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Dynamic Linkages among Asian Pacific Exchange Rates 1995 – 2004

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ABSTRACT

This paper analyzes the dynamic interrelationships among the exchange rates of twelve countries in the Asian-Pacific region using Vector Auto regression Models. The exchange rates of the following countries are analyzed: Australia, China, Indonesia, Japan, Malaysia, New Zealand, Philippines, South Korea, Singapore, Taiwan, Thailand, and Vietnam. The daily data spans from May 1995 until the end of 2004. One of the more interesting findings is that the Chinese foreign exchange is not as isolated as one may hypothesize given both the results of the Granger Causality tests and the declared exchange rate policy of the Beijing Government.

JEL Classification: *F0, F3, G0, C3, C5, E4, P0.*

Keywords: *Exchange rates; Asian- Pacific region; Australia, China, Indonesia, Japan, Malaysia, New Zealand, Philippines, South Korea, Singapore, Taiwan, Thailand, and Vietnam; Correlograms; Impulse Responses; Variance Decompositions*.

I. INTRODUCTION

This paper investigates the dynamic linkages among the exchange rate returns of the following Asian-Pacific countries: Australia, China, Indonesia, Japan, Malaysia, New Zealand, Philippines, South Korea, Singapore, Taiwan, Thailand, and Vietnam. The daily data spans from May 1995 until the end of 2004. Vector Auto Regression (VAR) models are used to study the dynamic interrelations among these rates of returns in foreign exchanges. These markets are becoming more and more important as the region takes its appropriate position in the world economy.

The countries studied are reshaping world trade, world finances, global manufacturing, and the entire East-West relationship. As the countries in this region are opening to the world, they are merging their relatively low costs and manpower resources with the financial and technological strengths of wealthier countries such as Australia, Japan, New Zealand, South Korea, and Singapore. Table 1 presents some economic data as well as population figures and government types for the countries in this study.

Table 1a

	GDP (Purch. Power Parity) (2004)	GDP/Capita (Purch Power Parity) (2004)	Population (July 2005 est.)	Govern. Type	Investment (gross fixed) % of GDP (2004)	Inflation rate (cons. prices) (2004)	Unemploy rate (2004)
Australia	$611.7 billion	$30,700	**20,090,437**	democratic, federal-state system recognizing the British monarch as sovereign	25.30%	2.30%	5.10%
China	$7.262 trillion	$5,600	**1,306,313,812**	Communist state	46%	4.10%	9.8% *(1)*
Indonesia	$827.4 billion	$3,500	**241,973,879**	republic	16.60%	6.10%	9.20%
Japan	$3.745 trillion	$29,400	**127,417,244**	constit. monarchy with a parliamentary govern.	24%	-0.10%	4.70%
Malaysia	$229.3 billion	$9,700	**23,953,136**	constitutional monarchy	21.70%	1.30%	3%
New Zealand	$92.51 billion	$23,200	**4,035,461**	parliamentary democracy	22.40%	2.40%	4.20%
Philippines	$430.6 billion	$5,000	**87,857,473**	republic	17%	5.50%	11.70%
South Korea	$925.1 billion	$19,200	**48,422,644**	republic	28.70%	3.60%	3.60%
Singapore	$120.9 billion	$27,800	**4,425,720**	parliamentary republic	27.40%	1.70%	3.40%
Taiwan	$576.2 billion	$25,300	**22,894,384**	multiparty democratic regime headed by popularly-elected president	18%	1.70%	4.50%
Thailand	$524.8 billion	$8,100	**6,544,4371** ***(3)***	constitutional monarchy	22.50%	2.80%	1.50%
Vietnam	$227.2 billion	$2,700	**83,535,576**	Communist state	36.60%	9.50%	1.90%

Table 1b

	Public Debt % of GDP (2004)	Exports (Billion) (2004)	Imports (Billion) (2004)	Reserves of foreign exchange and gold (Billion) (2004)	Debt-external (Billion) (2004)	Currency
Australia	17.40%	$86.89	$98.10	$35.14	$308.70	Australian dollar (AUD)
China	31.40%	$583.10	$552.40	$609.90	$233.30	Yuan (CNY)
Indonesia	56.20%	$69.86	$45.07	$35.82	$141.50	Indonesian rupiah (IDR)
Japan	164.30%	$538.80	$401.80	$664.60	N/A	Yen (JPY)
Malaysia	45.40%	$123.50	$99.30	$55.27	$53.36	Ringgit (MYR)
New Zealand	22.10%	$19.85	$19.77	$4.805 billion	$47.34	New Zealand dollar (NZD)
Philippines	74.20%	$38.63	$37.50	$16.05 billion	$16.05	Philippine peso (PHP)
South Korea	21.30%	$250.60	$214.20	$199.1 billion	$160	South Korean won (KRW)
Singapore	102.50%	$174	$155.20	$112.8 billion	$19.40	Singapore dollar (SGD)
Taiwan	32.40%	$170.50	$165.40	$246.5 billion	$55.50	New Taiwan dollar (TWD)
Thailand	47.60%	$87.91	$80.84	$48.3 billion	$50.59	Baht (THB)
Vietnam	65.90%	$23.72	$26.31	$6.51 billion	$16.55	Dong (VND)

Source: CIA's The World Fact Book,
http://www.cia.gov/cia/publications/factbook/docs/profileguide.html

The reminder of the paper is organized as follows. Section II gives a brief review of the literature. Section III presents the Vector Auto-Regression Model. Section IV describes the data. Sections V through Section VII present the empirical results. Section V presents some diagnostic statistics for the lag structure and residuals tests. Section VI reports the result of the impulse response functions, and Section VII discusses the variance decomposition analysis. Section VIII provides a brief conclusion.

