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Monetary Policy and the Price Behavior in Emerging Shock Markets

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Abstract

This paper examines whether the six largest and most active emerging stock markets are informationally efficient with respect to changes in the money supply. To investigate if stock prices fully reflect the information contained in money supply changes, two different econometric techniques are employed. First, direct Granger-causality tests are used, which focus on the short-run relationship between stock prices and money. Second, the long-run behavior of the two variables is studied by means of co-integration tests. The results suggest that at least for two markets profitable trading rules can be developed to earn consistently higher-than-normal rates of return.

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### Summary

In recent years several developing countries have taken steps to establish and invigorate stock markets. Such markets now exist in more than forty countries. The volume traded in these markets has grown rapidly and in a number of cases the market capitalization is already larger than in some developed European markets.

This paper examines whether the six largest and most active emerging stock markets are informationally efficient. Starting from the notion that in an informationally efficient market stock prices reflect all available information and react instantaneously and in an unbiased fashion to new information, the paper investigates how efficiently stock market participants incorporate into stock prices the information contained in money supply changes.

For this purpose, two econometric techniques are employed. First, direct Granger-causality tests are used, which focus on the short-run relationship between stock prices and money. Second, the long-run behavior of the two variables is studied by means of co-integration tests.

The results suggest that at least for two markets profitable trading rules can be developed to earn consistently higher-than-normal rates of return. However, such a possibility is inconsistent with informational efficiency. Therefore, these findings cast doubt on the markets' ability to channel funds to the most productive sectors of the economy.



## I. Introduction

In recent years several developing countries have made important efforts to establish and invigorate equity markets. Such markets now exist in more than forty countries, most of them being monitored by the International Finance Corporation (1990). The total capitalization of these markets quintupled between 1984 and 1989, 1/ and a few of them are already larger than some developed European markets (Chart 1). 2/ The volume traded in these markets has grown rapidly and despite the high degree of volatility, which most of them have shown in the past, there is an increasing interest by international investors. A report published recently by the World Institute for Development Economics Research (1990) estimates that the emerging stock markets could attract US\$100 billion by the year 2000--provided that important legal and institutional reforms will take place. 3/

In light of the rapid growth of developing country stock markets, the question arises how efficiently they allocate scarce resources. If they were in fact able to channel funds to the most productive sectors of the economy, they would make an important contribution to economic development. Given that credit markets in developing countries are often characterized by imperfect information and oligopolistic banking structures, a well functioning equity market has even been regarded as a precondition for complete financial liberalization (Cho, 1986, p. 192).

One important aspect of a well functioning equity market is its informational efficiency in the sense that the prices of the securities traded in the market act as though they fully reflect all available information and react instantaneously and in an unbiased fashion to new information. 4/ If this were not the case, market participants would be able to earn consistently higher-than-normal rates of return, casting

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1/ In part, this rapid growth has been the result of the remarkable increase in the number of companies listed on those markets; in part, it also reflects increases in the market value of companies already listed on those exchanges, especially in the more advanced markets such as Hong Kong, India or Singapore.

2/ However, in the second half of 1990 equity prices fell sharply in most emerging markets, to a large extent reflecting developments in the Middle East region.

3/ See also Gill and Tropper (1988), The World Bank (1989), and Barger (1990).

4/ This definition refers to the so-called semi-strong form of informational efficiency, where equilibrium security prices reflect not only information available in previous share prices (weak form efficiency) but all information that is publicly available. In contrast, strong form efficiency would exist, if equilibrium security prices also reflected information to which an investor might have monopolistic access. See Fama (1970) and Strong and Walker (1987), pp. 121-142.

serious doubts about the ability of the market to play its allocative role properly (Mookerjee, 1987, p. 1521).

As far as stock markets in industrial countries are concerned, there is a vast and rapidly expanding empirical literature. One line of research has focused on the question how efficiently stock market participants incorporate the information contained in money supply changes into stock prices. 1/ Based on the idea that in an informationally efficient market stock prices immediately reflect changes in monetary policy and accurately anticipate future monetary growth, this approach argues that monetary policy cannot have a systematically lagged effect. 2/ Otherwise, investors would be able to develop profitable trading rules. In fact, the majority of the empirical studies, which have exclusively been concentrated on industrial country stock markets, 3/ tend to support the efficient market hypothesis.

In this paper, it is examined whether similar findings can be derived for the six largest and most active emerging markets, namely, Taiwan (Province of China), Korea, Malaysia, India, Thailand and Mexico 4/ where the rapid overall growth of emerging stock markets has been mainly concentrated. For this purpose two alternative econometric techniques will be employed, first, the direct Granger-causality test, and, second, co-integration tests. Section 2 deals with the first technique. It briefly describes the methodology of this test, discusses the data, and, finally, presents the empirical results. In Section 3, these results are exposed to co-integration tests, which are also briefly discussed before the empirical findings are presented. Finally, Section 4 summarizes the results and concludes.

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1/ In light of Grossman and Stiglitz's (1980) argument that markets can only be informationally efficient if information is costless, this approach seems particularly appropriate as information about money supply changes is readily accessible.

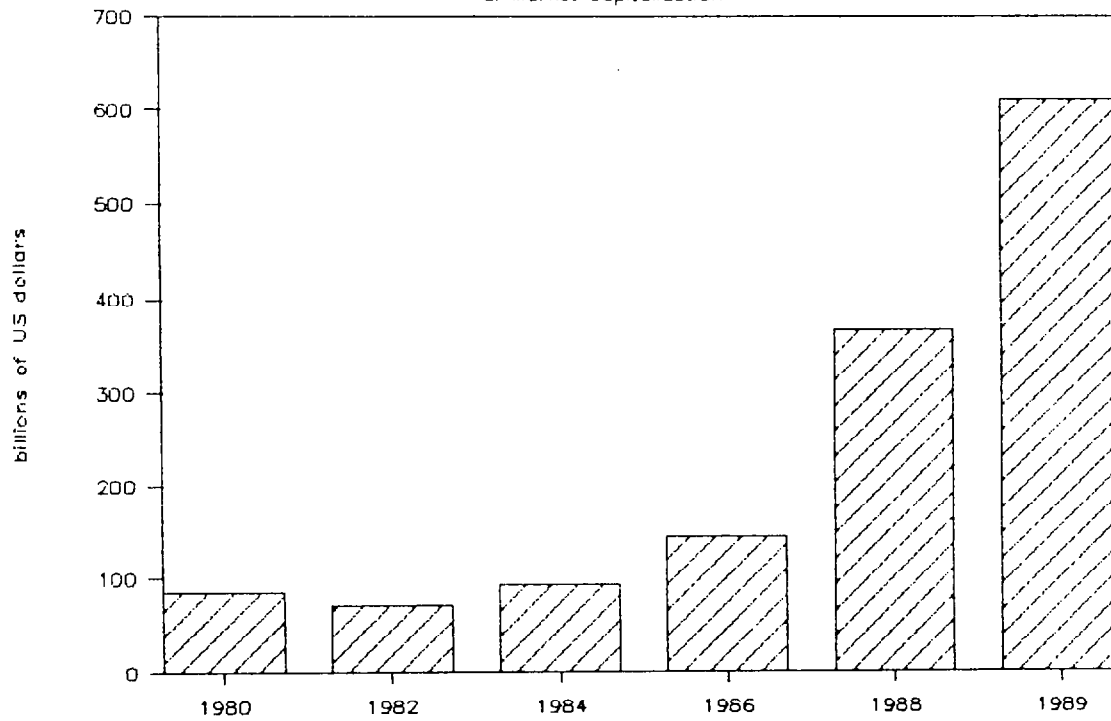
2 Underlying this approach is the belief that money supply changes affect stock prices directly through portfolio changes and indirectly through their effects on real economic variables. See, for example, Homa and Jaffee (1971), Hamburger and Kochin (1972), Cooper (1974), Rozeff (1974), Kraft and Kraft (1977), Rogalski and Vinso (1977), Tanner and Trapani (1977), Davidson and Froyen (1982), Jones and Uri (1987), Mookerjee (1987), Hashemzadeh and Taylor (1988), Hancock (1989), and Darrat (1990).

