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The Cointegration Experience of Eastern Currencies: Evidence from the 1980s

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ABSTRACT

This study examines the co-movement in the Japanese Yen, Australian Dollar, Singapore Dollar, Malaysian Ringgit and New Zealand Dollar exchange rates during the late 1980s by employing cointegration tests that are robust to the nonstationarity problems commonly found in financial time-series. In addition, Vector Autoregressive (VAR) tests are performed to determine the pair-wise channels of influence among these series. The results from the VAR formulation fitted to the overall 1985 to 1989 interval suggest that the Japanese Yen, Australian Dollar, and to some extent the Singapore Dollar, influence the behaviour of the other currencies under study. On the other hand, while the results from the cointegration tests provide striking evidence of integration of these currencies during the 'target-zone' Louvre Accord interval of February 1987 to December 1989, the evidence does not support integration for the January, 1985 to February, 1987 'managed-float' Plaza Accord interval. The cointegration of secondary currencies seem to be contingent on the success of the exchange rate stabilizing policies of major countries.

WHILE IT IS well known that exchange rate movements play an influential role in the macroeconomic policies of open economies, the nature of the international linkages among currencies is a matter of considerable interest to governments in general, and financial markets and corporations in particular. According to Mckinnon (1991) and Eichengreen (1992), the stability of exchange rates could largely mitigate currency risk and lead to more integrated financial markets, equality among interest rates, and possibly eliminate the current account imbalances among trading countries. It is not surprising therefore, that since the dissolution of the Bretton Woods system in the early 1970s, and the subsequent developments that have led to the numerous subleties in how currencies are now related to one another, issues pertaining to the efficiency and antecedents of these markets have attracted a great deal of attention.

The more traditional means for evaluating the pricing of spot exchange rates, that involve keying into certain macro economic variables[1], are now

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frequently supplemented with analysis that focus on pair-wise exchange rate stochastics (Domowitz and Hakkio (1985)), the role of forward markets (Fama (1984)), co-movements and causality among various currencies (Corbae and Ouliaris (1988)), the possible gains from currency diversification (Levy(1981)), and the role of transaction costs in potentially profitable trading strategies (Bahmani-Oskooee and Das (1985)), Further with the persistence of the trends towards globalization, currency theorists and analysts have begun to focus more keenly on currencies that have not received as much attention in the past. Moreover, researcher (including Meese and Rogoff (1988), Enders (1988), and Hakkio and Rush (1989) are increasingly cognizant of the need for addressing a major methodological impedance; the nonstationarity of exchange rate series.

There are two primary objectives of this paper. The first is to focus in on the long run relationship among the Japanese Yen (JY), Singapore Dollar (Sgp$), Malaysian Ringgit (MalR), Australian Dollar (Aus$) and New Zealand Dollar (NZ$). The cointegration tests, robust to nonstationarity of data series, and Vector Autoregressive (VAR) models are applied to examine the forecastability and channels of influence among these currencies [2]. A systematic and comprehensive evaluation of this nature in these markets is yet to be undertaken. The second objective of this paper is to investigate the nature of change in these relationships over the two important currency-coordinating agreements, the Plaza Accord, that came into effect early in 1985 and encompasses the first three years of our sample, and the Louvre Accord of January 1987. The former arose amidst the debt crisis of the early 1980s, which forced the G-5 countries to recognize the dangers of freely floating currencies. The agreement was designed to contain the excessive fluctuations among currencies through aggressive intervention by the member nations, and thus to form a 'managed float' system of exchange rates. However, the impetus of the Plaza Accord to intervene in the market had its drawbacks and generally did not seem to solve the problem of excessive fluctuations in the major currencies. Since several researchers have suggested that the stability of exchange rates is a necessary condition for cointegrated currency systems (see for instance, McKinnon (1991) and Eichengreen (1992)), there is reason to suspect that the currencies investigated in the present paper are not integrated for this 'managed float' interval. On the other hand, a more cointegrated system of currencies is expected for the post 1987 Louvre Accord era. The G-7 nations in recognizing the failure of sheer intervention policies, devised policies involving certain economic measures (of which direct currency intervention, would be only one) that were intended to ensure that currencies floated within a narrow band or 'target-zone,.