II. A BRIEF LITERATURE REVIEW

Foreign exchange markets have been thoroughly researched by Einzig (1966), Beenstock (1978), Krueger (1983), Weisweiller (1984, 1990), Dornbush (1988), and Walmsley (1992). More recently Manzur (2002), Sarno and Taylor (2002), and Shamah (2003) also have delved into this subject.

Gandolfo (2004) discusses the foreign exchange market, exchange-rate regimes, and the international monetary system using the basic models of international finance and open-economy macroeconomics. Semmler (2004) presents theories, dynamic models, and empirical evidence on the interrelation of the global financial market, economic activity, and the macroeconomy. He incorporates the foreign exchange market and international borrowing and lending into the analysis of the financial market and economic activity. In addition, he discusses exchange-rate volatility and financial crisis.

Gallagher and Taylor (2002) assemble forty-five previously published papers that are selected as important contributions to the study of speculation and financial markets, including foreign exchange market efficiency. Using VAR modeling, Kim, Kim, and Wang (2004) study the macroeconomic effects of capital account liberalization in South Korea. The current paper is the first to study the simultaneous dynamic interrelations among the exchange rates of twelve exchange rates in the Asian-Pacific region.

III. THE VECTOR-AUTO-REGRESSION MODEL

As is currently well-known, economic theory by itself is often incapable to provide a dynamic specification that identifies all these dynamic interrelationships between exchange rates. This issue is further complicated due to the fact that endogenous variables appear on both sides of the estimated equation, hindering appropriate statistical inferences. These problems lead to inferences based on the non-structural approach to modeling the co-movements among several time series. For example, see Pindyck and Rubinfeld (1998) and Sims (1972, 1980, and 1986).

The Vector Autoregression (VAR) is used for analyzing the dynamic impact of random disturbances on the system of variables. The VAR model treats every endogenous variable in the system as a function of the lagged value of all the endogenous variables in the system of equations.

The mathematical representation of a VAR is:

$$y_t = A_1 y_{t-1} + \ldots + A_p y_{t-p} + B\, x_t + \varepsilon_t, \quad (1)$$

where y_t is a *k* vector of endogenous variables, x_t is a *d* vector of exogenous variables, A_1, …, A_p and B are matrices of coefficients to be estimated, and ε_t is a vector of innovations that may be contemporaneously correlated but is uncorrelated with both its own lagged values and all of the right-hand side variables.

Since only lagged values of the endogenous variables appear on the right-hand side of the equations, problems of simultaneity are avoided. In this case, Ordinary Least Squares (OLS) yields consistent estimates. Moreover, even though the innovations may be contemporaneously correlated, OLS is efficient and equivalent to Generalized Least Squares (GLS) because all of the estimated equations in the system have the same right-hand side variables.

The determinant of the residual covariance (degree of freedom adjusted) is computed as:

$$|\hat{\Omega}| = \det \{[1/(T - p)] \sum_t \hat{\varepsilon}_t \hat{\varepsilon}'_t\} \quad (2)$$

where p is the number of parameters per equation in the VAR. The unadjusted calculation ignores p. The log likelihood value is computed assuming a multivariate normal (Gaussian) distribution as:

$$£ = -(T/2)\{k(1 + \log 2\pi) + \log|\Omega\hat{}|\} \quad (3)$$

The two information criteria are computed as:

$$AIC = -2\ £/\ T + 2n/T \quad (4)$$

and

$$SC = -2\ £/\ T + n\ \log T/T, \quad (5)$$

where $n = k(d + pk)$ is the total number of estimated parameters in the VAR. These information criteria are used for model selection such as determining the lag length of the VAR, with preference for smaller values of the information criterion (see Akaike, 1973 and Schwarz, 1968). It is worth noting that some reference sources may define the AIC/SC differently, either omitting the "inessential" constant terms from the likelihood, or not dividing by T (see Grasa, 1989 and Lütkepohl, 1991).

IV. DESCRIPTION OF THE DATA

The database includes daily exchange rates of the following twelve countries to the U.S. dollar: Australia, China, Indonesia, Japan, Malaysia, New Zealand, Philippines, South Korea, Singapore, Taiwan, Thailand, and Vietnam. The data is compiled from DataStream (with the exception of Vietnam, for which the data comes from the Central Bank of Vietnam). Table 2 presents the codes for the data from DataStream. The data spans from May 1995 to December 31, 2004. For each exchange rate, daily returns, r_t, are computed as the first differences of the natural logarithms of P_t, the daily close values of the indices, $r_t = (\ln P_t - \ln P_{t-1})*100$.

Table 2
Source of data and codes in DataStream

AUSTRALIAN $ TO US $(BBI) - EXCHANGE RATE	Code BBAUDSP
CHINESE YUAN TO US $(WMR) - EXCHANGE RATE	Code CHIYUA$
INDONESIAN RUPIAH TO US $ (GTIS) - EXCHANGE RATE	Code USINDON
JAPANESE YEN TO US $(BBI) - EXCHANGE RATE	Code BBJPYSP
MALAYSIAN RINGGIT TOUS $ (BBI) - EXCHANGE RATE	Code BBMYRSP
NEW ZEALAND $ TO US $ (BBI) - EXCHANGE RATE	Code BBNZDSP
PHILIPPINE PESO TO US $ (PH) - EXCHANGE RATE	Code PHUSDSP
SINGAPORE $ TO US $ (BBI) - EXCHANGE RATE	Code BBSGDSP
SOUTH KOREAN WON TO US $ (GTIS) - EXCHANGE RATE	Code USSKORW
TAIWAN NEW $ TO US $(WMR) - EXCHANGE RATE	Code TAIWDO$
THAI BAHT TO US $ (GTIS) - EXCHANGE RATE	Code USTHAIB
VIETNAMESE DONG TO US $ EXCHNAGE RATE	Central Bank of Vietnam Data Base

V. EMPIRICAL RESULTS

A few tests to check the suitability of the estimated VAR are performed. It is assumed that the constants are the only exogenous variables in the system of equations. The results on the lag structure of the estimated VAR are reported in Section V.I. Sub-section V.2 reports the test statistics of the Residual Test.