3/ There are a few studies focusing on the informational efficiency of emerging stock markets, which, however, apply different approaches. See, for example, Sharma and Kennedy (1977), Cooper (1982), Errunza and Losq (1985), Darrat and Mukherjee (1987), Yalawar (1987), and Mookerjee (1988).

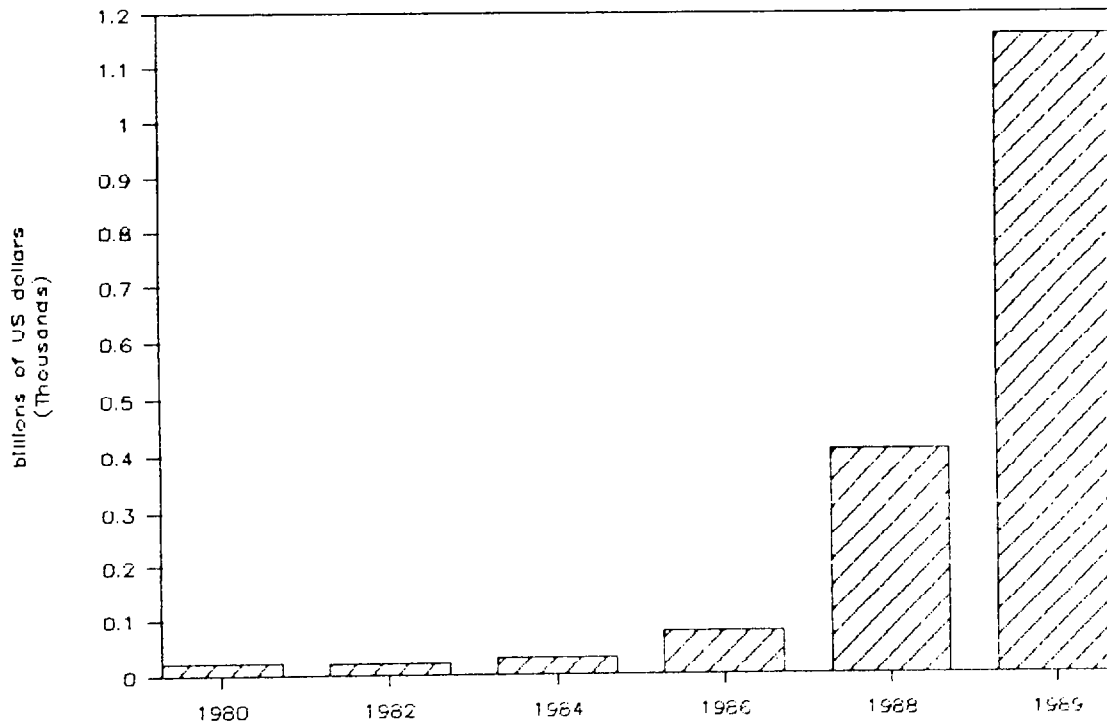
4/ Brazil (São Paulo), the third largest market, has been excluded due to the lack of monetary data.

Chart 1. Emerging Stock Markets

a. Market Capitalization



b. Value traded







## II. The Direct Granger-Causality Test

### 1. Methodology

To examine whether the six above-mentioned emerging stock markets are informationally efficient with regard to changes in the money supply, we first employed the conventional direct Granger-causality test (Granger, 1969). In contrast to similar tests proposed, for example, by Sims (1972) or Geweke (1978), it does not require a pre-filtration of the data, which increases the probability of inefficient estimates (Feige and Pierce, 1979). <sup>1/</sup>

The direct Granger-causality test is based on the predictability of a time series. In the bivariate case, where (X,Y) are assumed to be jointly covariance stationary, a variable X is said to Granger-cause Y, if prediction of the current value of Y is enhanced by using past values of X (and vice versa):

- (1) If  $\sigma^2(X:X,Y) < \sigma^2(X:X) \rightarrow Y$  Granger-causes X;
- (2) If  $\sigma^2(Y:Y,X) < \sigma^2(Y:Y) \rightarrow X$  Granger-causes Y;
- (3) If  $\sigma^2(X:X,Y) < \sigma^2(X:X)$   
and  $\sigma^2(Y:Y,X) < \sigma^2(Y:Y)$  }  $\rightarrow$  bilateral causality;
- (4) If  $\sigma^2(X:X) < \sigma^2(X:X,Y)$   
and  $\sigma^2(Y:Y) < \sigma^2(Y:Y,X)$  }  $\rightarrow$  independence,

where  $\sigma^2(X:X,Y)$  ( $\sigma^2(Y:Y,X)$ ) is the prediction error variance of time series X (Y) derived from knowledge of X and Y and  $\sigma^2(X:X)$  ( $\sigma^2(Y:Y)$ ) is the prediction error variance of time series X (Y) based on information only of X (Y).

Assuming that  $Z_t$  is an m-dimensional covariance-stationary purely non-deterministic vector time series and supposing that  $Z_t = (X_t, Y_t)$  where  $X_t$  and  $Y_t$  are of dimensions k and l, respectively, the Granger causality test examines (after suitable parametrization)

$$(5) X_t = \sum_{j=1}^q \alpha_{1j} X_{t-j} + \mu_{1t}$$

as a restriction of

---

<sup>1/</sup> Although none of the causality tests is free from methodological criticisms, a number of simulation studies (e.g., Geweke, et. al., 1983), which have been undertaken to compare the power of these tests, indicate that the direct Granger-causality test appears particularly appropriate for relatively small samples.

$$(6) X_t = \sum_{j=1}^q \alpha_{2j} X_{t-j} + \sum_{i=1}^p \beta_{2i} Y_{t-i} + \mu_{2t},$$

and

$$(7) Y_t = \sum_{j=1}^q \gamma_{1j} Y_{t-j} + v_{1t}$$

as a restriction of

$$(8) Y_t = \sum_{j=1}^q \gamma_{2j} Y_t + \sum_{i=1}^p \delta_{2i} X_{t-i} + v_{2t}$$

According to this approach a stock market would be said to be informationally inefficient if a casual relationship from changes in the money supply to stock prices could be detected. This would be the case if in the following two equations  $\beta_i$  (as a group) were significantly different from zero and  $\delta_i$  (as a group) were not significantly different from zero:

$$(9) PRICE_t = \sum_{j=1}^q \alpha_j PRICE_{t-j} + \sum_{i=1}^p \beta_i M_{t-i} + \mu_t$$

$$(10) M_t = \sum_{j=1}^q \gamma_j M_{t-j} + \sum_{i=1}^p \delta_i PRICE_{t-i} + v_t,$$

where  $\mu$  and  $v$  are not correlated and  $E(\mu_t, \mu_s) = 0$ ,

$E(v_t, v_s) = 0$ ,  $E(v_t, \mu_s) = 0$ , for all  $t = s$ , and where PRICE denotes the stock price and M the money supply.