Two of the numerous implications of the findings of cointegrated currencies are considered important for this study. First, if two series are cointegrated, there must be Granger causality at least in one direction [see Granger (1986)]. Moreover, the long-run forecasts of cointegrated systems will be tied together regardless of the fact that individual forecasts diverge infinitely [see Engle

and Yoo (1987)]. Second, the cointegration of the series will rule out the possibility that the series are owned by jointly efficient speculative markets [Granger (1986)]. This follows directly from the first implication in that forecastability of certain series would contradict the efficient market hypothesis.

The remainder of this paper is organized as follows. Section II presents the data and methodology employed. The empirical results are presented in Section III. The final section summarize the findings of this study.

Data and Methodology

Daily closing spot rates for the Australian Dollar (Aus$), Japanese Yen (JY), Singapore Dollar (Sgp$), Malaysian Ringgit (MalR) and New Zealand Dollar (NZ$) for the period January 2, 1985 to December 31,1989, were obtained from the data resources, inc [3]. As is the international convention, all spot rates are quoted with the U.S. dollar as the base currency. The days for which data is not available for any one or more series are dropped from the study. In all, 1292 data points for each series are available for analysis. Prior to testing for co-integration, the unit root test for stationarity must be conducted. The following regressions are fitted to the exchange series,xi,(i=1..5):

$$\delta X_{it} = \beta_i X_{it-1} + \sum T_i \delta X_{i,t-j} + u_{it} \qquad (1)$$

where δ represents the first difference of the series x^i, and p is selected to be large enough to ensure that the residual u_{it} is white noise. The null hypothesis, that the series X_{it} is stationary after the first differencing, is rejected if the estimate of βi is negative and significantly different from zero (see Dickey and Fuller (1981) and Engle and Granger (1987)). Conditional to each element of the vector of exchange rate series achieving stationarity after differencing, co-integration may be implied if a linear combination of this vector achieves stationarity without this adjustment[4]. The test for co-integration between pairs of series (X_t,Y_t,) employed in this study involves the formulation of the co-integrating regression equation:

$$X_t = c + \propto y_t + u_t \qquad (2)$$

Tests of the null hypothesis, that x_t and Y_t are not co-integrated, are based on the Dickey-Fuller (DF) t-statistic for u^t in equation 2. This study considers an alternative cointegration test suggested by Phillips and Perron (1988), which departs substantially from the DF test in that this test imposes only weak restrictions on the error sequence, and does not require the crucial *iid*-error assumption of the DF test (also see Phillips (1987) and Phillips and Perron (1988).

To determine the channels of influence in this system of currencies, Vector Autoregressive (VAR) models are employed on the transformed stationary series. The VAR representation allows us to treat all the exchange rate series as potentially endogenous. This has an advantage over traditional econometric models that implicitly rely on an a -priority classification of independent and dependent variables. Each variable in the system is regressed

on lagged values of itself and lagged values of the other series under consideration. For instance, in the following VAR representation:

$$X_t = C + \sum_{k=1}^{P} \delta_k X_{t-k} + \sum_{k=1}^{P} \beta_k Y_{t-k} + u_t, \qquad (3)$$

Where $\propto$ and β are coefficient matrices and u_t is an n*1 vector of random disturbances, each series x_{it} , (i=1....n), is regressed on p lags of itself and p lags of the other n-1 series [5].

Empirical Results

Table 1 presents selected descriptive statistics for the five spot rates under study. The first order coefficients indicate the presence of excessive kurtosis, and support the notion that at least four of the five series are asymmetrically distributed (the results indicate negative Pearson's skewness for the Aus$, NZ$ and Sgp$ and positive skewness for the MalR). The results of the unit root tests indicate that, but for Sgp$ series, the hypothesis of non-stationarity for the undifferenced (level) series cannot be rejected at the 1 percent level of significance[6]. The coefficients are found to be negative but not significant for all the raw or log transformed series. As is generally the case for financial time series, upon taking the first difference, the coefficients are statistically significant, indicating integration of order one for the series[7]. Subsequently, only the first differenced spot rates are considered in the implementation of the VAR models.