A. Lag Structure

A few tests of the lag structures were conducted.

1. Lag Exclusion Tests

For each lag in the VAR, the χ^2 Wald – statistics for the joint significance of all exogenous variables at that lag are calculated for each equation both separately and jointly.

2. Autoregression (AR) Roots

The inverse roots of the characteristic AR polynomial are calculated. The estimated VAR is stable, or stationary, if all roots have modulus less than one and lie inside the unit circle. If the VAR is not stable, certain results, including the impulse response standard errors, are not valid. The examination of all roots reveals that no root lies outside the unit circle. Thus, the VAR satisfies the stability condition. These results are available from the author upon request.

3. Lag Length Criteria

Various tests for selecting the lag order of the unrestricted VAR are performed. All these criteria are discussed in Lütkepohl (1991, Section 4.3). The sequential modified likelihood ratio (LR) test is carried out by starting from the maximum lag, and testing the hypothesis that the coefficients on lag ζ are jointly zero using the χ^2 statistics:

$$LR = (T - m)\{\log|\Omega_{\zeta -1}| - \log|\Omega_{\zeta}|\} \sim \chi^2(k^2), \quad (6)$$

where m is the number of parameters per equation under the alternative. Sims' (1980) small sample modification uses (T – m) rather than T. Based on the different tests, the lag length chosen for this study is 108 lags. Each equation consists of 108 lagged values of all 12 foreign exchanges plus a constant, i.e., 108*12 + 1 = 1297 parameters to be estimated.

Experiments with lower number of lags show that some results are sensitive to the number of lags chosen. It appears that when studying foreign exchange daily data versus stock markets data, the number of lags required to capture the dynamic of the interrelationships is enormous. For example, studying different stock markets, Friedman and Shachmurove (1996, 1997) and Shachmurove (1996, 2005) found that 25 lags are sufficient to represent the dynamic character of the data. Some Portmanteau Autocorrelation tests performed based on the computation of multivariate Box-Pierce/

Ljung-Box Q-Statistics for residual serial correlation show that lags up to 519 may be necessary. This issue is left for further research.

4. Pairwise Granger Causality Tests

This section reports the test statistics for pairwise causality tests and tests whether an endogenous variable can be treated as exogenous. For each equation of the 108-lag VAR, the output displays χ^2 Wald – statistics for the joint significance of each of the other lagged endogenous variables in that equation. The statistics in the last raw (ALL) is the χ^2 Wald statistic for joint significance of all other lagged endogenous variables in the equation. The tests indicate whether a variable, for example, the return in the Australian foreign exchange market Vis-à-vis the U.S. dollar, can help forecast the foreign exchange return of the Indonesian currency one step ahead. It is worth noting that the Australian return can still affect, for example, the Indonesian return through other equations in the system. An important advantage of this test is that it is insensitive to the order of the equations in the VAR system.

Table 3 presents the results for the VAR Granger Causality/Block Exogeneity Wald Tests. The statistics in the last raw (ALL) presents the χ^2 Wald statistic that tests for joint significance of all other lagged endogenous variables in the equation. Only China shows no joint significance of all other lagged variables in the Chinese equation. All other countries' exchange rates show that, jointly, the effects of other exchange rates are significant. It is clear from the table that China has pursued a different foreign exchange policy as compared with its Asian – Pacific neighbors.

Table 3
VAR Granger causality/block exogeneity Wald Tests, rates of returns

	AUS	CHI	IND	JAP	MAL	NWZ	PHP	SKOR	SPR	TAI	THA	VIE
AUS	N/A	0.65	0.19	0.17	0.02	0.04	0.41	0.19	0.02	0.12	0.56	0.05
CHI	0.54	N/A	0.97	0.85	1	0.92	1	1	0.76	0.98	1	1
IND	0.87	1	N/A	0.09	0	0.43	0	0	0	0	0.05	0
JAP	0.15	0.45	0.03	N/A	0	0.21	0	0.03	0.02	0.01	0.06	0.01
MAL	0.86	0.96	0	0.02	N/A	0.86	0	0	0	0	0	0
NWZ	0.85	0.96	0.23	0.39	0.09	N/A	0.11	0.02	0.17	0.04	0.96	0
PHP	0.93	1	0	0.39	0	0.84	N/A	0	0.2	0.03	0.03	0
SKOR	0.63	0.91	0	0.93	0	0.97	0	N/A	0.13	0	0	0
SPR	0.34	0.02	0.05	0.64	0	0.22	0.08	0.21	N/A	0.7	0.3	0
TAI	0.69	1	0	0.59	0	0.61	0	0	0.31	N/A	0.3	0
THA	0.52	0.97	0	0.68	0	0.79	0	0	0	0	N/A	0
VIE	0.28	1	0	0	0	0.32	0	0	0	0	0	N/A
All	0	1	0	0	0	0	0	0	0	0	0	0

Sample: 5/04/1995 12/31/2004, Included observations: 2413, Chi-sq df = 108

Table 3 also shows that Australia is not significantly affected by any other specific exchange rate market. The Indonesian market is affected by all other foreign exchanges except those of China and New Zealand. Japan is significantly affected by only Malaysia, Vietnam and Indonesia (with probability of about 9 percent). The Malaysian foreign exchange is affected by all markets except those of China and New Zealand (probability of 9 percent for the latter). The New Zealander foreign exchange is affected only by the Australian exchange rate. The Philippines, South Korean, and Taiwanese markets are affected by all markets except the Australian, Chinese and Singaporean ones. The Singaporean market is affected by the Australian, Indonesian, Japanese, Malaysian, Thailand, and Vietnamese markets. The Thai market is affected by all except the Australian, Chinese, New Zealand, Singaporean and Taiwanese markets. The Vietnamese market is affected by all markets except the Chinese foreign exchange.