In turn, the null hypothesis of informational efficiency would not be rejected, if the estimated coefficients on the lagged money supply variable ( $\beta_j$ ) were (as a group) not significantly different from zero and the estimated coefficients on the lagged stock price variable ( $\delta_j$ ) were significantly different from zero (as a group).<sup>1/</sup> While bidirectional causality, where  $\beta_j$  and  $\delta_j$  are significantly different from zero, would also be consistent with informational efficiency, the

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1/ Note that finding a relationship between lagged values of stock prices and changes in the current money supply is equivalent to finding a relationship between current values of stock prices and future changes in the money supply. This would imply a stock market with a forward-looking propensity, where monetary policy changes are correctly anticipated (Rozeff, 1974).

two series would be said to be independent, if the estimated coefficients on the lagged variables of both stock prices and the money supply were not significantly different from zero.

Before the direct Granger-causality test can be applied, the appropriate lag order has to be determined. For this purpose the Hannan-Quinn parametrization procedure (HQ) (Hannan and Quinn, 1979) was adopted. In contrast to other parametrization schemes (e.g., the Akaike Information Criterion (AIC) or the Schwarz Criterion (SC)) this procedure appears less likely to under- or overestimate the true order in moderate size samples. First, the HQ criterion was applied to the unrestricted version of the regressions (equations 5 and 7) in order to determine the lag order of the dependent variable. Then, the HQ criterion was applied anew to determine the lag order of the independent variable.

The HQ parametrization procedure should guarantee the absence of serial correlation. To check whether the residuals are really white noise, we applied the Lagrange Multiplier Test, whereby the F-form suggested by Harvey (1981) was used as the diagnostic statistic. 1/

## 2. Data

To run the regressions, the following monthly data were used: 2/ First, stock price indexes were taken from the IFC Emerging Markets Data Base. These indexes, which are weighted by market capitalization, are derived from changes in prices, adjusted for changes in capitalization that affect prices per share, such as a stock split. Second, two alternative money supply measures were employed, narrowly defined money, M1 and M2 as the sum of M1 and time deposits. 3/ These two series were taken from the IMF's International Financial Statistics (lines 34 and 35), except for Taiwan (Province of China) where M1 was taken from National Conditions of the Taiwanese Bureau of Statistics and the Quarterly National Economic Trends of the Directorate-General of the Budget Accounting and Statistics. All three series, which are shown in Chart 2 (on a quarterly basis), were converted into growth rates by taking the first difference of the log of each series; all regressions included a constant term.

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1/ For a description of this test, see Hendry (1989).

2/ The estimation period covered January 1984 to June 1990, thus excluding possible exogenous disturbances from the Middle East crisis in the second half of 1990. Due to the lack of data for Malaysia and Taiwan (Province of China) the sample period in these two cases comprised December 1984 and June 1990.

3/ Empirical studies on industrial country stock markets have not provided clear evidence which money supply aggregate market participants regard as relatively more important for gauging changes in monetary policy.

### 3. Empirical Results

The Granger-test results are reported in Table 1.

As regards changes in narrowly defined money none of the emerging stock markets appears to be informationally inefficient. While in the case of Korea a bidirectional causality between M1 and stock prices seems to exist (however, only at the 10 percent level of significance), in all other cases no temporal ordering between the two series could be established. Moreover, as the Lagrange Multiplier test for autocorrelation indicates, none of the regressions suffered serial correlation.

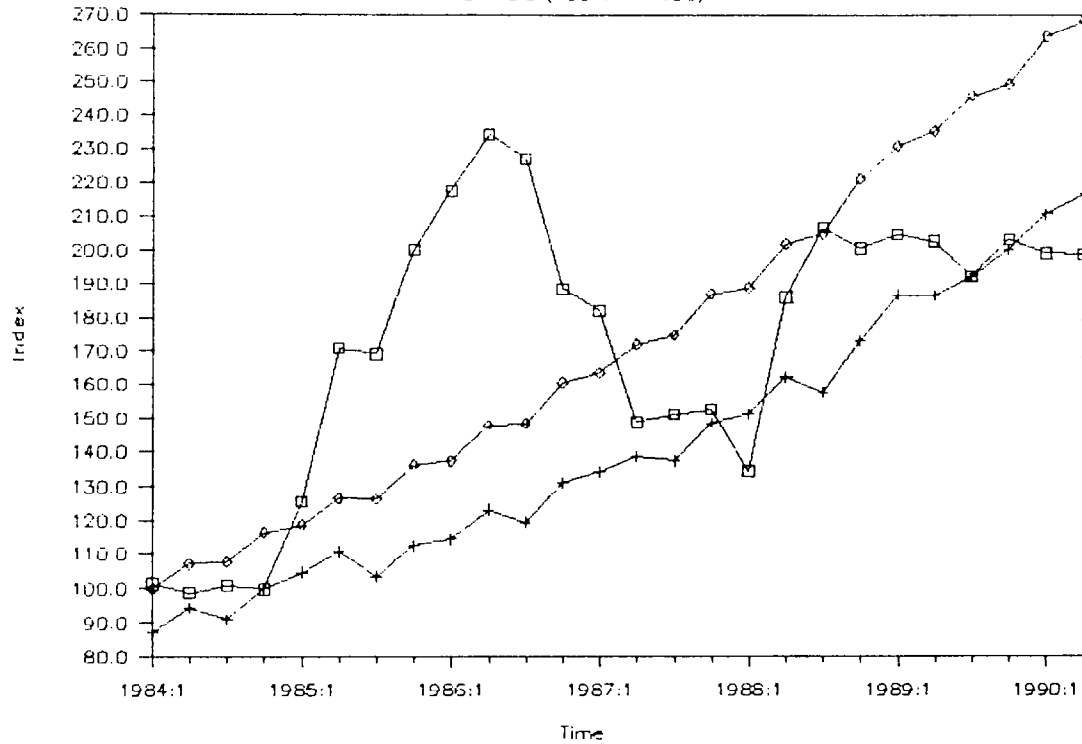
Similar results were obtained when M2 was used. However, in the case of Thailand the null hypothesis that stock prices do not Granger-cause the growth of M2 could be rejected, implying a forward-looking propensity of the Bangkok stock exchange. In all other cases, the direct Granger-causality test was unable to establish a temporal ordering. In fact, the estimated coefficients on the lagged money variable ( $\beta_i$ ) and the lagged stock price variable ( $\delta_i$ ), respectively, were in all cases insignificant.

