102.40	86.80	86.80	87.10	69.50	42.10	80.20	91.90	83.70	59.38	58.80	48.40	90.50

Date	Canada	Japan	UK	Albania	Armenia	Colombia	Dominican Republic	Iceland	Israel	South Korea	Sri Lanka	Madagascar	Malawi	Norway
--														
15/01/2001	90.00	102.00	89.10	88.80	89.80	75.40	47.00	83.10	91.80	86.39	68.98	64.60	61.00	93.50
--														
15/01/2002	91.20	100.60	90.30	94.50	90.20	81.00	48.10	90.90	94.60	89.11	75.12	67.50	70.50	94.70
--														
15/01/2003	95.30	100.20	92.90	94.80	93.70	87.00	54.60	92.20	99.90	92.50	85.35	75.70	78.00	99.50
--														
15/01/2004	96.60	99.90	95.40	97.60	100.20	92.40	82.30	94.40	97.60	95.64	85.79	75.40	85.40	97.70
--														
15/01/2005	98.40	100.10	98.40	100.70	105.10	97.40	97.80	98.20	98.40	98.61	97.19	97.40	97.40	98.70
--														
15/01/2006	101.10	100.00	100.70	102.10	102.00	101.80	105.90	102.50	101.10	101.10	104.30	107.20	114.20	100.50
--														
15/01/2007	102.30	100.00	105.00	105.00	107.20	106.60	110.50	109.50	101.10	102.80	118.60	118.80	125.20	101.70
--														
15/01/2008	104.50	100.70	109.30	108.20	114.20	113.00	120.50	115.90	104.70	106.80	143.37	129.10	134.90	105.40
--														
15/01/2009	105.60	100.70	109.40	110.50	118.80	121.10	124.90	137.40	108.10	110.80	158.68	141.60	148.40	107.80
--														
15/01/2010	107.60	99.40	113.50	115.20	127.10	123.70	133.50	146.40	112.20	114.20	169.07	153.60	160.10	110.50
--														
15/12/2010	109.80	99.60	119.00	117.90	136.80	126.70	140.00	150.50	115.90	117.80	178.37	166.80	161.20	113.30

Note: One sample from each period is reported. The full sample is available upon request.

Appendix 2.9b

Consumer Price Index (CPI): 15-28 of 31 Countries Monthly, 1973(1) – 2010(12)

Date	Poland	South Africa	Sweden	Sierra Leone	Switzerland	Turkey	Tanzania	Uganda	Indonesia	Malaysia	Singapore	Thailand	Philippines	US
15/01/1973	-	-	-	-	-	-	-	-	-	28.80	38.00	-	3.40	21.80
--														
15/01/1974	-	-	-	-	-	-	-	-	-	34.10	50.60	-	4.70	23.90
--														
15/01/1975	-	-	-	-	-	-	-	-	-	38.10	55.20	-	5.50	26.70
--														
15/01/1976	-	-	-	-	-	-	-	-	-	38.60	54.50	-	5.80	28.50
--														
15/01/1977	-	-	-	-	-	-	-	-	-	40.20	54.40	-	6.30	30.00
--														
15/01/1978	-	-	-	-	-	-	-	-	-	41.80	57.10	-	7.00	32.00
--														
15/01/1979	-	-	-	-	-	-	-	-	6.15	43.30	58.70	-	7.60	35.00
--														
15/01/1980	-	-	-	-	-	-	-	-	7.49	46.10	63.00	-	9.20	39.90
--														
15/01/1981	9.10	38.20	-	-	8.70	-	-	-	8.78	49.80	66.90	-	10.70	44.50
--														
15/01/1982	10.40	41.90	-	-	9.80	-	-	-	9.74	53.70	74.30	-	11.90	48.30
--														
15/01/1983	11.90	45.90	-	-	11.10	-	-	-	10.71	56.40	74.10	-	12.70	50.10
--														
15/01/1984	13.10	49.70	-	-	12.10	-	-	-	11.85	58.80	75.90	-	16.90	52.20
--														
15/01/1985	14.90	53.40	-	-	14.40	-	-	-	12.56	58.70	76.30	46.50	24.60	54.00
--														