The VAR test results for forecasting performance of the five currency series are presented in Table 2. There is an indication that the Aus$ series seems to possess considerable forecasting ability as per the NZ$. Further, there seems to be a positive lead-lag relationships between the JY and Sgp$ (and to some extent, the MalR), and between the Sgp$ and MalR. Less noteworthy indirect channels of influence among these currencies are also apparent from the seemingly anomalous relationship between Sgp$ and the lagged NZ$ series.

The Engle-Granger tests for pair-wise cointegration between the five exchange rate (level) series for the entire test period are presented in Panel A of Table 3. Panels B and C present the evidence from the Plaza Accord and Louvre Accord intervals, respectively. To avoid spurious *a priori* classification of causality, all currencies were individually modelled as independent variables. The Dickey-Fuller t-statistics in panel A suggests that only the Sgp$ is cointegrated with all the other currencies included in this study. The evidence of cointegration among the other currencies is somewhat weaker. The hypothesis of no cointegration among the Aus$ and NZ$ and the Aus$ and JY is rejected at only a 10% level of significance. The results contained in Panel B and C provide evidence of cointegration over the intervals spanning the two major accords. For the Plaza Accord interval, the statistics do not reject the hypothesis of no cointegration for any combination of currencies. The failure of the G-5 to stabilize their currencies via aggressive intervention seems to have also hindered the co-movements among the currencies investigated in the present study. On the other hand,

the presence of cointegration for the Louvre Accord interval as seen in Panel C of Table 3 suggests that the largely successful efforts of the G-7 to restrict the fluctuations of their currencies within a narrow band may have led to cointegration within the group of eastern currencies. However, the Sgp$ is common to all pairs of cointegrated currencies. It would seem that there is a 'Sgp$-zone', at least for the period under investigation.

Following the distinctive pair-wise cointegration results obtained over the Plaza and Louvre Accord regimes, multivariate cointegration tests are also conducted. The results from the Engle-Granger and Phillips-Perron tests indicate cointegration of the currencies for the overall (1985-1990) interval, and the post-Louvre Accord interval (1987-1990). Neither test is able to reject the null hypothesis of no co-integration for the post-Plaza Accord interval (1985-1987). Thus the multivariate tests for co-integration confirm the pattern in Table 3 of the lack of cointegration of the eastern currencies during the managed-flot era of 1985-1987.

The various tests employed in this study aided in investigating the efficiency of the five currencies under consideration in at least two respects. First, the results from the cointegration and VAR tests indicated cross dependencies and forecasting abilities for at least some of the currencies under investigation. For instance, the VAR tests result revealed the fairly strong forecasting abilities of the Aus$ (with regards to the NZ$) and of the JY (with regards to the Sgp$ and MalR). Second, the evidence from the cointegration tests conducted separately for the consecutive 'managed float' and 'target zone' intervals largely indicates that the nature of the interrelationships between secondary currencies is contingent on the success or failure of the exchange rate stabilizing policies deployed by major countries.

Conclusions

This study set out to examine the potential dependencies and forecastability in spot rates of five currencies by applying cointegration tests that are robust to the non-stationarity problems commonly found in financial time series. In addition, Vector Autoregressive (VAR) tests were performed to determine the channels of influence among these exchange rate series. The results indicate that the behavioral clustering of the currencies under investigation seem to be contingent on the success of the currency stabilizing policies of the major countries. This indication gives rise to the need for further exploration important questions including: Does international trade tend to expand when major currencies are relatively stable? Do certain underlying parities (such as those suggested by the Purchasing Power Parity and Interest Rate Parity theorems) hold more consistently during periods when the fluctuation in major currencies is restricted ? While the evidence of causality among the Eastern currencies implied by the results may arguably call into question the efficiency of these markets, no comment on the speculation significance of the findings may be offered prior to a careful examination of the consistency of the implied relationships, and the role of transaction costs involved in any trading strategies based on such information.

