XXVII ANNUAL CONFERENCE OF MONETARY STUDIES

MONETARY POLICY AND THE SPOT EXCHANGE RATES: EFFICIENCY MARKETS - RATIONAL EXPECTATIONS APPROACH

Edward E Ghartey
University of the West Indies, Mona

JACK TAR VILLAGE
FRIGATE BAY
ST KITTS

♦

NOVEMBER 8 - 11, 1995

MONETARY POLICY AND THE SPOT EXCHANGE RATES: EFFICIENCY MARKETS - RATIONAL EXPECTATIONS APPROACH

Edward E. Ghartey, Ph.D.
Department of Economics
The University of the West Indies
Mona, Kingston 7
Jamaica, West Indies
November 1995

proposed by Friedman (1953).[2,3]

In policy making, it is important to know if the FEM is efficient in the country. The reason being that in a situation of a small highly open non-repressed island economy, if the FEM is inefficient, then a fixed exchange rate will assist in stabilizing price-level expectation and inspire confidence in the financial future of the country. However, if the economy is small, repressed and highly insulated from financial and commodity arbitrage competition, then the appropriate policy course for the government will be to adjust the exchange rate gradually, and steadily to avert a massive devaluation,[4] which will in all probability destabilize the economy both politically and economically. See McKinnon (1993).

The object of this study is to measure the efficiency of the FEM to assist in the policy making process of the Central Bank and the government. Following the introduction, the model is developed to suit current advances in the literature, and to meet the characteristics and data constraint of Jamaica in section 2. The results is presented and discussed in section 3, and the policy recommendations and conclusions is summarized in section 4.

---

[2]Nurkse (1945), one of the pioneers of the literature on exchange rate economics cautioned that the 'band wagon effects' of the activities of speculators will destabilize the FEM. See also McKinnon (1988).

[3]See Hodrick (1990) for a discussion on market fundamentals.

[4]A devaluation policy is described as massive and destabilizing if it is in excess of 10 per cent.

2: THE EMPIRICAL METHODOLOGY

The FEM is part of the asset market because the foreign exchange rate is an asset which provides liquid alternatives to other assets such as bonds, stocks and mortgages. In LDCs because inflation erodes the value of domestic assets, currency substitution has become an important alternative to investors in the local markets. It is therefore important that in assesing the efficiency of the FEM we incorporate rational expectation. This is because in the current globalization of the floating exchange rate, any deficiency in information will render the FEM socially inefficient. See McKinnon (1988, p.86). However, when rational expectation is tied to risk neutrality we obtain uncovered interest rate parity condition (UIRPC), which means that the expected depreciation (appreciation) of domestic currency must be equivalent to the domestic interest rate being higher (lower) than the foreign interest rate. Thus we can write UIRPC as follows:[5]

$$E(\Delta e_{t+k}) = r_t - r_t^* \qquad (1)$$

where

$E(\Delta e_{t+k}/\omega) = E(\Delta e_{t+k}) = E(e_{t+k}) - E(e_t)$.

e_t = logarithmic form of the spot foreign exchange rate at time t.

$m1_t$ = logarithmic form of domestic M1 at time t.

μ_t = logarithmic form of domestic M1 relative to foreign M1 at time t.

---

[5]Taylor (1995) and MacDonald and Taylor (1992) discuss this in some detail.

$f_{t,k}$ = forward foreign exchange rate at time t which matures at period k.

k = maturity period of the future contract

$E(/\omega_t)$ = market expectation operator conditioned on ω_t

Δ = the difference operator

ω_t = all available information at time t.

r_t, r_t^* = logarithmic form of the nominal interest rate at time t for domestic and foreign securities of similar type respectively.