Date	Poland	South Africa	Sweden	Sierra Leone	Switzerland	Turkey	Tanzania	Uganda	Indonesia	Malaysia	Singapore	Thailand	Philippines	US
15/01/1986	-	18.00	56.70	-	16.70	-	-	-	13.21	59.60	76.40	47.90	25.50	56.10
--														
15/01/1987	-	20.90	58.40	0.60	18.40	-	-	-	14.29	60.10	75.80	48.90	25.40	56.90
--														
15/01/1988	-	23.90	61.20	1.10	22.80	-	-	10.40	15.61	60.50	76.40	50.40	27.50	59.20
--														
15/01/1989	0.50	27.10	65.30	1.50	25.30	-	-	18.90	16.51	62.60	77.60	52.50	30.00	62.00
--														
15/01/1990	5.60	31.20	71.00	3.30	27.50	-	-	31.30	17.59	63.90	80.70	55.60	33.90	65.20
--														
15/01/1991	11.60	35.70	78.10	6.80	30.50	-	-	37.50	19.31	66.30	83.30	59.10	39.70	68.90
--														
15/01/1992	17.70	41.50	82.10	12.90	33.50	-	-	49.50	21.17	69.20	85.70	62.10	44.00	70.70
--														
15/01/1993	24.80	45.50	85.90	17.10	36.70	-	-	53.90	22.78	72.30	87.90	63.90	47.30	73.00
--														
15/01/1994	33.30	50.00	87.40	20.80	41.30	-	-	58.00	24.69	75.00	89.80	66.90	51.50	74.90
--														
15/01/1995	44.10	54.80	89.60	25.20	46.90	1.40	40.40	60.90	27.05	77.50	92.20	70.20	54.90	77.00
--														
15/01/1996	53.50	58.60	91.20	34.80	51.60	2.60	50.60	66.30	30.04	80.20	93.00	75.20	60.90	79.10
--														
15/01/1997	63.10	64.10	90.80	35.30	54.10	4.50	57.70	70.00	31.42	82.80	94.80	78.60	64.20	81.50
--														
15/01/1998	71.60	67.70	91.60	66.40	58.40	9.10	66.40	76.80	36.43	85.60	96.30	85.30	68.70	82.70
--														
15/01/1999	76.50	73.70	91.40	96.10	62.80	15.00	72.50	75.00	62.34	-	95.30	88.20	76.60	84.10
--														
15/01/2000	84.20	75.70	91.90	75.20	63.00	25.40	77.30	79.50	62.52	-	96.20	88.70	75.30	86.40

Date	Poland	South Africa	Sweden	Sierra Leone	Switzerland	Turkey	Tanzania	Uganda	Indonesia	Malaysia	Singapore	Thailand	Philippines	US
--														
15/01/2001	90.50	81.10	93.30	69.80	72.20	34.50	81.40	83.00	67.70	-	98.10	89.90	80.90	89.70
--														
15/01/2002	93.80	85.20	95.90	74.20	82.00	59.80	84.90	80.20	77.45	-	97.00	90.60	83.90	90.70
--														
15/01/2003	94.10	95.00	98.40	74.10	91.20	75.50	88.70	85.70	84.24	-	97.90	92.70	86.50	93.00
--														
15/01/2004	95.80	95.20	99.10	85.40	95.00	87.80	94.70	89.10	88.30	-	98.60	93.90	89.80	94.80
--														
15/01/2005	99.60	98.00	99.10	93.00	98.10	96.10	98.30	96.70	94.76	98.60	98.90	96.40	97.30	97.60
--														
15/01/2006	100.30	101.90	99.70	96.60	102.70	106.10	104.90	102.60	110.90	101.80	100.70	102.10	103.90	101.50
--														
15/01/2007	101.90	108.00	101.60	106.10	108.90	116.60	112.30	112.00	118.26	105.10	100.90	105.20	107.90	103.60
--														
15/01/2008	106.10	119.20	104.90	120.30	120.50	126.10	121.90	113.60	125.43	107.50	107.60	109.70	113.10	108.10
--														
15/01/2009	109.50	128.90	106.20	133.20	135.30	138.10	138.60	136.70	136.94	111.70	111.20	109.30	121.10	108.10
--														
15/01/2010	113.80	136.90	106.60	152.90	140.80	149.40	147.70	148.80	142.03	113.30	111.40	113.80	126.30	111.00
--														
15/12/2010	116.70	141.20	109.70	173.00	146.30	156.10	153.50	154.40	150.65	115.40	115.60	116.60	129.80	112.20