B. Residual Tests – Correlograms

Table 4 displays the pairwise cross-correlograms, or sample autocorrelations, for the estimated residuals in the VAR for lag zero. The VAR Residual Cross-Correlations shows that, in general, the pairwise cross correlograms are small. Exceptions to this finding include the results for Australia and New Zeeland (0.76). Again, China stands out as the country with relatively very low cross correlations. This is true for Vietnam as well. The Singaporean foreign exchange shows pairwise correlations that seem to be high. For example, correlations include: 0.47 with the Japanese currency, about 0.32 with the Australian and New Zealand currencies, and just above 0.2 with Indonesian, Malaysian, South Korean, Taiwanese and Thailand currencies.

Table 4
VAR residual cross-correlations, pairwise cross-correlograms, rates of returns

	AUS	CHI	IND	JAP	MAL	NWZ	PHP	SKOR	SPR	TAI	THA	VIE
AUS	1.00	-0.01	0.07	0.19	0.00	0.76	0.02	0.09	0.32	0.12	0.11	-0.05
CHI		1.00	0.04	-0.06	-0.04	-0.02	0.00	0.02	-0.08	-0.05	-0.01	0.02
IND			1.00	0.07	0.24	0.04	0.05	0.08	0.21	0.08	0.20	-0.04
JAP				1.00	0.05	0.22	-0.02	0.19	0.47	0.19	0.16	-0.05
MAL					1.00	0.00	0.06	0.11	0.24	0.06	0.16	0.00
NWZ						1.00	-0.01	0.09	0.33	0.10	0.11	-0.02
PHP							1.00	-0.02	0.01	0.07	-0.03	0.00
SKOR								1.00	0.20	0.17	0.12	0.00
SPR									1.00	0.23	0.26	-0.01
TAI										1.00	0.13	-0.03
THA											1.00	-0.04
VIE												1.00

VI. IMPULSE RESPONSES

For example, a shock to the Australian exchange rate not only directly affects the Australian exchange rate, but is also transmitted to all of the other endogenous exchange rates of the different countries through the dynamic lagged structure of the VAR. The impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous exchange rates.

If the innovations ε_t are contemporaneously uncorrelated, interpretation of the impulse response is as follows: The i-th innovation $\varepsilon_{i,t}$ is simply a shock to the i-th endogenous variable $y_{i,t}$. However, innovations are generally correlated, and may be viewed as having a common component which cannot be associated with a specific variable. In order to interpret the impulses, it is common to apply a transformation P to the innovations so that they become uncorrelated, i.e.,

$$v_t = P\,\varepsilon_t \sim (o, D), \tag{6}$$

where D is a diagonal covariance matrix.

The results are presented in Figures 1–3, which are available from the authors upon request. Figure 1 and Figure 2 show the impulse responses, 100-period ahead. Figure 1 presents the multiple graphs, using Monte Carlo simulations with 100 repetitions. Figure 2 plots the impulse responses with combined graphs. For stationary VARs, the impulse responses should die out to zero. Figures 1 and Figure 2 confirm that this is indeed the case for the VAR studied in this paper.

Figure 3 presents the accumulated impulses responses with multiple graphs using Monte Carlo simulations with 100 repetitions. The figure also contains the plus/minus two standard error bands about the impulse responses. For stationary VARs, the accumulated impulse responses should converge to some non-zero constant. These are the cases in all the displays of Figure 3.

VII. VARIANCE DECOMPOSITION

Whereas the impulse response functions trace the effect of a shock to one exchange rate on the other exchange rates in the VAR model, the variance decomposition separates the variation in one exchange rate into the component shocks to the VAR. This way, the variance decomposition provides information about the relative importance of each random innovation in affecting the exchange rates present in the VAR.

Table 5 displays a separate variance-decomposition for each exchange rate. The second column, labeled "S.E.", contains the forecast error of the variable at the given forecast horizon. The source of this forecast error is the variation in the current and future values of the innovations to each exchange rate in the VAR. The remaining columns give the percentage of the forecast variance due to each innovation, with each row adding up to 100 percent. The impulse responses and the variance decomposition based on the Cholesky factor can change dramatically if one alters the ordering of the variables in the VAR.

Table 5 presents the results. To save space, the results are given only for 10, 20, 30 step ahead forecasts up to 100 periods ahead. The table shows that, after 100 periods, the exchange rates of Australia and Japan are affected by their neighbors by about 40 percent. The relatively independent market of China is now being affected by 32 percent by its neighbors. Japan is being affected by 41 percent by its neighbors; others include: Thailand by 50 percent, the Philippines, South Korea, and Taiwan, each by 60 percent, Vietnam by 63 percent, Indonesia by 65 percent, New Zealand by 72 percent (with 39 percent being the effect of the Australian market alone), and Malaysia by 73 percent. The Singaporean exchange rate is being affected by almost 70 percent from innovations in other exchange rates in the Asian -Pacific region. The main conclusion one can draw from Table 5 is the fact that the Chinese foreign exchange is not as isolated as one may hypothesize given the presence of the Granger Causality tests and the declared exchange rate policy of the Beijing Government.

VIII. CONCLUSION

This paper uses VAR modeling to study the dynamic interrelationships among exchange rates for twelve countries in the Asian-Pacific region. The model uses daily observations spanning from May 1995 to the end of 2004.

One interesting and surprising result is the number of lags required to capture the dynamics of the data. There are 108 lags in this study. In addition, it is found that the Chinese foreign exchange is not as isolated as one may hypothesize given both the results of the Granger Causality tests and the declared exchange rate policy of the Chinese government. Moreover, all these markets show high level of dependency, ranging from 40 percent for the large economies of Australia and Japan to more than 70 percent for the smaller economies in the region. In this respect, the paper presents the first step in studying the newly emerging economies of the Asian- Pacific region.