The UIRPC holds because of the presence of transaction cost that exists among international boundaries. However, if we assume that there are no barriers to arbitrage in international financial markets, then covered interest parity condition (CIRPC) will hold good, meaning that assets of similar characteristics and maturity periods will have their interest rate differential matched by the movement of prices in the forward FEM. The CIRPC is:

$$r_t - r_t^* = f_{t,k} - e_t \qquad (2)$$

Equations (1) and (2) yield

$$E(e_{t+k}) = f_{t,k} \qquad (3)$$

Equation (3) establishes a relationship between the expected spot exchange rate and the forward exchange rate, which is Fama's general condition for market efficiency and it is estimated by Frenkel (1981) as follows:

$$e_{t+k} = \alpha_0 + \alpha_1 f_{t,k} + \zeta_{t+k} \qquad (4)$$

Thus the FEM is deemed as efficient if and only if α_1 is either equivalent to or close to unity, and ζ_{t+k} is a white noise innovation. However, according to Froot and Thaler (1990) preponderance empirical evidence indicate that $\alpha_1 = -1$. This result implies that when foreign currency exists at a premium in the forward market over the maturity period of the contract, the domestic currency is less likely to be predicted to depreciate over the maturity period of the contract.[6] Taylor (1995) provides a mathematical variant of equation (4) and discusses the errors associated with the estimation.

Since most macroeconomic series have been proven or found to be random walk, and e_{t+k} is also found to exhibit a random walk, the traditional method of estimating equation (4) by either the ordininary least squares (OLS) or the Aitken method may not yield an unbiased estimates. Thus to circumvent the above problems, it is suggested that an efficiency FEM hypothesis can be obtained by testing the orthogonality of the forward rate forecast error (e_{t+k} - $f_{t,k}$) with respect to a given information set ω_t. The resulting equation becomes

$$e_{t+k} - f_{t,k} = \eta\Omega_t + \zeta_{t+k} \qquad (5)$$

where

Ω_t = vector of variables selected from ω_t.

Mussa (1979), McKinnon (1988), and Caves and Feige (1980) describe the information set quite differently. Additionally, Meese and Rogoff (1983), Frenkel and Mussa (1980), and Cooper (1974) extend

[6]Taylor (1995) argues that because the constant term in equation (4) tend to be very large in empirical works, the domestic currency cannot be deemed to appreciate when the foreign currency exists at a premium in the forward market.

the information set to include past, current and future monetary aggregates, interest rates, taxes, trade balance, weather reports, etc. In our current modifications, we shall assume away $f_{t,k}$ since there are no forward FEM in Jamaica, and assume Sims' (1972) and Sargent's (1976) operational definition of Granger's (1969) causality, to provide variables for the vector of information sets. We shall test for weak-, incremental-, and semistrong-forms of efficiency in the FEM[7] by using domestic and foreign money supplies as our information.

We shall estimate the following autoregressive (AR) equations:

$$\Delta e_t = \Sigma\beta_i \Delta e_{t-i} + \Sigma\beta_i{}' \Delta(m_{t-i} \text{ or } \mu_{t-i}) + \Sigma\beta_i{}'' \Delta(m_{t+i} \text{ or } \mu_{t+i}) + u_t, \qquad \forall i \epsilon [1,n] \qquad (6)$$

$$\Delta e_t = \Sigma\delta_j \Delta e_{t-j} + \Sigma\delta_j \Delta(m_{t-j} \text{ or } \mu_{t-j}) + v_t, \ \forall j \epsilon [1,n],\ n \geq p \qquad (7)$$

where u_t and v_t are white noise innovations.

Equation (6) is basically Geweke et al. (1983) modified Sims test, while equation (7) is Hsiao (1979) stepwise Granger test. Note that in equation (7), p is the optimum lag-length of the manipulated variable (Δm_t). The underlying causality test above is that $\Delta(m_t$ or $\mu_t)$ causes ($\Rightarrow$) Δe_t. The variables are then reversed for a reverse causality test. See Ghartey (1993) for some details.

Unlike the earlier studies of Frenkel (1976), Caves and Feige (1980), and Sims (1972), we shall employ Dickey-Fuller (DF) and augmented DF (ADF) methods to test the stationarity of money stock

---

[7]See Caves and Feige (1980) for proofs of the propositions, weak-, and incremental-forms of efficiency in the FEM. Cooper (1974) also provides other versions of efficiency of the FEM using stock returns and money supplies.

and exchange rate variables before estimating equations (6) and (7). We shall also employ Akaike's (1969) finite prediction error (FPE) to choose the lag lengths in the model. Note that whereas the Sims (1972) test required Aitkens or some version of asymptotic generalized least squares for estimation, the OLS estimator yields unbiased and consistent estimates for the modified Sims test and the stepwise Granger test.