Note: One sample from each period is reported. The full sample is available upon request.

Appendix 2.10

Exchange Rates & Consumer Price Index: 29-31 of 31 Countries Quarterly, 1973(Q1)-2010(Q4)

Date	EXCHANGE RATES			CONSUMER PRICE INDEX			
	Australia	New Zealand	Papua New Guinea	Australia	New Zealand	Papua New Guinea	US
Q1 1973	1.3464	1.2832	1.3464	13.80	10.20	7.80	22.00
Q2 1973	1.4153	1.3272	1.4153	14.20	10.40	7.90	22.50
Q3 1973	1.4341	1.3790	1.4336	14.70	10.70	8.30	23.00
Q4 1973	1.4826	1.4566	1.4826	15.30	10.90	8.80	23.50
Q1 1974	1.4843	1.4105	1.4843	15.60	11.20	9.30	24.20
Q2 1974	1.4840	1.4580	1.4840	16.30	11.50	10.20	24.90
Q3 1974	1.4703	1.4271	1.4703	17.10	11.90	10.40	25.60
Q4 1974	1.3125	1.3059	1.3125	17.70	12.30	10.50	26.40
Q1 1975	1.3478	1.3364	1.3478	18.40	12.70	10.80	26.80
Q2 1975	1.3417	1.3224	1.3417	19.00	13.20	11.00	27.30
Q3 1975	1.2891	1.1548	1.2891	19.20	13.60	11.20	27.80
Q4 1975	1.2623	1.0491	1.2623	20.20	14.20	11.70	28.30
Q1 1976	1.2569	1.0407	1.2569	20.80	14.80	11.80	28.60
Q2 1976	1.2352	0.9965	1.2352	21.40	15.50	11.90	28.90
Q3 1976	1.2422	0.9965	1.2883	21.80	16.00	12.10	29.40
Q4 1976	1.1664	0.9514	1.2679	23.10	16.40	12.20	29.70
Q1 1977	1.0926	0.9548	1.2384	23.70	16.90	12.30	30.20
Q2 1977	1.1059	0.9630	1.2535	24.20	17.70	12.40	30.90
Q3 1977	1.1108	0.9709	1.2672	24.70	18.30	12.70	31.30
Q4 1977	1.1269	0.9946	1.2969	25.30	19.00	12.90	31.70
Q1 1978	1.1382	1.0226	1.3658	25.60	19.40	13.00	32.20
Q2 1978	1.1363	1.0166	1.3860	26.10	19.80	13.10	33.10
Q3 1978	1.1524	1.0503	1.4407	26.60	20.40	13.40	33.80
Q4 1978	1.1521	1.0616	1.4542	27.30	20.80	13.70	34.50
Q1 1979	1.1317	1.0561	1.4286	27.70	21.40	13.60	35.40
Q2 1979	1.1088	1.0434	1.3918	28.50	22.30	13.80	36.60
Q3 1979	1.1277	1.0131	1.4139	29.10	23.50	14.10	37.80
Q4 1979	1.1035	0.9789	1.3867	30.00	24.30	14.80	38.90
Q1 1980	1.1015	0.9746	1.4427	30.60	25.30	15.20	40.40
Q2 1980	1.1251	0.9717	1.4711	31.50	26.30	15.50	41.90
Q3 1980	1.1619	0.9826	1.5181	32.10	27.30	15.80	42.70
Q4 1980	1.1696	0.9679	1.5346	32.80	28.30	16.50	43.80
Q1 1981	1.1683	0.9396	1.5353	33.50	29.10	16.90	44.90
Q2 1981	1.1445	0.8818	1.4624	34.30	30.30	16.90	46.00
Q3 1981	1.1431	0.8298	1.4552	35.00	31.50	17.00	47.30
Q4 1981	1.1414	0.8286	1.4956	36.40	32.70	17.40	48.00
Q1 1982	1.0868	0.7953	1.4177	37.10	33.70	17.70	48.40
Q2 1982	1.0482	0.7623	1.3804	38.00	35.40	17.60	49.10
Q3 1982	0.9834	0.7327	1.3260	39.30	36.70	18.00	50.00
Q4 1982	0.9511	0.7172	1.2997	40.40	37.70	18.60	50.20
Q1 1983	0.9448	0.7055	1.2937	41.30	38.00	18.90	50.10