Table 5
Variance decomposition, rates of returns

	Period	S.E.	AUS	CHI	IND	JAP	MAL	NWZ	PHP	SKOR	SPR	TAI	THA	VIE
AUS	5	0.67	96.32	0.05	0.20	1.25	0.42	0.58	0.10	0.15	0.35	0.23	0.32	0.04
	10	0.69	91.83	0.37	0.78	1.71	0.67	0.96	0.41	0.50	0.99	0.74	0.69	0.36
	20	0.71	85.57	0.85	0.94	2.43	1.26	1.31	0.89	1.09	1.81	1.70	1.48	0.67
	30	0.73	81.12	1.61	1.19	2.95	1.42	1.65	1.71	1.33	1.86	2.07	2.08	1.00
	40	0.76	77.37	1.95	1.32	3.13	1.59	2.33	2.10	1.49	2.48	2.32	2.46	1.44
	50	0.77	74.64	2.31	1.44	3.21	1.74	2.83	2.23	1.79	2.69	2.65	2.77	1.70
	60	0.79	72.15	2.61	1.66	3.53	1.96	2.99	2.45	1.93	2.75	2.89	3.05	2.02
	70	0.81	69.54	3.07	1.93	3.53	2.04	3.53	2.99	2.12	2.85	3.02	3.12	2.28
	80	0.82	67.58	3.08	1.99	3.68	2.17	3.63	3.18	2.45	3.20	3.20	3.40	2.42
	90	0.84	65.57	3.29	2.12	3.86	2.32	3.76	3.24	2.84	3.24	3.42	3.73	2.61
	100	0.85	63.75	3.70	2.24	3.92	2.38	3.89	3.36	2.96	3.53	3.70	3.89	2.68
CHI	5	0.10	0.20	97.64	0.09	0.27	0.66	0.16	0.11	0.16	0.27	0.15	0.21	0.07
	10	0.10	0.57	94.81	0.13	0.61	0.76	0.29	0.35	0.21	1.15	0.29	0.33	0.51
	20	0.10	0.86	88.83	0.84	1.60	1.39	0.97	0.61	0.83	1.87	0.77	0.65	0.78
	30	0.11	1.13	84.22	1.09	2.26	1.37	1.45	0.76	1.74	2.49	0.93	1.49	1.07
	40	0.11	1.34	80.70	1.33	3.07	1.46	1.97	1.00	2.19	2.81	1.13	1.68	1.33
	50	0.11	1.82	77.71	1.40	3.25	1.47	2.39	1.13	2.49	3.70	1.34	1.74	1.56
	60	0.12	2.02	75.29	1.51	3.84	1.62	2.87	1.24	2.62	3.98	1.52	1.94	1.56
	70	0.12	2.36	73.48	1.61	4.18	1.70	2.96	1.28	2.68	4.40	1.72	1.99	1.64
	80	0.12	2.57	71.05	1.78	4.40	1.93	3.11	1.37	3.00	4.97	2.07	2.12	1.61
	90	0.12	2.78	69.69	1.86	4.77	2.04	3.26	1.51	3.05	5.14	2.07	2.20	1.63
	100	0.12	3.24	68.06	2.00	4.70	2.13	3.61	1.50	3.22	5.33	2.29	2.27	1.64
IND	5	1.23	1.53	0.21	89.90	0.57	2.09	0.31	0.60	1.59	0.42	0.17	0.32	2.30
	10	1.29	2.26	0.39	83.06	1.01	3.37	0.55	1.40	2.13	0.97	1.33	0.75	2.79

	20	1.41	2.34	1.10	72.00	1.77	4.05	1.26	2.12	6.21	1.49	2.74	1.20	3.69
	30	1.51	2.24	1.42	64.75	1.69	5.25	1.81	2.49	7.37	1.91	4.09	2.45	4.54
	40	1.62	2.26	1.80	57.80	2.43	5.47	2.09	4.05	9.29	2.28	4.20	3.56	4.77
	50	1.73	2.19	1.72	51.67	2.65	7.03	2.15	4.23	10.05	3.09	5.30	4.70	5.22
	60	1.85	2.24	1.68	46.97	2.51	9.39	2.70	4.06	10.48	3.45	6.08	5.03	5.43
	70	1.95	2.27	1.76	42.69	2.50	10.49	2.69	4.67	12.02	3.49	6.30	5.81	5.33
	80	2.06	2.37	1.75	39.23	2.66	12.11	2.79	5.52	11.43	3.74	6.62	6.18	5.61
	90	2.13	2.57	1.93	37.21	2.89	12.26	3.12	6.07	11.21	3.81	6.92	6.48	5.54
	100	2.20	2.78	1.96	35.87	3.17	12.40	3.15	5.97	11.34	4.16	6.78	6.87	5.55
JAP	5	0.64	4.00	0.45	0.76	92.84	0.04	0.38	0.10	0.03	0.35	0.41	0.40	0.24
	10	0.65	4.53	0.60	1.43	89.48	0.26	0.79	0.54	0.41	0.36	0.47	0.63	0.52
	20	0.69	4.45	1.02	2.44	81.27	0.98	1.65	1.49	1.01	1.09	1.10	2.22	1.28
	30	0.72	4.52	1.65	2.94	76.18	1.53	2.08	2.66	1.23	1.43	1.65	2.53	1.60
	40	0.74	4.53	1.94	3.01	73.19	1.80	2.77	2.89	1.50	1.95	1.86	2.76	1.80
	50	0.75	4.79	2.10	3.48	70.22	2.02	3.01	3.13	1.84	2.02	2.30	2.89	2.18
	60	0.77	5.01	2.44	3.61	67.83	2.32	3.22	3.21	2.01	2.41	2.42	3.24	2.28
	70	0.79	5.13	2.71	3.88	65.28	2.34	3.34	3.31	2.15	2.65	2.87	3.22	3.12
	80	0.80	5.16	2.75	4.09	63.46	2.41	3.50	3.79	2.27	2.92	3.14	3.20	3.31
	90	0.82	5.53	2.82	4.30	60.92	2.50	4.01	4.18	2.40	3.20	3.32	3.38	3.44
	100	0.84	5.51	3.46	4.29	59.00	2.46	4.18	4.42	2.51	3.33	3.79	3.73	3.33
MAL	5	0.25	0.11	0.54	6.05	0.28	85.69	0.12	0.86	2.81	0.38	0.90	0.15	2.10
	10	0.28	0.89	0.63	6.33	0.66	76.49	0.67	2.19	3.47	0.47	1.35	3.45	3.39
	20	0.32	1.63	0.87	8.52	0.88	62.98	1.08	2.57	4.39	2.87	2.30	6.59	5.32
	30	0.36	1.66	1.36	11.39	1.81	53.12	1.09	3.87	6.73	2.93	2.66	8.31	5.07
	40	0.39	1.80	1.78	11.28	2.11	45.94	1.28	4.14	10.41	3.29	3.43	9.41	5.13
	50	0.43	1.82	1.83	10.89	2.73	39.96	1.82	4.95	11.19	3.76	3.51	11.69	5.85
	60	0.45	1.92	1.98	10.42	2.86	35.98	1.93	5.14	12.48	3.47	4.36	14.05	5.42