3: DISCUSSION OF THE RESULTS

The weak-form efficiency is tested by examining a simple random walk in e_t during and after the Bretton Woods era by computing the Lyung-Box Q-statistics:

$$Q_{LB} = T(T+2)\Sigma(T-h)^{-1}r_h^2, \qquad \forall h \in [1,25]$$

where T is the number of observations, and r_h is h-th autocorrelation. Q_{LB} is used to test the hypothesis that the series is white noise and it is asymptotically distributed as $\chi^2(25)$. The results indicate that Q_{LB} is 23.52 during the Bretton Woods era and 63.26 afterwards. The $\chi^2_{(25)}$ critical value is 34.4, and it is significant at a 0.10 level, which is the norm in such a test. Thus whereas we cannot reject weak-form efficiency in the earlier periods because of random walk behaviour of e_t, we reject weak-form efficiency in the period after the Bretton Woods era.

The more robust random walk test is the unit root test. Using the DF and the ADF tests reported in Table 1, we conclude that in the period 1963.1 to 1991.4, the FEM exhibits a weak-form efficiency. However, if the period is sub-divided into two because of the globalization of the floating exchange rate, the results

Table 1: Unit root tests results, 1963.1 - 1993.1

Variable	DF	Crit. Test.	Vect. Coef.	D.W.
Δe	-4.759*	-3.516	-0.605	2.001
Δe†	-3.224**	-3.523	-0.510	1.798
Δe★	-4.530*	-3.597	-1.051	2.002
$\Delta m1$	-6.720*	-3.518	-1.095	2.005
$\Delta \mu$	-6.768*	-3.518	-1.122	2.012
	ADF, 4lags			
Δe	-3.589*	-3.518	-0.658	2.000
Δe†	-2.128	-3.523	-0.479	1.801
Δe★	-3.705*	-3.518	-1.567	2.014
$\Delta m1$	-3.304*	-3.518	-0.899	2.025
$\Delta \mu$	-3.400*	-3.518	-0.947	2.028

The time series x_t is nonstationary (contains unit root) and is determined by running the following regression:

$$\Delta x_t = \varphi_0 + \varphi_1 x_{t-1} + \xi_1 \qquad \text{(DF)}$$
$$\Delta x_t = \varphi_0 + \varphi_1 x_{t-1} + \Sigma\varphi_\kappa \Delta x_{t-\kappa} + \xi_2 \qquad \text{(ADF)}$$

where κ is number of lagged difference terms, and ξs are white noise error terms. The H_0 is that x_t is a non stationary time series and its rejection means that the variables are stationary. The critical tests above are quoted from MacKinnon (1990) and are significant at a 0.01 level. *, **, and *** denote significance at a 0.01, 0.05, and 0.10 levels respectively.

† Covers the period 1974.1 - 1991.4
★ Covers the period 1963.4 - 1973.4

Table 2a: Granger causality test results of the growth rate of money stock and exchange rate.