Notes

1. Such as money growth and inflation [see for instance, Frenkel and Razin (1980)], and Corbae and Ouliaris (1988)], and interest rate differentials [Cumby and Obstfels (1981)].
2. There is reason to suspect that the currencies in question are closely integrated. The non-uniform nature of the distribution of natural resources within these countries has led to steadily greater interdependence [see Yamazawa (1992)]. Trade between these countries, and in particular, the Japanese investments in Singapore, Australia and New Zealand, has soared in the last ten years. Consequently, several Asian countries have now begun switching their debt from dollars into Yen [for instance, see Frenkel (1991)].
3. The Australian Dollar was floated in December 1983 prior to which it was pegged against a basket of currencies that included the U.S. Dollar, Japanese Yen and British Pound. Both forward trading (the Official Forward Market) and futures trading the Sydney Futures Exchange) has since been available [see Morris (1984)]. The value of the ringgit is currently based on a multilateral trade index that assigns to each of Malaysia's 15 biggest trading partners a weight based on the value of traded merchandise [see Beng 1991)]. The other currencies under consideration employ a managed float, with singapore using the US dollar as a principal denominator. Also see Rowley (1992).
4. For extensions of the Dickey-Fuller methodology for the dealing with cases where more than one differencing is required to achieve stationarity, see Said and Dickey (1984) and Engle and Yoo (1987).
5. Akaike's minimum Final Prediction Error (FPE) criterion is employed in the selection of the optimal lag structure. An intuitive guide to establish this lag is to select p that results in an estimated model without significant autocorrelation. For an extensive discussion on the several VAR representations and their pros and cons, see Sims (1982), and Litterman (1986).
6. The residual u_t in Equation 2 was found to be empirical white noise for all three pairs of series by the third lag. Therefore, Augmented Dickey-Fuller statistics only for p=3 are reported.
7. These test statistics are not t-distributed and are evaluated for significance based on tables provided by Dickey and Fuller (1979).

Table 1

Descriptive Statistics for Aus$, Sgp$, MalR, NZ$ and JY Spot Exchange Rates (1985-1990)a,b

	Aus$	NZ$	JY	Sgp$	MalR
Mean	0.731	0.576	0.00645	0.481	0.387
Sd.Dev	0.061	0.063	0.00128	0.025	0.0136
Skewness	-1.078	-0.942	-0.030	-1.090	0.691
Kurtosis	6.440***	6.338***	3.740***	56.773***	15.708***
U-Root(X_t):	-3.125	-1.869	-0.024	-3.208	-2.511
U-Root(δX_t):	-5.590***	-4.785***	-4.622***	-5.514***	-5.663***
N	1292	1292	1292	1292	1292

a. U-Root(X_t) represents the unit root test for stationarity in the Level series; U-Root(X_s) represents the unit root test in the first differenced series. The Augmented Dickey Fuller statistics test the hypothesis: the series is integrated of order one, under the alternative hypothesis is: series is stationary. The test statistic for β

$$\delta X_{it} = \beta X_{t-1} + \sum_{j=1}^{N} t\delta X_{t-j} + u_{it}$$

rejects the null hypothesis if negative and significant. Levels of significance of these statistics were evaluated from Dickey and Fuller (1979).

b. Sd. Dev and N represent the standard devation and number of observations respectively.

*,**, and *** indicate significance levels of 10%, 5% and 1% respectively.

Table 2

Testing the Pair-Wise Currency Forecasting Performance Using VAR (1985-1990)[a]