	70	0.50	2.42	1.76	8.89	2.59	31.60	2.00	6.62	13.53	3.29	4.79	17.14	5.36
	80	0.53	2.57	1.82	8.96	2.66	30.60	2.03	7.14	12.60	3.26	5.20	16.99	6.15
	90	0.57	2.46	1.83	8.97	2.80	28.98	2.41	7.31	11.95	3.41	6.00	17.93	5.94
	100	0.60	2.68	1.80	8.94	2.98	27.44	2.78	7.20	11.96	3.31	6.24	18.69	5.98
NWZ	5	0.69	56.62	0.17	0.37	0.98	0.21	40.42	0.22	0.19	0.36	0.25	0.16	0.06
	10	0.71	54.23	0.39	0.65	1.69	0.62	38.66	0.70	0.69	0.94	0.54	0.42	0.49
	20	0.74	50.64	0.64	0.76	2.64	1.33	36.63	1.18	0.95	1.32	1.35	1.90	0.67
	30	0.76	48.25	1.09	1.06	3.03	1.66	34.62	1.98	1.55	1.47	1.57	2.86	0.87
	40	0.78	46.43	1.47	1.47	3.51	1.76	33.27	2.24	1.78	1.87	1.87	3.10	1.23
	50	0.80	45.20	1.82	1.71	3.59	2.05	31.98	2.46	1.94	2.33	2.25	3.18	1.48
	60	0.82	43.61	1.97	2.00	3.65	2.35	30.76	3.01	2.14	2.53	2.57	3.67	1.73
	70	0.84	42.20	2.14	2.38	3.59	2.48	30.24	3.44	2.24	2.58	3.05	3.67	1.98
	80	0.86	41.02	2.37	2.52	3.69	2.61	29.42	3.59	2.47	2.97	3.44	3.72	2.18
	90	0.87	40.05	2.62	2.64	3.91	2.67	28.87	3.67	2.67	3.03	3.56	3.82	2.47
	100	0.89	38.96	3.09	2.73	3.98	2.66	28.13	3.65	2.95	3.48	4.02	3.83	2.52
PHP	5	0.47	0.53	0.04	2.35	1.48	1.89	0.30	88.23	1.34	1.43	0.80	1.13	0.49
	10	0.50	0.74	0.23	2.51	2.01	2.37	0.93	78.68	1.90	1.61	1.27	6.84	0.90
	20	0.56	1.57	0.63	4.13	2.08	5.81	1.57	66.38	2.44	1.91	2.40	9.53	1.55
	30	0.59	2.21	1.45	4.37	2.13	6.57	2.38	59.97	2.85	2.19	2.95	10.22	2.70
	40	0.61	3.04	1.41	4.46	2.81	6.58	3.18	56.03	3.57	2.36	2.99	10.78	2.78
	50	0.64	3.50	1.42	4.55	3.09	6.62	3.38	52.12	4.52	2.40	3.85	11.43	3.12
	60	0.67	3.69	1.59	4.59	3.43	6.64	3.63	49.58	5.07	2.53	4.02	11.79	3.44
	70	0.69	3.70	1.77	4.78	3.60	6.98	3.94	46.45	5.30	2.49	4.39	13.19	3.42
	80	0.72	3.75	1.74	4.78	3.69	6.96	3.97	43.97	6.21	2.73	4.66	14.07	3.47
	90	0.74	3.86	1.70	4.91	4.01	6.67	4.59	41.96	6.07	2.87	5.35	14.51	3.49
	100	0.75	3.95	1.84	4.93	4.21	6.64	5.13	40.27	6.13	3.39	5.32	14.33	3.85
SKOR	5	0.61	1.65	0.41	1.27	3.55	1.20	0.12	0.33	89.38	0.04	0.51	1.11	0.43