	1963.4 - 1973.4			1974.1 - 1991.4		
Vars.	Δm1	Δm1	Δm1	Δm1	Δm1	Δm1
c	0.031	0.025	0.026	0.049	0.049	0.049
	[2.312]	[1.753]	[1.915]	[2.771]	[2.599]	[2.583]
$\Delta m1_{-1}$	-0.155	-0.089	-0.071	0.033	0.024	0.048
	[0.992]	[0.517]	[0.428]	[0.256]	[0.173]	[0.366]
$\Delta m1_{-2}$	0.036	0.132	0.115	-0.142	-0.157	-0.144
	[0.240]	[0.080]	[0.725]	[1.148]	[1.201]	[1.118]
$\Delta m1_{-3}$	-0.214	-0.286	-0.302	-0.188	-0.220]	-0.215
	[1.488]	[1.849]	[2.030]	[1.522]	[1.684]	[1.656]
$\Delta m1_{-4}$	0.302	0.323	0.312	0.341	0.299	0.308
	[2.142]	[2.077]	[2.054]	[2.608]	[2.174]	[2.256]
Δe		0.106			0.080	
		[0.467]			[0.677]	
Δe_{-1}		-0.124	-0.124		0.065	0.101
		[0.551]	[0.558]		[0.456]	[0.764]
Δe_{-2}		0.439	0.438		0.056	0.059
		[1.999]	[2.021]		[0.398]	[0.417]
Δe_{-3}		0.182	0.182		0.053	0.058
		[0.827]	[0.836]		[0.374]	[0.413]
Δe_{-4}		-0.433	-0.433		-0.152	-0.149
		[1.362]	[1.377]		[1.147]	[1.132]
N	41	41	41	72	72	72
DW	1.940	1.924	1.927	1.729	1.714	1.702
SSR	0.083	0.067	0.068	0.533	0.510	0.514
$FPE10^{-3}$	2.609	2.713	2.595	8.511	9.381	9.488
		Joint test of restrictions				
LR		8.76	8.7^{***}		3.1	2.6
F		1.5	1.8		0.5	0.6

Note: The t-values are presented in the parentheses.

Table 2b: Granger's causality test results of the growth rate of the exchange rate and the money stock.

	1963.4 - 1973.4			1974.1 - 1991.4		
Vars.	Δe	Δe	Δe	Δe	Δe	Δe
c	0.006	0.011	-0.001	0.022	-0.011	0.010
	[0.999]	[0.979]	[0.189]	[1.620]	[0.534]	[0.665]
Δe_{-1}	-0.024	0.008	-0.002	0.445	0.442	0.480
	[0.145]	[0.046]	[0.013]	[3.207]	[3.070]	[3.508]
Δe_{-2}	-0.027	-0.035	-0.032	0.010	0.025	0.018
	[0.164]	[0.193]	[0.200]	[0.065]	[0.160]	[0.127]
Δe_{-3}	-0.028	-0.014	-0.063	0.081	0.060	0.066
	[0.166]	[0.078]	[0.397]	[0.546]	[0.395]	[0.453]
Δe_{-4}	0.042	0.034	-0.115	0.060	0.049	0.027
	[0.178]	[0.132]	[0.487]	[0.426]	[0.344]	[0.196]
Δm1		0.066			0.092	
		[0.467]			[0.677]	
$\Delta m1_{-1}$		0.174	0.256		0.301	0.260
		[1.313]	[2.307]		[2.123]	[1.989]
$\Delta m1_{-2}$		-0.166			0.177	
		[1.303]			[1.258]	
$\Delta m1_{-3}$		-0.132			0.083	
		[1.053]			[0.578]	
$\Delta m1_{-4}$		-0.131			0.081	
		[1.018]			[0.525]	
N	41	41	41	72	72	72
DW	1.979	1.978	1.920	1.782	1.877	1.864
SSR	0.053	0.041	0.046	0.648	0.591	0.611
$FPE10^{-3}$	1.664	1.679	1.518	10.67	10.86	10.04
		Joint test of restrictions				
LR		9.99^{***}	5.80^{**}		6.66	4.19^{**}
F		1.71	5.32^{**}		1.20	3.96^{**}

Note: See Table 2a.

Table 3a: Modified Sims' causality test results of the growth rate of the exchange rate and the money stock.