		Dependent Variable				
	Lag	δAus$	δJY	δSgp$	δMalR	δNZ$
δAus$	-1		0.000	0.017	-0.120	0.061
			(0.278)	(0.641)	(-0.938)	(2.213)**
	-2	-	0.000	-0.020	0.109	-0.054
			(0.519)	(-0.514)	(0.850)	(-1.362)
	-3		0.000	0.068	0.137	-0.056
			(-0.830)	(1.733)*	0.968)	(-1.393)
δJY	-1	1.399		9.516	1.402	2.791
		(0.407)		(2.943)***	(1.738)*	(0.877)
	-2	-1.805	-	-3.802	-0.739	-0.063
		(-0.369)		(-0.825)	(-0.648)	(-0.014)
	-3	-7.195		1.427	-1.511	-5.111
		(-1.470)		(0.309)	(-1.322)	(-1.128)
δSgp$	-1	-0.035	0.000		0.244	-0.000
		(-1.236)	(0.022)		(1.993)**	(0.000)
	-2	-0.007	0.000	-	0.037	-0.034
		(-0.272)	(-0.944)		(0.221)	(-1.286)
	-3	0.034	0.000		-0.161	0.031
		(1.177)	(0.838)		(-0.953)	(1.166)
δMalR	-1	0.003	0.000	-0.002		0.106
		(0.453)	(0.034)	(-0.286)		(0.896)
	-2	-0.004	0.000	-0.002	-	-0.201
		(-0.804)	(0.273)	(-0.372)		(-1.234)
	-3	0.065	0.001	-0.001		0.106
		(0.788)	(1.093)	(-0.129)		(0.650)
δNZ$	-1	0.012	0.000	0.0217	0.000	
		(0.391)	(0.961)	(0.0749)	(-0.056)	
	-2	-0.048	0.000	-0.084	-0.002	-
		(-1.061)	(-0.500)	(-2.017)**	(-0.249)	
	-3	0.028	0.000	0.127	0.002	
		(0.623)	(0.184)	(3.029)***	(0.288)	

a. t-statistics in () are listed below the VAR coefficients.
*,** and *** represent significance levels of 10%, 5%, and 1% respectively.

Table 3

The Engle-Granger Tests for Co-integration Among the 5 Spot Exchange Rate Series

Panel A: Entries Period (1985-1990)

Independent Variable	Aus$	JY	Sgp$	MalR	NZ$
Aus$	-	-3.570*	-3.673*	-3.446	-3.559*
JY	0.253	-	-0.975	0.461	-1.474
Sgp$	-7.867***	-7.708***	-	-7.709***	-7.532***
MalR	-2.621	-2.380	-2.716	-	-2.874
NZ$	-2.064	-2.733	-1.903	-2.320	-

Panel B: Post-Plaza Accord (1985-Feb 1987)

Independent Variable Estimate	Aus$	JY	Sgp$	MalR	NZ$
Aus$	-	-3.048	-3.136	-3.029	-3.118
JY	-0.917	-	-1.073	-1.239	-0.012
Sgp$	-2.029	-2.156	-	-1.807	-2.401
MalR	-1.804	-2.078	-1.661	-	-1.752
NZ$	-1.731	-1.931	-2.244	-1.719	-

Panel C. Post-Lourve Accord (Feb 1987-1990)

Independent Variable Estimate	Aus$	JY	Sgp$	MalR	NZ$
Aus$	-	-1.618	-2.744	-2.856	-1.716
JY	-0.934	-	-0.899	-1.197	-2.089
Sgp$	-4.185***	-3.422**	-	-6.108***	-3.569**
MalR	-2.311	-0.902	-4.757	-	-1.245
NZ$	-1.879	-2.676	-2.184	-2.244	-

a. ∅ is the coefficient from the co-integrating vector.

b. D-F is the Dickey Fuller t-statistic and will reject the null hypothesis: x_t, y_t not co-integrated if significantly negative.

*,**,*** represent significance levels of 10%, 5% and 1% respectively.

Table 4

Multivariate Cointegration Test Results for the Five Currencies[a]

	Engle-Granger test	Phillips-Perron test
Over all Interval (Jan 85-Dec 89)	-4.854**	-6.609**
Post-Plaza Accord (Jan 1985-Feb 1987)	-3.640	-3.769
Post-Louvre Accord (Feb 1987-Dec 89)	-6.468***	-9.532***

a. Five currencies pertain to Singapore dollar, Japanese Yen, Australian dollar, Malaysian Ringgit and New Zealand dollar spot exchange rates.

*,**,*** indicates significance at 10%, 5% and 1% level respectively.

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