	10	0.64	1.57	0.41	1.71	3.91	2.43	1.03	1.16	82.51	0.39	1.27	2.46	1.15
	20	0.70	1.93	0.86	2.40	3.76	4.98	1.58	2.13	73.91	0.89	2.16	2.79	2.62
	30	0.75	2.51	1.29	3.27	3.78	6.90	2.30	2.80	66.73	1.30	2.66	2.89	3.56
	40	0.80	2.91	1.36	4.71	4.10	8.31	2.54	2.76	60.27	1.63	4.38	3.30	3.72
	50	0.86	2.92	1.68	4.31	4.05	8.91	2.85	3.20	54.97	2.25	6.57	4.31	3.98
	60	0.90	3.13	1.76	4.61	4.16	11.24	2.91	4.19	50.02	2.57	6.89	4.63	3.90
	70	0.94	3.56	1.78	4.68	4.06	11.50	3.01	4.87	47.87	3.09	6.79	4.87	3.92
	80	0.98	3.57	1.89	4.91	4.04	12.15	3.10	5.10	44.50	3.11	7.52	5.78	4.35
	90	1.01	4.14	1.93	4.85	4.11	12.84	3.19	5.06	42.19	3.21	7.45	6.68	4.35
	100	1.05	4.09	2.17	5.16	4.27	12.67	3.31	5.41	39.22	3.73	8.03	7.51	4.44
SPR	5	0.28	10.55	0.68	3.82	15.38	3.79	1.07	0.35	0.82	61.12	0.41	0.72	1.30
	10	0.29	10.60	0.82	3.97	15.18	4.58	1.45	0.56	1.03	58.55	0.49	0.81	1.96
	20	0.31	10.02	1.66	4.87	13.70	6.81	1.56	1.40	2.11	51.11	1.17	2.75	2.85
	30	0.32	9.32	2.06	5.75	12.68	6.80	2.13	1.93	2.79	46.55	1.72	4.89	3.38
	40	0.34	9.16	2.18	5.95	12.70	6.67	2.19	2.37	3.96	43.65	2.12	5.17	3.87
	50	0.35	9.07	2.33	5.97	12.20	6.85	3.11	2.64	4.60	40.47	2.53	5.76	4.46
	60	0.36	8.93	2.26	5.78	11.63	7.53	3.21	2.97	5.24	38.64	2.82	6.44	4.56
	70	0.38	8.60	2.28	5.75	11.48	7.74	3.36	3.62	5.61	36.35	3.47	6.49	5.26
	80	0.39	8.60	2.38	5.94	11.53	7.96	3.28	4.43	5.38	34.57	3.96	6.62	5.33
	90	0.40	8.80	2.42	6.12	11.24	8.05	3.31	4.93	5.34	33.32	4.09	6.77	5.60
	100	0.41	8.43	2.72	6.39	10.88	8.61	3.64	5.32	5.32	31.67	4.42	7.13	5.49
TAI	5	0.22	2.95	0.61	1.21	5.22	0.69	0.19	0.66	2.09	1.63	83.75	0.52	0.48
	10	0.23	3.33	0.75	1.47	5.82	1.59	1.39	1.26	2.36	2.36	78.18	0.54	0.93
	20	0.25	3.70	1.12	2.42	6.00	3.56	1.79	1.75	3.50	2.60	70.11	1.73	1.73
	30	0.26	3.78	1.60	3.11	5.93	4.07	2.73	2.12	4.36	2.80	64.11	3.50	1.87
	40	0.27	4.00	2.02	3.87	6.40	4.77	3.16	2.09	4.64	3.14	59.87	3.81	2.23
	50	0.28	4.27	2.16	4.14	6.65	5.03	3.16	2.05	5.04	3.67	57.38	4.17	2.28

	60	0.29	4.49	2.42	4.19	6.73	5.46	3.23	2.26	5.57	3.67	55.06	4.49	2.43
	70	0.30	4.75	2.88	4.25	6.95	5.53	3.28	2.98	5.52	3.84	51.84	4.93	3.26
	80	0.32	4.45	2.81	4.26	6.44	5.12	3.27	3.91	4.99	3.51	47.15	10.77	3.33
	90	0.33	4.49	2.98	4.30	6.30	5.22	3.54	4.47	4.66	3.45	43.59	13.52	3.46
	100	0.34	4.48	3.04	4.36	6.41	5.24	4.01	5.19	4.53	3.44	41.45	14.30	3.53
THA	5	0.68	2.26	0.33	3.61	2.08	1.80	0.57	1.09	0.73	1.96	0.44	83.95	1.18
	10	0.71	2.42	0.50	3.76	2.01	3.15	0.85	1.21	0.90	2.09	1.08	80.44	1.59
	20	0.75	2.89	0.63	3.75	2.71	4.93	1.24	2.18	2.26	2.52	1.50	73.36	2.03
	30	0.80	3.24	0.86	5.28	2.81	5.85	1.66	2.50	3.90	2.77	1.87	66.51	2.75
	40	0.83	3.20	1.00	5.45	3.61	6.43	2.37	3.21	4.28	2.73	2.27	62.62	2.83
	50	0.85	3.59	1.15	5.45	3.59	6.46	2.54	3.74	4.68	2.94	2.51	60.35	2.98
	60	0.88	3.79	1.59	5.61	3.65	6.92	2.58	3.94	5.25	2.86	2.78	57.92	3.09
	70	0.91	4.02	1.62	5.67	3.84	7.09	2.66	3.96	6.02	2.87	2.84	56.27	3.14
	80	0.93	3.96	1.68	5.77	3.81	7.29	2.70	4.19	6.24	3.23	3.20	54.46	3.47
	90	0.95	4.01	1.72	5.75	4.00	7.29	2.72	4.39	6.31	3.47	3.53	53.40	3.41
	100	0.97	4.24	1.71	6.18	4.34	7.50	2.96	4.51	6.45	3.58	3.67	51.40	3.46
VIE	5	1.99	0.31	0.35	1.21	0.33	3.27	0.44	0.67	0.09	0.61	0.33	0.57	91.81
	10	2.09	0.58	0.43	3.24	0.71	3.26	0.95	1.75	0.47	1.26	1.45	1.29	84.61
	20	2.34	1.28	0.51	4.50	1.92	4.93	2.17	2.06	2.96	3.47	2.07	2.18	71.96
	30	2.54	1.38	0.62	6.16	2.10	7.33	2.04	2.20	3.63	3.36	2.34	2.17	66.66
	40	2.77	1.38	0.79	11.95	2.28	7.75	2.65	2.32	4.33	3.27	3.75	2.00	57.53
	50	2.98	1.42	0.79	13.53	2.49	12.61	2.52	2.22	4.45	3.05	3.56	2.22	51.15
	60	3.09	1.79	0.95	13.61	2.41	12.52	2.84	2.32	5.27	3.25	4.25	2.40	48.40
	70	3.23	1.96	1.02	12.85	2.45	13.52	3.09	2.74	6.10	3.46	4.51	2.69	45.62
	80	3.39	2.10	1.04	12.69	2.54	14.73	3.01	3.20	6.88	3.39	5.18	2.97	42.28
	90	3.52	2.29	1.05	13.55	2.45	15.62	3.28	3.16	7.23	3.80	5.09	3.01	39.48
	100	3.65	2.28	1.14	12.77	2.61	15.98	3.26	3.27	7.94	3.83	5.62	3.85	37.44