While these results are consistent with informational efficiency, they do not indicate that monetary policy changes are correctly anticipated. This could mean that the two series are independent. Therefore, it was further tested whether a contemporaneous relationship existed between monetary aggregates and stock prices. For this purpose, the regressions were run again by including current (zero-lag) values of the two variables. If the markets were indeed informationally efficient, then such a contemporaneous relationship could be expected. However, the test results did not support this hypothesis. In none of the regressions, the coefficient on the current value of the stock price variable (nor on the current value of the monetary variable) was significantly different from zero.

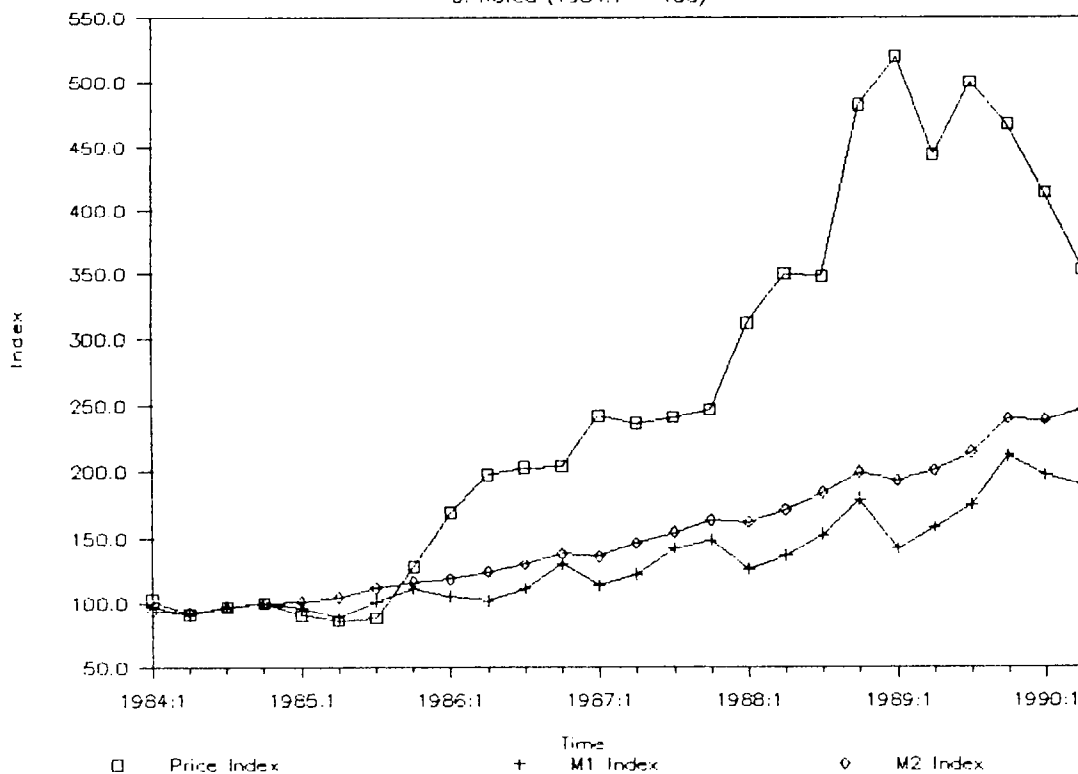
In sum, the empirical evidence from direct Granger-causality tests suggests that the relationship between money and stock prices is rather spurious, supporting Fama's (1981) contention. However, in light of similar studies, which have exclusively focused on industrial country stock markets, these results are somewhat surprising. In contrast to the findings presented here, most of these studies did detect a causal relationship, either from stock prices to money (indicating informational efficiency) or, less often, from money to stock prices (indicating informational inefficiency). A possible explanation for the different findings might be that developed and emerging stock markets have very different characteristics, especially with regard to their legal and institutional frameworks. One consequence could be that the speed with which information is disseminated in developing markets is rather slow so that the lag structure commonly assumed in studies on developed markets may be inappropriate for studying the price behavior in emerging markets. Therefore, it cannot be ruled that informational

Chart 2. Stock Prices and Money

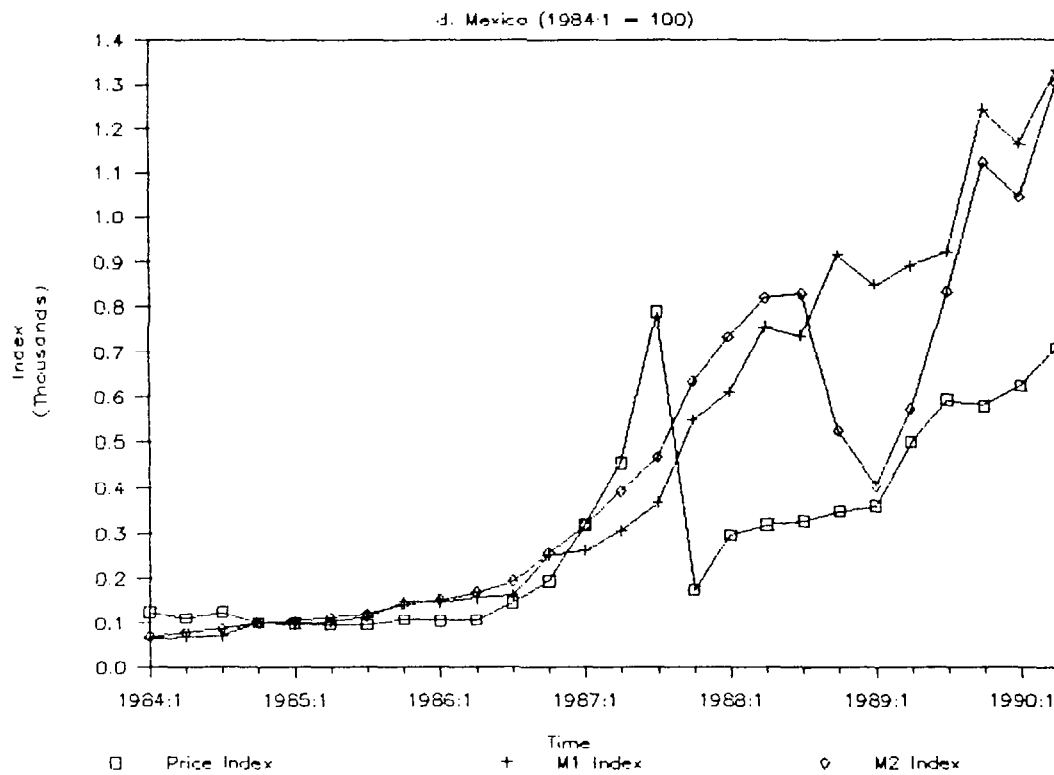
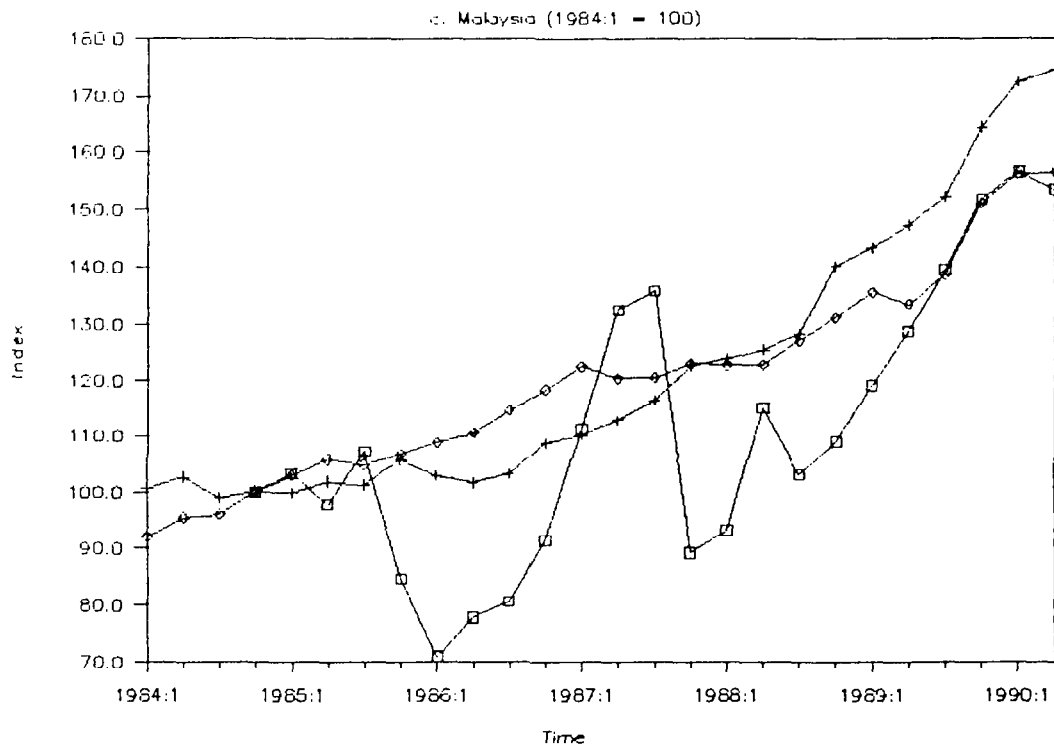
a. India (1984:1 = 100)