Date	EXCHANGE RATES			CONSUMER PRICE INDEX			
	Australia	New Zealand	Papua New Guinea	Australia	New Zealand	Papua New Guinea	US
Q2 1983	0.8744	0.6586	1.1767	42.20	38.40	19.00	50.80
Q3 1983	0.8806	0.6532	1.1590	42.90	38.70	19.40	51.40
Q4 1983	0.9098	0.6581	1.1662	43.90	39.00	20.20	51.80
Q1 1984	0.9306	0.6583	1.1634	43.80	39.40	20.80	52.40
Q2 1984	0.9040	0.6509	1.1496	43.90	40.20	20.50	52.90
Q3 1984	0.8380	0.5169	1.0847	44.40	41.40	20.80	53.50
Q4 1984	0.8457	0.4878	1.0754	45.10	42.70	21.10	53.90
Q1 1985	0.7513	0.4593	1.0076	45.70	44.60	21.40	54.30
Q2 1985	0.6667	0.4551	0.9726	46.80	46.90	21.40	54.90
Q3 1985	0.6979	0.5209	1.0106	47.80	48.10	21.60	55.30
Q4 1985	0.6873	0.5582	1.0094	48.80	49.20	22.00	55.80
Q1 1986	0.7014	0.5253	1.0166	49.90	50.40	22.40	56.00
Q2 1986	0.7130	0.5555	1.0514	50.70	51.70	22.60	55.80
Q3 1986	0.6217	0.5053	1.0230	52.10	53.50	23.00	56.20
Q4 1986	0.6475	0.5096	1.0276	53.60	58.20	23.20	56.60
Q1 1987	0.6711	0.5478	1.0622	54.60	59.60	23.30	57.20
Q2 1987	0.7142	0.5804	1.1123	55.40	61.50	23.30	57.90
Q3 1987	0.7143	0.6054	1.1082	56.40	62.50	23.60	58.60
Q4 1987	0.7039	0.6352	1.1221	57.30	63.80	23.90	59.10
Q1 1988	0.7196	0.6621	1.1138	58.40	64.90	24.40	59.40
Q2 1988	0.7786	0.6834	1.1583	59.40	65.40	24.40	60.20
Q3 1988	0.7995	0.6449	1.1487	60.50	66.00	24.80	61.00
Q4 1988	0.8392	0.6335	1.1942	61.70	66.80	25.70	61.60
Q1 1989	0.8475	0.6193	1.2046	62.30	67.60	26.00	62.30
Q2 1989	0.7777	0.5984	1.1616	63.90	68.40	25.70	63.30
Q3 1989	0.7638	0.5862	1.1506	65.30	70.80	25.80	63.80
Q4 1989	0.7811	0.5900	1.1573	66.50	71.60	26.10	64.50
Q1 1990	0.7659	0.5934	1.0411	67.70	72.30	26.90	65.60
Q2 1990	0.7681	0.5785	1.0294	68.80	73.60	27.60	66.20
Q3 1990	0.8087	0.6088	1.0570	69.30	74.30	27.90	67.40
Q4 1990	0.7825	0.6071	1.0591	71.10	75.10	28.50	68.50
Q1 1991	0.7784	0.5974	1.0543	71.00	75.60	29.20	69.00
Q2 1991	0.7719	0.5846	1.0442	71.10	75.60	29.50	69.40
Q3 1991	0.7820	0.5739	1.0472	71.50	75.90	29.90	70.00
Q4 1991	0.7841	0.5607	1.0560	72.20	75.80	30.10	70.50
Q1 1992	0.7531	0.5437	1.0432	72.20	76.20	30.50	71.00
Q2 1992	0.7584	0.5401	1.0443	72.00	76.40	30.70	71.60
Q3 1992	0.7312	0.5427	1.0391	72.00	76.60	31.00	72.10
Q4 1992	0.6986	0.5259	1.0204	72.40	76.80	31.60	72.70
Q1 1993	0.6875	0.5196	1.0181	73.10	76.90	32.00	73.30
Q2 1993	0.6949	0.5407	1.0298	73.30	77.40	32.10	73.80
Q3 1993	0.6694	0.5507	1.0227	73.70	77.80	32.70	74.10
Q4 1993	0.6686	0.5519	1.0179	73.80	77.90	33.10	74.60