REFERENCES

Akaike, H., 1973, "Information Theory and the Extension of the Maximum Likelihood Principle," in *2nd International Symposium on Information Theory,* B.N. Petrov and F. Csaki, eds., Budapest.

Beenstock, Michael, 1978, *The Foreign Exchanges: Theory, Modeling, Policy.* New York, NY: St. Martin's Press.

Central Intelligence Agency, "The World Fact Book", available on line at http://www.cia.gov/cia/publications/factbook/docs/profileguide.html

Dornbusch, Rudiger, 1998, *Exchange Rates and Inflation*. Cambridge, MA and London, England: The MIT Press.

Einzig, Paul**,** 1996, A Textbook on Foreign Exchange. New York, NY: St. Martin's Press, (London, Melbourne, Toronto: Macmillan)

Gallagher, Liam A. and Taylor, Mark P. Ed., 2002, "Speculation and Financial Markets," Volume I and II, Elgar Reference Collection. *International Library of Critical Writings in Economics, vol. 143.* Cheltenham, U.K. and Northampton, Mass.: Elgar; distributed by American International Distribution Corporation, Williston, Vt.

Gandolfo, Giancarlo, 2004, *Elements of International Economics*. Heidelberg and New York: Springer, pp. xv, 341.

Grasa, Antonio Aznar, 1989, *Econometric Model Selection: A New Approach*, Dordrecht: Kluwer Academic Publishers.

Friedman, Joseph and Shachmurove, Yochanan, 1996, "International Transmission of Innovations Among European Community Stock Markets" in *Research in International Business and Finance*, edited by John Doukas, JAI Press, Greenwich, CT, Vol. 13, pp. 35-64.

Friedman, Joseph and Shachmurove, Yochanan, 1997, "Co-Movements of Major European Community Stock Markets: A Vector Autoregression Analysis," *Global Finance Journal*, Vol. 8(2), 257-277, Fall/Winter.

Kim, Soyoung, Kim, Sunghyun Henry and Wang, Yungjong, 2004, "Macroeconomic Effects of Capital Account Liberalization: The Case of Korea," *Review of Development Economics*, vol. 8, no. 4, November, pp. 624-39.

Krueger, Anne O., 1983, *Exchange-rate Determination*. New York, NY: Cambridge University Press.

Lütkepohl, Helmut, 1991, *Introduction to Multiple Time Series Analysis*. New York: Springer-Verlag.

Manzur, Meher, 2002, *Exchange Rates, Interest Rates and Commodity Prices*. Northampton, MA: Edward Elgar Publishing Limited.

Pindyck, Robert S. and Rubinfeld, Daniel L., 1998*, Econometric Models and Economic Forecast.* Fourth Edition, Irwin/McGraw-Hill. Singapore, International Edition.

Sarno, Lucio and Taylor, Mark P., 2002, *The Economics of Exchange Rates*. Cambridge, UK: Cambridge University Press.

Semmler, Willi, 2003, *Asset Prices, Booms and Recessions: Financial Market, Economic Activity and the Macro-economy*. Heidelberg and New York: Springer, pp. x, 175.

Schwarz, Gideon, 1968, "Estimating the Dimension of a Model," *Annals of Statistics*, Volume 6, pp. 461-464.

Shachmurove, Yochanan, 2005, "Dynamic Linkages Among the Emerging Middle Eastern and the United States Stock Markets," *International Journal of Business*, Volume 10(1), pp. 103-132.

Shachmurove, Yochanan, 1996, "Dynamic Linkages Among Latin American and Other Major World Stock Markets" in *Research in International Business and Finance: International Stock Market Interactions and Financial Issues in Emerging Markets,* Vol. 13, edited by John Doukas and Larry Lang, JAI Press Inc., pp. 3-34.

Shamah, Shani, 2003, *A Foreign Exchange Primer*. West Sussex, England: John Wiley & Sons Ltd.

Sims, Christopher A., 1972, "Money, Income and Causality," *American Economic Review*, Volume 62, pp. 540-552.

Sims, Christopher A., 1980, "Macroeconomics and Reality," *Econometrica*, Vol. 48. No. 1, 1-49.

Sims, Christopher A., 1986, "Are Forecasting Models Usable for Policy Analysis?" *Quarterly Review of the Federal Reserve Bank of Minneapolis*, 2-16.

Urzua, Carlos M., 1997, "Omnibus Tests for Multivariate Normality Based on a Class of Maximum Entropy Distributions," *Advances in Econometrics*, Volume 12, Greenwich, Conn.: JAI Press, 341-358.

Walmsley, Julian, 1992, *The Foreign Exchange and Money Markets Guide*. New York, John Woley & Sons, Inc.

Weisweiller, Rudi, 1984, *Introduction to Foreign Exchange*. Second Edition, Dover, NH: Woodhead-Faulkner Ltd.

Weisweiller, Rudi, 1990, *How the Foreign Exchange Market Works*. New York, NY: New York Institute of Finance Corporation.