b. Korea (1984:1 = 100)











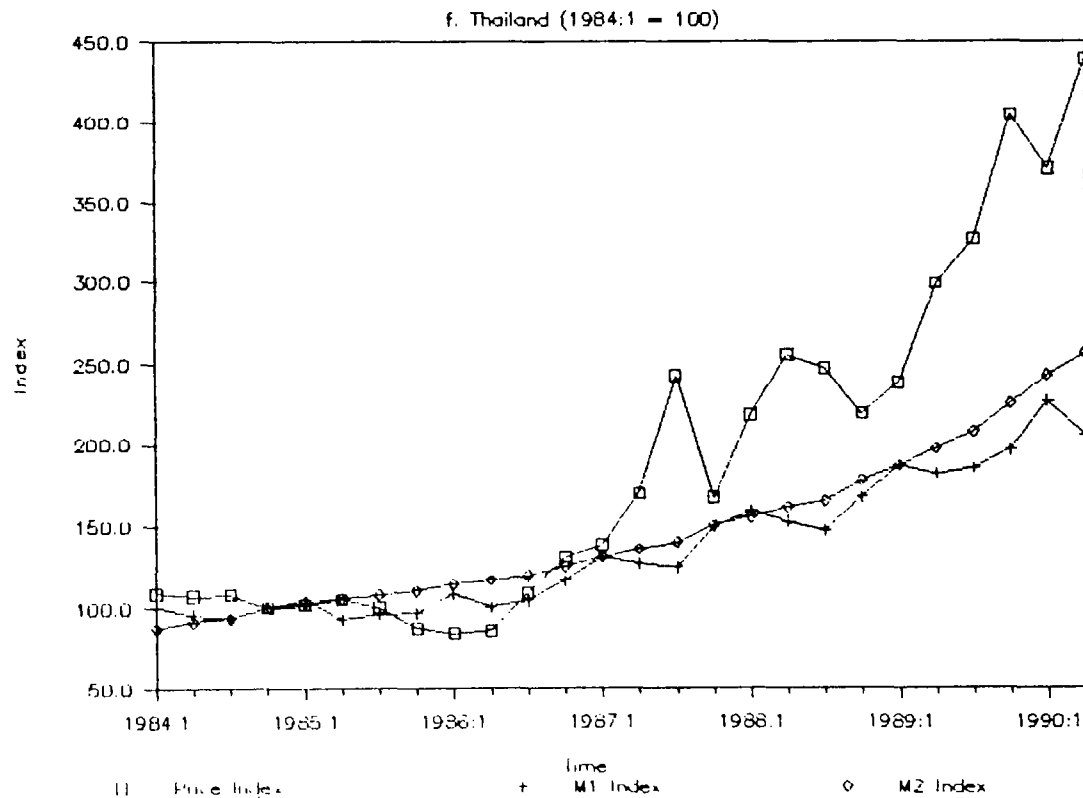
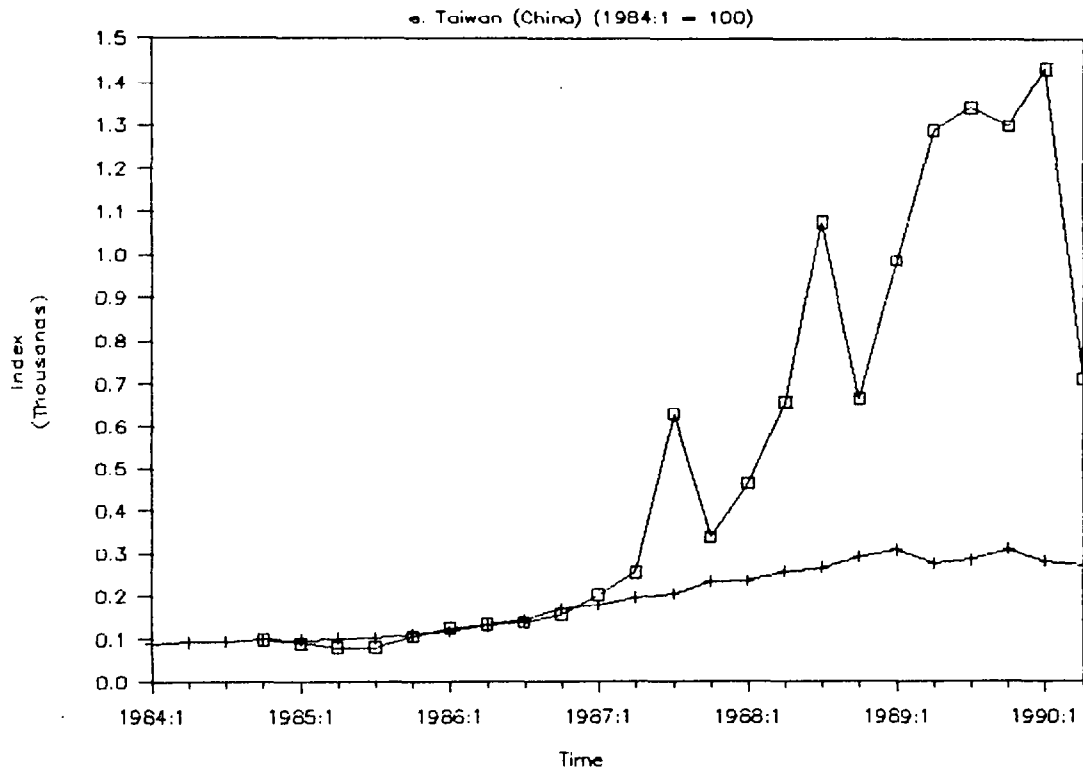