Date	EXCHANGE RATES			CONSUMER PRICE INDEX			
	Australia	New Zealand	Papua New Guinea	Australia	New Zealand	Papua New Guinea	US
Q1 1994	0.7078	0.5697	1.0376	74.10	78.00	32.80	75.10
Q2 1994	0.7246	0.5815	1.0501	74.60	78.20	32.60	75.60
Q3 1994	0.7389	0.6016	1.0289	75.10	79.20	32.90	76.30
Q4 1994	0.7554	0.6219	0.8635	75.70	80.10	35.30	76.60
Q1 1995	0.7489	0.6406	0.8474	76.90	81.00	36.90	77.30
Q2 1995	0.7278	0.6684	0.7895	77.90	81.80	37.50	77.90
Q3 1995	0.7407	0.6625	0.7409	78.90	82.00	40.50	78.30
Q4 1995	0.7485	0.6542	0.7564	79.50	82.40	41.90	78.70
Q1 1996	0.7563	0.6721	0.7448	79.80	82.80	43.30	79.40
Q2 1996	0.7918	0.6815	0.7743	80.40	83.40	43.50	80.20
Q3 1996	0.7884	0.6914	0.7689	80.60	84.00	44.20	80.60
Q4 1996	0.7953	0.7055	0.7470	80.70	84.60	44.10	81.20
Q1 1997	0.7783	0.6971	0.7281	80.80	84.30	44.50	81.70
Q2 1997	0.7692	0.6905	0.7189	80.60	84.40	45.10	82.00
Q3 1997	0.7358	0.6469	0.7074	80.30	84.80	45.80	82.40
Q4 1997	0.6929	0.6176	0.6355	80.50	85.20	46.40	82.70
Q1 1998	0.6659	0.5780	0.5526	80.70	85.40	48.10	82.90
Q2 1998	0.6291	0.5340	0.4881	81.20	85.80	49.30	83.30
Q3 1998	0.5991	0.5084	0.4404	81.40	86.30	52.60	83.70
Q4 1998	0.6235	0.5263	0.4626	81.80	85.60	56.60	84.00
Q1 1999	0.6336	0.5386	0.4520	81.70	85.30	54.90	84.30
Q2 1999	0.6533	0.5427	0.3957	82.00	85.50	56.30	85.10
Q3 1999	0.6506	0.5254	0.3647	82.80	85.80	62.20	85.60
Q4 1999	0.6438	0.5115	0.3630	83.20	86.00	64.00	86.20
Q1 2000	0.6321	0.4986	0.3386	84.00	86.60	65.70	87.00
Q2 2000	0.5900	0.4794	0.3963	84.70	87.20	68.60	87.90
Q3 2000	0.5748	0.4420	0.3779	87.80	88.40	69.80	88.60
Q4 2000	0.5325	0.4095	0.3340	88.10	89.40	70.40	89.10
Q1 2001	0.5319	0.4329	0.3076	89.00	89.30	71.50	90.00
Q2 2001	0.5130	0.4145	0.3172	89.80	90.00	74.00	90.90
Q3 2001	0.5137	0.4197	0.2909	90.00	90.50	76.80	91.00
Q4 2001	0.5119	0.4155	0.2698	90.80	91.10	77.70	90.80
Q1 2002	0.5181	0.4251	0.2709	91.60	91.60	79.00	91.10
Q2 2002	0.5516	0.4643	0.2665	92.30	92.50	80.90	92.10
Q3 2002	0.5478	0.4719	0.2505	92.90	92.80	86.20	92.50
Q4 2002	0.5581	0.4956	0.2414	93.60	93.40	89.20	92.80
Q1 2003	0.5929	0.5495	0.2640	94.80	93.70	95.40	93.70
Q2 2003	0.6405	0.5692	0.2735	94.80	93.70	96.30	94.00
Q3 2003	0.6582	0.5840	0.2909	95.30	94.20	96.30	94.50
Q4 2003	0.7160	0.6263	0.2973	95.80	94.80	96.70	94.50
Q1 2004	0.7655	0.6752	0.3033	96.70	95.20	97.80	95.40
Q2 2004	0.7151	0.6290	0.3111	97.10	95.90	98.10	96.70
Q3 2004	0.7092	0.6532	0.3114	97.50	96.50	97.90	97.10