	1963.4 - 1973.4			1974.1 - 1991.4		
Vars	Δe	Δe	Δe	Δe	Δe	Δe
c	0.013	0.011	0.013	0.013	0.023	0.016
	[1.206]	[0.769]	[0.945]	[0.703]	[0.806]	[0.584]
Δe_{-1}	-0.000	0.058	0.042	0.342	0.380	0.386
	[0.000]	[0.302]	[0.221]	[2.618]	[2.771]	[2.825]
Δe_{-2}	-0.007	0.115	0.154	-0.015	-0.058	-0.065
	[0.038]	[0.616]	[0.897]	[0.111]	[0.383]	[0.437]
Δe_{-3}	-0.002	0.017	0.023	0.097	0.149	0.145
	[0.010]	[0.094]	[0.127]	[0.703]	[0.986]	[0.961]
Δe_{-4}	0.006	0.022	0.004	-0.022	-0.063	-0.046
	[0.023]	[0.087]	[0.015]	[0.169]	[0.625]	[0.659]
$\Delta m1_{-1}$	0.170	0.182	0.186	0.154	0.100	0.105
	[1.297]	[1.341]	[1.387]	[1.164]	[0.625]	[0.659]
$\Delta m1_{-2}$	-0.159	-0.314	-0.311	0.086	0.064	0.079
	[1.270]	[2.244]	[2.249]	[0.674]	[0.428]	[0.537]
$\Delta m1_{-3}$	-0.152	-0.097	-0.121	-0.061	-0.089	-0.049
	[1.302]	[0.715]	[0.952]	[0.473]	[0.603]	[0.365]
$\Delta m1_{-4}$	-0.110	-0.029	-0.006	-0.036	0.023	0.016
	[0.925]	[0.223]	[0.049]	[0.267]	[0.148]	[0.105]
$\Delta m1$		0.085			-0.104	
		[0.609]			[0.695]	
$\Delta m1_1$		-0.099	-0.099		0.003	-0.000
		[0.715]	[0.729]		[0.022]	[0.002]
$\Delta m1_2$		0.273	0.282		-0.044	-0.029
		[2.073]	[2.173]		[0.298]	[0.197]
$\Delta m1_3$		0.034	0.019		0.100	0.124
		[0.251]	[0.144]		[0.750]	[0.969]
$\Delta m1_4$		-0.235	-0.221		-0.129	-0.154
		[1.840]	[1.776]		[0.961]	[1.195]
N	41	41	41	72	72	72
DW	1.982	1.992	1.964	1.982	2.009	2.004
SSR	0.042	0.032	0.033	0.451	0.429	0.433
$FPE10^{-3}$	1.605	1.606	1.542	8.498	9.393	9.194
		Joint test of restrictions				
LR		10.5^{**}	10.3^{**}		3.4	2.8
F		1.6	2.0		0.6	0.6

Note: See Tables 1 and 2a.

Table 3b: Modified Sims causality test results of the growth of the money stock and exchange rate.

	1963.4 - 1973.4			1974.1 - 1991.1		
Vars.	Δm1	Δm1	Δm1	Δm1	Δm1	Δm1
c	0.026	0.022	0.024	0.065	0.060	0.058
	[1.915]	[1.549]	[1.713]	[3.578]	[3.201]	[3.096]
$\Delta m1_{-1}$	-0.071	-0.072	-0.045	-0.066	-0.041	-0.052
	[0.429]	[0.391]	[0.256]	[0.517]	[0.307]	[0.389]
$\Delta m1_{-2}$	0.115	0.191	0.170	-0.203	-0.150	-0.165
	[0.725]	[1.040]	[0.954]	[1.642]	[1.171]	[1.279]
$\Delta m1_{-3}$	-0.302	-0.130	-0.154	-0.317	-0.376	-0.369
	[2.030]	[0.772]	[0.954]	[2.559]	[2.955]	[2.884]
$\Delta m1_{-4}$	0.312	0.343	0.325	0.194	0.197	0.218
	[2.054]	[2.115]	[2.068]	[1.484]	[1.432]	[1.591]
Δe_{-1}	-0.124	-0.160	-0.162	0.007	0.036	-0.017
	[0.558]	[0.662]	[682]	[0.053]	[0.273]	[0.129]
Δe_{-2}	0.438	0.302	0.308	0.035	0.030	0.036
	[2.021]	[1.302]	[1.345]	[0.264]	[0.225]	[0.268]
Δe_{-3}	0.182	0.074	0.076	0.073	0.088	0.071
	[0.836]	[0.322]	[0.334]	[0.548]	[0.665]	[0.531]
Δe_{-4}	-0.433	-0.373	-0.371	-0.193	-0.190	-0.189
	[1.377]	[1.129]	[1.139]	[1.561]	[1.540]	[1.522]
Δe		0.131			-0.177	
		[0.576]			[1.359]	
Δe_{1}		0.241	0.246		0.016	-0.039
		[1.053]	[1.087]		[0.114]	[0.293]
Δe_{2}		-0.328	-0.324		0.250	0.258
		[1.421]	[1.421]		[1.848]	[1.891]
Δe_{3}		-0.234	-0.211		-0.030	-0.031
		[1.017]	[0.944]		[0.254]	[0.256]
Δe_{4}		-0.231	-0.238		-0.004	-0.016
		[0.990]	[1.035]		[0.037]	[0.143]
N	41	41	41	72	72	72
DW	1.927	2.033	2.080	1.768	1.769	1.742
SSR	0.068	0.056	0.057	0.420	0.379	0.392
$FPE10^{-3}$	2.594	2.822	2.705	7.924	8.299	8.323
		Joint test of restrictions				
LR		7.4	6.9		7.1	4.8
F		1.1	1.3		1.2	1.0