Table 1. Emerging Stock Markets: Granger-Causality Tests of Stock Market Efficiency with M1 and M2

	Null Hypothesis				AR(N)	Conclusion
	M1 does not Granger- cause PRICE	PRICE does not Granger- cause M1	M2 does not Granger- cause PRICE	PRICE does not Granger- cause M2		
India	1.26	0.99	1.03	0.33	1.10 2.04 0.80 1.43	Accept Accept Accept Accept
Korea	1.87*	1.96*	0.89	1.15	0.52 0.61 0.65 0.73	Reject Reject Accept Accept
Malaysia	0.55	1.50	0.84	0.77	0.94 1.73 1.36 0.70	Accept Accept Accept Accept
Mexico	1.32	1.44	0.53	0.24	0.99 1.36 0.61 1.27	Accept Accept Accept Accept
Taiwan (China)	1.06	0.92	...	...	0.75 1.15 ... ...	Accept Accept ... ...
Thailand	0.72	1.70	0.68	2.78**	1.59 1.72 0.51 0.54	Accept Accept Accept Reject

Source: Staff calculations.

Note. \* and \*\* denote significance at the 10 percent and 5 percent levels of significance, respectively.

efficiency does exist without being detected by the direct Granger-causality test. Therefore, a different (co-integration) test was applied, which is discussed in the following section.

### III. Test for Co-integration

#### 1. Methodology

As discussed above, the direct Granger-causality test (as well as other causality tests) makes use of differenced variables in order to get stationary time series for which the standard test theory is applicable. The assumption of stationarity is crucial, because the causality tests do not assume strict exogeneity of lagged  $X$  in the regression for  $Y$  and vice versa. This implies that nonstationary economic time series have to be transformed into stationary ones, for example, by means of a nonlinear transformation like a Box-Cox transformation or a difference filter as applied in this paper. However, it is not clear, whether or not these transformations affect the causality structure (Geweke, 1984). As a result, the differenced time series do not contain any information about the long-run relation between the trend components (levels) of the original series. <sup>1/</sup> While Granger-causality therefore implies long-run neutrality between the variables from the beginning, the tests describe short-run relations only. Therefore, Granger-causality tests do not seem appropriate if variables are moving apart in the short run, but are brought together again to a stationary equilibrium in the long run.

A suitable framework to study variables, which may show such a behavior, is provided by the co-integration approach, mainly developed by Granger and Weiss (1983), Granger (1986), and Engle and Granger (1987). This approach may be briefly described as follows:

A variable,  $X_t$ , which has a stationary, invertible non-deterministic ARMA representation after differencing  $d$  times is said to be integrated of order  $d$ , denoted by  $X_t \sim I(d)$ . <sup>2/</sup> For a pair of variables to be co-integrated, a necessary (but not sufficient) condition is that they be integrated of the same order. If both  $X_t$  and  $Y_t$  are  $I(d)$ , then the linear combination  $Z_t = X_t - \alpha Y_t$  will generally also be  $I(d)$ . However, if there exists a constant scalar  $\alpha$  so that  $Z_t \sim I(d-b)$ ,  $b > 0$ ,  $X_t$  and  $Y_t$  are said to be co-integrated of order  $d$ ,  $b$  denoted  $(X_t, Y_t)' \sim CI(d, b)$ .

The case where  $d = b = 1$  is of particular practical importance. Both  $X_t$  and  $Y_t$ , being  $I(1)$  have dominant long-run components. But although the two variables may each have infinite variance, the linear combination  $Z_t$  is stationary. This means that unless  $Z_t$  is  $I(0)$ ,

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<sup>1/</sup> See, for example, Hendry (1986), Engle and Granger (1987), and Campbell and Shiller (1988).

<sup>2/</sup> A series which is integrated of order zero [ $I(0)$ ] is itself stationary.

$X_t$  and  $Y_t$  will tend to drift apart without bound. Therefore, co-integration of a pair of variables is at least a necessary condition for them to have a stable long-run (linear) relationship.

However, if such a stable long-run relationship existed between stock prices and money, i.e., if the two variables were co-integrated, then the stock market concerned would be said to be informationally inefficient. The logic behind this argument is as follows: If  $\alpha'Z_t \sim CI(1,1)$ , then by the Granger Representation Theorem (Engle and Granger, 1987) there exists an error correction representation of the form

$$(11) A(L)\Delta Z_t = -\gamma \alpha'Z_{t-1} + d(L)\xi_t$$

where  $A(L)$  is a matrix polynomial in the lag operator  $L$  with  $A(0) = I_N$ ,  $\gamma$  is an  $n \times 1$  vector of constants,  $d(L)$  is a scalar polynomial in  $L$ , and  $\xi_t$  is a white noise disturbance term.

Since at least one lagged value of the vector  $Z_t$  enters the system with a non-zero coefficient, the knowledge of  $Z_{t-1}$  can be used to forecast the current level of  $Z_t$ . However, the forecastability of one variable by another due to co-integration is inconsistent with the definition of informational efficiency as this would imply the existence of profitable arbitrage opportunities. In other words, the absence of co-integration is a necessary (but not a sufficient) condition for informational efficiency, where current stock prices reflect all available information in such a way that the best predictor of the stock price variable is its own lagged variable.

Following the co-integration approach outlined above we applied the two-step procedure suggested by Engle and Granger (1987). First, we employed univariate tests for unit roots. To test the null hypothesis that each element of  $Z_t$  is  $I(1)$ , we estimated the following equations using ordinary least squares:

$$(12) \Delta Z_{it} = \beta_0 + \beta_1 Z_{it-1}$$

$$(13) \Delta Z_{it} = \beta_0 + \beta_1 Z_{it-1} + \sum_{j=1}^p \delta_j \Delta Z_{it-j} + \mu_t$$

The conventionally calculated t-statistic for the estimated coefficient  $\beta_1$  was used, with critical values taken from Guilkey and Schmidt (1989). The parameter  $p$  was chosen in such a way that the disturbance term  $\mu_t$  was free of serial correlation. <sup>1/</sup>

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<sup>1/</sup> For  $p = 0$  (equation 12), the test procedure is referred to as the Dickey-Fuller (DF) test; for  $p \geq 1$ , it is known as the Augmented Dickey-Fuller (ADF) test.