Date	EXCHANGE RATES			CONSUMER PRICE INDEX			
	Australia	New Zealand	Papua New Guinea	Australia	New Zealand	Papua New Guinea	US
Q4 2004	0.7565	0.6986	0.3158	98.30	97.40	99.00	97.70
Q1 2005	0.7771	0.7161	0.3205	98.90	97.80	97.80	98.30
Q2 2005	0.7685	0.7154	0.3210	99.50	98.70	99.00	99.60
Q3 2005	0.7597	0.6913	0.3238	100.50	99.80	99.50	100.80
Q4 2005	0.7502	0.6946	0.3242	101.00	100.50	103.70	101.30
Q1 2006	0.7395	0.6659	0.3231	101.90	101.10	100.60	101.90
Q2 2006	0.7463	0.6236	0.3249	103.50	102.60	101.40	103.60
Q3 2006	0.7570	0.6348	0.3297	104.40	103.30	104.70	104.20
Q4 2006	0.7706	0.6737	0.3310	104.30	103.10	102.70	103.30
Q1 2007	0.7860	0.6958	0.3300	104.40	103.60	101.70	104.30
Q2 2007	0.8308	0.7410	0.3310	105.70	104.70	102.40	106.30
Q3 2007	0.8474	0.7438	0.3387	106.40	105.20	103.10	106.60
Q4 2007	0.8900	0.7639	0.3501	107.40	106.40	106.00	107.40
Q1 2008	0.9066	0.7904	0.3536	108.80	107.10	109.40	108.60
Q2 2008	0.9435	0.7759	0.3650	110.40	107.10	113.40	111.00
Q3 2008	0.8981	0.7134	0.3829	111.70	108.90	117.00	112.30
Q4 2008	0.6729	0.5786	0.3816	111.40	110.50	118.00	109.10
Q1 2009	0.6638	0.5328	0.3579	111.50	110.00	120.50	108.60
Q2 2009	0.7590	0.6024	0.3555	112.00	110.30	121.00	109.70
Q3 2009	0.8330	0.6738	0.3679	113.10	110.90	123.20	110.50
Q4 2009	0.9095	0.7285	0.3718	113.70	112.40	124.70	110.70
Q1 2010	0.9040	0.7094	0.3658	114.70	112.10	126.50	111.10
Q2 2010	0.8831	0.7015	0.3600	115.40	112.60	128.50	111.70
Q3 2010	0.9034	0.7175	0.3669	116.30	112.80	130.10	111.80
Q4 2010	0.9876	0.7577	0.3790	116.70	114.00	-	112.10

Note: These are the only three countries that do not report monthly CPI.