Note: See Tables 1 and 2a.

Table 4: Goodness of fit of restriction and the direction of causation.

Cont. Var.	Man. Var.	$FPE10^{-3}$	LR	F	Direct Causation
Modified Sims Test, 1963.4 - 1973.4					
Δe,-4	Δm1,-4	1.606			
Δe,-4	Δm1,-4,0,+4	1.607	10.8**	1.6	Δm1⇒ Δe
Δe,-4	Δm1,-4,+4	1.542	10.3**	2.0***	Δm1⇒ Δe
Δm1,-4	Δe,-4	2.595			
Δm1,-4	Δe,-4,0,+4	2.823	7.4	1.1	Δe⇏ Δm1
Δm1,-4	Δe,-4,+4	2.705	6.9	1.3	Δe⇏ Δm1
Stepwise Granger Test					
Δe,-4		1.664			
Δe,-4	Δm1,-4,0	1.679	10.0***	1.7	Δm1⇒ Δe
Δe,-4	Δm1,-1	1.518	5.8**	5.3**	Δm1⇒ Δe
Δm1,-4		2.609			
Δm1,-4	Δe,-4,0,+4	2.713	8.8	1.5	Δe⇏ Δm1
Δm1,-4	Δe,-4,+4	2.595	8.5	1.8	Δe⇏ Δm1
Modified Sims Test, 1974.1 - 1991.1					
Δe,-4	Δm1,-4	8.499			
Δe,-4	Δm1,-4,0,+4	9.394	3.4	0.6	Δm1⇏ Δe
Δe,-4	Δm1,-4,+4	9.195	2.8	0.6	Δm1⇏ Δe
Δm1,-4	Δe,-4	7.925			
Δm1,-4	Δe,-4,0,+4	8.299	7.1	1.2	Δe⇏ Δm1
Δm1,-4	Δe,-4,+4	8.323	4.8	1.0	Δe⇏ Δm1
Stepwise Granger Test					
Δe,-4		10.670			
Δe,-4	Δm1,-4,0	10.860	6.7	1.2	Δm1⇏ Δe
Δe,-4	Δm1,-1	10.043	4.2**	4.0**	Δm1⇒ Δe
Δm1,-4		8.511			
Δm1,-4	Δe,-4,0	9.381	3.1	0.5	Δe⇏ Δm1
Δm1,-4	Δe,-4	9.488	2.6	0.6	Δe⇏ Δm1

Note: The numbers after the commas are the lag lengths. A minus (-) indicates lags, a plus (+) indicates leads, and a zero indicates current. Additionally, *, **, and *** denote significance at a 0.01, 0.05, and 0.10 levels respectively.

show differences in FEM efficiency. The DF and ADF tests are 4.53 and 3.71 respectively. As compared with the MacKinnon's critical value of 3.6 at a 0.01 significant level we have a weak-form efficiency in the FEM for the period 1963.4 - 1973.4. However, in the period 1974.1 - 1991.4, the DF test of 3.22 is significant at a 0.05 level, which shows a weak-form efficient FEM, while the ADF test of 2.13 is not significant even at a 0.10 level, an indication of a weak-form inefficient FEM.