Those pairs of series, which are integrated of the same order, have then to be tested for co-integration. We employed three different tests with regard to the null hypothesis that  $X_t$  and  $Y_t$  are not co-integrated, namely the co-integrating Durbin-Watson (CRDW) test, the Dickey-Fuller (DF) test and the Augmented Dickey-Fuller (ADF) test.

For all three tests the following co-integrating regression was run:

$$(14) X_t = \alpha_0 + \alpha_1 Y_t + \varepsilon_t$$

Then, the CRDW statistic was tested to see if the residuals appear stationary, with critical values taken from Engle and Granger (1987). If the residuals are nonstationary, the Durbin-Watson approaches zero; on the other hand, if it exceeds the critical value the test rejects non-cointegration, i.e., finds co-integration. Although Engle and Granger (1987) note various limitations of this test, they nevertheless suggest it for a quick approximate result because of its simplicity.

For the DF and ADF tests, which are based on the tests for unit roots as initially formulated by Fuller (1976) and later extended by Dickey and Fuller (1979 and 1981), the following regressions were run, respectively:

$$(15) \Delta \mu_t = \phi \mu_{t-1} + \varepsilon_t$$

and

$$(16) \Delta \mu_t = \phi_0 \mu_{t-1} + \sum_{j=1}^p \phi_j \Delta \mu_{t-j} + \varepsilon_t,$$

where  $\mu_t$  denote the residuals from equation (14) and  $\Delta \mu_t$  their first differences.

However, one important problem of applying the DF and ADF tests is the determination of  $p$  in (16). If lags are present in the true relationship ( $p \geq 1$ ), equation (15) is inappropriate; if, however, lags are absent ( $p=0$ ), equation (15) appears appropriate. As the use of data-based information criteria like the Akaike Information Criterion (AIC) or the Hannan-Quinn Criterion (HQ) may result in reduced power of the tests (Engle and Granger, 1987), a rather pragmatic approach was chosen. First, equation (16) was estimated with  $p=4$  for which Engle and Granger (1987) provide approximate critical values. In those cases where the  $\mu_t$ 's were significant, equation (16) was regarded as the appropriate regression. However, in those cases where the  $\mu_t$ 's were found to be insignificant, equation (15) was estimated and the DF statistic was selected for which Engle and Granger (1987) also provide critical values at different levels of significance.

Both equations were estimated by ordinary least squares and the conventionally calculated t-statistic for the estimated coefficients was used.

## 2. Empirical Results

The DF and ADF tests for unit roots produced the following results, with values of  $p$  ranging from 0 to 4 (Table 2). 1/

In fact the results were overwhelmingly supportive of the null hypothesis that the (log) level of each stock price and monetary aggregate series has a unit root. Not even in one case the tests were able to reject the null hypothesis of  $I(1)$ .

Based on these findings, the co-integration regression (14) was run. The results are presented in Table 3. 2/

As regards M1 co-integration appears to be most likely in the cases of Malaysia and Thailand where both test statistics rejected the null hypothesis. While for Korea and Taiwan (Province of China) alone the CRDW was significant, there was no indication for co-integration in the cases of India and Mexico. When M2 was used, however, the ADF statistic did indicate co-integration for the Mexican stock market. While the same result was obtained for Malaysia, there were no indications of co-integration as regards the other four markets.

According to these findings, the Kuala Lumpur and Bangkok stock exchanges seem particularly likely to be informationally inefficient. However, in three other cases at least one test statistic indicates the possibility of co-integration. Although the empirical evidence appears less strong for Korea, Mexico, and Taiwan (Province of China), there is reason to be cautious. In fact very little is known about the power of co-integration tests for relatively small samples (Blangiewicz, 1990). According to recent studies (e.g., Blanerjee et al., 1986) the efficiency of those tests appears rather weak, especially for a high ratio of unexplained to explained variances of the co-integrating regressions. As Stock (1984) has pointed out, offsetting the rapid convergence to the true parameter values enjoyed by OLS estimates is a small sample bias that can in certain cases be substantial. Therefore, it cannot be ruled out that informational inefficiency does exist without being clearly indicated by the co-integration analysis.

## IV. Conclusion

This paper examined whether the six largest and most active emerging stock markets appear to be informationally efficient with regard to changes in monetary policy. Two different tests were employed; first, the direct

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1/ Higher values of  $p$  appeared unnecessary for producing white noise residuals in (14).

2/ Estimated coefficient standard errors are not reported since they may be misleading in this context (Granger and Newbold, 1974).

Table 2. Unit Root Tests of Monthly Log Stock  
Price Indexes and Money Supply Aggregates 1/

Country	Dickey-Fuller	Augmented Dickey-Fuller (Lags)			
		1	2	3	4
India					
PRICE	-2.25	-2.21	-2.16	-2.23	-2.36
M1	-0.05	0.16	0.56	0.51	0.66
M2	-0.45	-0.42	-0.42	-0.41	-0.59
Korea					
PRICE	-1.23	-1.20	-1.22	-1.25	-1.38
M1	-1.00	-0.63	-0.29	-0.66	-0.18
M2	0.42	0.53	0.88	0.60	1.11
Malaysia					
PRICE	-1.12	-1.37	-1.42	-1.36	-1.62
M1	0.19	0.33	0.55	0.80	0.77
M2	0.59	0.22	0.27	0.40	0.63
Mexico					
PRICE	-0.78	-1.22	-0.67	-0.56	-0.63
M1	-0.48	-0.46	-0.46	-0.46	-0.45
M2	-0.40	-0.68	-0.75	-0.73	-0.75
Taiwan (China)					
PRICE	-1.29	-1.29	-1.34	-1.23	-1.15
M1	-2.20	-2.03	-2.04	-2.02	-2.00
Thailand					
PRICE	0.47	0.54	0.54	0.55	0.79
M1	0.06	-0.76	-0.90	-0.44	-0.07
M2	3.34	3.17	2.70	2.34	2.30

Source: Staff calculations.

1/ For India, Korea, Mexico, and Thailand the sample size is 73. For Malaysia and Taiwan (Province of China) the sample size is 62. The approximate 1, 5, and 10 percent critical values are -4.18, -3.51, and -3.18 respectively (Guilkey and Schmidt, 1989).



Table 3. Co-Integrating Regressions and Tests for Co-Integration

	Constant	M1	M2	R <sup>2</sup>	CRDW	DF	ADF (P=4)
India	1.379 1.062	0.603	0.562	0.35 0.37	0.13 0.13	-1.87 -1.83	-- --
Korea	-15.372 -15.043	2.294	1.948	0.82 0.90	0.42** 0.19	-- --	-2.46 -2.11
Malaysia	-3.794 -9.168	0.873	1.267	0.54 0.52	0.36* 0.31	-- --	-3.43** -3.41**
Mexico	0.071 -1.382	0.609	0.675	0.76 0.78	0.28 0.27	-- --	-2.71 -3.00*
Taiwan (China)	-28.628	2.454		0.93	0.40**	-2.73	--
Thailand	-3.078 -5.059	1.722	1.538	0.91 0.88	0.45** 0.20	-- -2.50	-3.88*** --

Source: Staff calculations.