The actual test of incremental efficiency in the FEM is reported in Tables 2a - 3b.[8] Table 2a reports the stepwise Granger causality results with Δm_t as the dependent variable. We find that $\Delta e_t \not\Rightarrow \Delta m_t$, even though in one instance the likelihood ratio (LR) test was significant at a 0.10 level in 1963.4 - 1973.4. Note that the F-test or the Wald-test which is a more reliable joint test of restrictions shows absence of causality in both periods. In the period 1974.1 - 1991.4, both the F- and LR-tests results indicate absence of causality, in Table 2a.

In Table 2b, the stepwise Granger causality results show that $\Delta m_t \Rightarrow \Delta e_t$ in both 1963.4 - 1973.4 and 1974.1 - 1991.4. Although in column three of Table 2b the LR-test which include a current value of Δm_t in the estimated equation is significant at a 0.10 level, the coefficient of the contemporaneous value is insignificant. The

---

[8]The results of μ_t which is represented in theory of foreign exchange rate is not reported. We have reported the results of m_t which fully captures government or Central Banks interventions only to avoid repetitions and to conserve space. Note that the results of μ_t and m_t are similar and offer the same conclusion.

modified Sims causality results in Table 3a show that $\Delta m_t \Rightarrow \Delta e_t$. In column four of Table 3a, the LR-test is significant at a 0.05 level while the F-test results is significant at a 0.10 level in the period 1963.4 - 1973.4. In the period 1974.1 - 1991.4, neither the F- nor LR-tests are significant, which means that $\Delta e_t \not\Rightarrow \Delta m_t$. In Table 3b, the modified Sims test indicate that $\Delta e_t \not\Rightarrow \Delta m_t$ in both periods, 1963.4 - 1973.4 and 1974.1 - 1991.4. Again, the LR- and F-tests are insignificant even at a 0.10 level.

The summary results in Table 4 highlight the goodness of fit of restrictions and the direction of causation. It is clear from the results that both the stepwise Granger test and the modified Sims test show that in 1963.4 - 1973.4, $\Delta m_t \Rightarrow \Delta e_t$. There was no reverse causation in the period. In 1974.1 - 1991.4, only the stepwise Granger test shows that $\Delta m_t \Rightarrow \Delta e_t$. Additionally, both tests show no reverse causal relationship in the period.

In 1974.1 - 1991.4 only the modified Sims test shows that Δe_t and Δm_t are independent as judged by the FPE measure of the direction of causation, and the joint tests of restrictions, F- and LR-tests. There are no contemporaneous relationship between Δm_t and Δe_t.

It is safe to conclude from the stepwise Granger results that the monetary approach to determine exchange rate is valid for both periods, and the FEM is incrementally inefficient. This could mean that the government's or central bank's interventions violate the efficiency of the FEM. However, the modified Sims test shows that the monetary approach to exchange rate determination exists only for the period 1963.4 - 1973.4, while the FEM is found to be incrementally efficient in 1974.1 - 1991.4, as the two variables are found to be independent. Thus, the past money supply cannot be used to forecast the current exchange rates.

4: CONCLUSION

In the paper, we have examined the efficiency of the FEM and the monetary approach to exchange rate determination using both the modified Sims and the stepwise Granger causality techniques. The analysis is conducted over the period prior to the global flexible exchange rate in 1973.4 and thereafter. The main empirical conclusions are:

(1) The FEM is weak-form efficient before 1973.4, and incrementally efficient after the global float. The FEM has never been semistrong-form efficient in the entire period of the study. The coefficients of the contemporaneous values were insignificant throughout the study for both techniques employed.

(2) The monetary approach to exchange rate determination is supported by both the stepwise Granger and modified Sims causality techniques in the period prior to 1973.4. However, only the Granger stepwise technique lends support to the monetary approach in the period prevailing after the global float.

(3) There is a strong empirical support for the exogeneity property of money supply in the nation. This means that exchange rates can be forecasted by money supply. Researches which assume the money supply to be endogenous, such as the various estimations of the demand for money in the country should be re-examined.

(4) The Central Bank's or government's interventions in the FEM is influential in the determination of exchange rate. However, it is not the exclusive behaviour of the Central Bank's or government's interventions that violates the efficiency of the FEM in the nation since the coefficient of the contemporaneous value is insignificant through out the study which rules out instantaneous causations.

(5) McKinnon (1993) proposal should be considered seriously in managing the country's exchange rate. In particular, a crawling peg whereby the changes in exchange rate are set by incremental, continual, and small adjustments dictated by the variations in the extent by which the domestic inflation varies from that of the trading partner whose currency is pegged to the domestic currency should be adopted. This method of managing the exchange rate will remove uncertainties, and create a conducive financial environment in both the medium-term and long-run to foster economic growth.

BIBLIOGRAPHY

Akaike, H. (1969),"Fitting autoregressive models for predictions," *Annals of the Institute of Statistical Mathematics*, **39**, 1-58.

Caves, D.W. and E.L. Feige (1980), "Efficient foreign exchange markets and the monetary approach to exchange rate determination," *American Economic Review,* **70**, 120-134.

Cooper, R.V.L. (1974), "Efficient capital markets and the quantity theory of money," *Journal of Finance,* **29**, 887-908.

Fama, E.F. (1970), "Efficient capital markets: a review of theory and empirical work," *Journal of Finance,* **LV**, 383-417.

Frenkel, J.A. (1981), "Flexible exchange rates, prices, and the role of 'news': lessons from the 1970s," *Journal of Political Economics,* **89**, 665-705.

----- and M.L. Mussa (1980), "The efficiency of foreign exchange markets and measures of turbulence," *American Economic Review,* **70**, 374-381.

Friedman, M. (1953), "The case of flexible exchange rates," in *Essays in Positive Economics*, (Chicago: University of Chicago Press), 157-203.

Froot, K.A. and R.H. Thaler (1990), "Anomalies: foreign exchange," *Journal of Economic Perspectives,* **4**, 179-192.

Geweke, J., R. Meese and W. Dent (1983), "Comparing alternative tests of causality in temporal systems: analytic results and experimental evidence," *Journal of Econometrics,* **21**, 161-194.

Ghartey, E.E. (1993), "Causal relationship between exports and economic growth: some empirical evidence in Taiwan, Japan, and the U.S.," *Applied Economics,* **25**, 1145-1152.

Granger, C.W.J. (1969), "Investigating causal relations by econometrics models and cross-spectral methods," *Econometrica,* **37**, 424-438.

Hodrick, R.J. (1990), "Volatility in the foreign exchange and stock markets: is it excessive?", *American Economic Review,* **80**, 186-191.

Hsiao, C. (1979), "Autoregressive modeling of Canadian money and income data," *Journal of American Statistical Association,* **74**, 553-560.

MacDonald, R. and M.P. Taylor (1992), "Exchange rate economics: a survey," *International Monetary Fund Staff Papers,* **39**, 1-57.

MacKinnon, J. (1990), "Critical values for cointegration tests," *Working Paper,* University of California, San Diego.

McKinnon, R.I. (1988), "Monetary and exchange rate policies for international financial stability: a proposal," *Journal of Economic Perspectives*, 83-103.

-----, (1993), *The order of Economic Liberalization* (Baltimore: The Johns Hopkins University Press).

Meese, R.A. and K. Rogoff (1983), "Empirical exchange rate models of the seventies: do they fit out of sample?", *Journal of International Econoomics,* **14**, 3-24.

Mussa, M. (1979), "Empirical regularities in the behaviour of exchange rates and theories of the foreign exchange market", in Brunner, K. and A.H. Meltzer, eds., *Policies for Employment Prices and Exchange Rates,* Carnegie-Rochester Conference

Series on Public Policy, 11, (New York: Amsterdam: North Holland Press), 9-58.

Nurkse, R.A. (1944), *International Curency Experience*, (Geneva: League of Nations).

Sargent, T.J. (1976), "A classical macroeconometric model of the U.S.", *Journal of Political Economy*, 87, 207-237.

Sims, C.A. (1972), "Money, income, and causality", *American Economic Review*, 62, 540-552.

Taylor, M. (1995), "The economics of exchange rates," *Economic Literature*, XXXIII, 13-47.