Note: Dependent variable is the stock price index PRICE. R<sup>2</sup> is the coefficient of determination, CRDW is the co-integrating Durbin-Watson statistic, with approximate critical values of the 1,5, and 10 percent level of significance of 0.511, 0.386, and 0.322 respectively. Approximate critical values for the Dickey-Fuller statistic (DF) at the 1,5, and 10 percent levels are, respectively, -4.07, -3.37, and -3.03. For the Augmented Dickey-Fuller statistic (ADF) the approximate critical values are -3.77, -3.17, and -2.84 for test sizes of 1,5, and 10 percent (Engle and Granger, 1987). \*, \*\*, and \*\*\* denote significance at 1,5, and 10 percent levels, respectively. Sample period is January 1984-June 1990 for India, Korea, Mexico, and Thailand, and December 1984-June 1990 for Malaysia and Taiwan (Province of China).

Granger-causality test, which was used to analyze the short-term relationship between stock prices and two different monetary aggregates, and, second, co-integration tests, which seem particularly appropriate to study the long-run relationship between these variables. While the results derived from direct Granger-causality tests were consistent with the efficient market hypothesis, the co-integration tests indicated that at least for two markets a causal relationship between money and stock prices does exist. In three other cases the evidence from these tests was ambiguous. However, as it was shown in the paper, co-integration of two variables implies that one variable can be forecast by the other, which is inconsistent with informational efficiency. This means that profitable trading rules can be established, which might beat the market. This, in turn, casts doubts on the ability of these emerging stock markets to channel funds into the most productive sectors of the economy.

Our results are broadly in line with similar studies, which employed random walk tests. <sup>1/</sup> In fact, most of these studies were able to detect first order serial correlation in stock prices. Negative serial correlations were normally found in those markets, where the trade of shares was rather thin and particularly subject to speculative influences. In the more active markets, however, on which this paper has focused, serial correlation often showed a positive sign. As Dailami and Atkin (1990, p. 31) argue, positive serial correlation is likely to result from slow incorporation of new information, insider trading, or infrequent trading. There may be barriers to the dissemination of information, and companies appear to divulge less information with a greater time lag than is the norm in developed markets.

However, our findings must not be interpreted as if these stock markets cannot improve the allocation of scarce resources. As Wai and Patrick (1973, p. 259) argue, one has to compare this situation with one where a stock market does not exist at all: "We have to examine instead where the buyers of securities obtain their funds, and how they would have used them alternatively; and how the lending bank derives its loanable funds, and to what use it would have put them alternatively." Without this information it appears impossible to identify the allocative effects of a stock market. One cannot come to any firm conclusion as to whether or not a stock market improves upon the allocative machinery provided by traditional channels. However, as Drake (1977, p. 76) argue, a stock market would constitute an additional avenue of borrowing and lending; as a result, the capital market would become wider than hitherto and should therefore function more competitively. To the extent that legal and institutional reforms would increase the speed at which new information is disseminated, further gains in the efficiency of capital allocation are likely to occur.

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<sup>1/</sup> These studies are summarized in Dailami and Atkin (1990).

## References

- Banerjee, A., J.J. Dolado, D.F. Hendry, and G.W. Smith, "Exploring Equilibrium Relationships in Econometrics Through Static Models: Some Monte Carlo Evidence," Oxford Bulletin of Economics and Statistics, Vol. 48 (1986), pp. 253-277.
- Barger, Teresa, "How to Set Up a Stock Exchange," The International Economy, (April/May 1990), pp. 64-70.
- Blangiewicz, Maria, and Wojciech W. Charemza, "Co-integration in Small Samples: Empirical Percentiles, Drifting Moments, and Customized Testing," Oxford Bulletin of Economic and Statistics, Vol. 52 (August 1990), pp. 303-315.
- Campbell, John Y., and Robert J. Schiller, "Interpreting Co-integrated Models," Journal of Economic Dynamics and Control, Vol. 12 (1988), pp. 505-522.
- Cho, Yoon Je, "Inefficiencies from Financial Liberalization in the Absence of Well-Functioning Equity Markets," Journal of Money, Credit and Banking, Vol. 18 (May 1986), pp. 191-199.
- Cooper, John C.B., "World Stock Markets: Some Random Walk Tests," Applied Economics, Vol. 14 (October 1982), pp. 515-535.
- Cooper, Richard V.L., "Efficient Capital Markets and the Quantity Theory of Money," The Journal of Finance, Vol. 24 (June 1974), pp. 887-921.
- Dailami, Mansoor, and Michael Atkin, "Stock Markets in Developing Countries. Key Issues and a Research Agenda," Working Paper WPS 515 (Washington, D.C.: The World Bank, October 1990).
- Darrat, Ali F., "Stock Returns, Money, and Fiscal Deficits," Journal of Financial and Quantitative Analysis, Vol. 25 (September 1990), pp. 387-398.
- \_\_\_\_\_, and T.K. Mukherjee, "The Behavior of the Stock Market in a Developing Economy," Economics Letters (1987), pp. 273-278.
- Davidson, Lawrence S., and Richard T. Froyen, "Monetary Policy and Stock Returns: Are Stock Markets Efficient?" Federal Reserve Bank of St. Louis Review, Vol. 64 (February 1982), pp. 3-12.
- Dickey, D.A., and W.A. Fuller, "Distribution of the Estimators for Autoregressive Time Series with a Unit Root," Journal of the American Statistical Association, Vol. 74 (1979), pp. 427-431.

- \_\_\_\_\_, "The Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root, Econometrica, Vol. 49 (1981), pp. 1057-1072.
- Drake, P.J., "Securities Markets in Less Developed Countries," The Journal of Development Studies, Vol. 13 (January 1977), pp. 73-91.
- Engle, Robert F., and Clive W.J. Granger, "Co-integration and Error Correction: Representation, Estimation and Testing," Econometrica, Vol. 55 (March 1987), pp. 251-276.
- Errunza, V.R., and E. Losa, "The Behavior of Stock Prices in LDC Markets," Journal of Banking and Finance (1975), pp. 561-575.
- Fama, Eugene F., "Efficient Capital Markets: A Review of Theoretical and Empirical Work," The Journal of Finance, Vol. 25 (May 1970), pp. 393-417.
- \_\_\_\_\_, "Stock Returns, Real Activity, Inflation, and Money," The American Economic Review, Vol. 71 (June 1981), pp. 545-565.
- Feige, Edgar L., and Douglas K. Pearce, "The Causal Relationship between Money and Income: Some Caveats for Time Series Analysis," The Review of Economics and Statistics, Vol. 61 (November 1979), pp. 521-533.
- Fuller, W.A., Introduction to Statistical Time Series, (New York: Wiley, 1976).
- Geweke, John, "Testing The Exogeneity Specification in the Complete Dynamic Simultaneous Equation Model," Journal of Econometrics, Vol. 7 (April 1978), pp. 163-185.
- \_\_\_\_\_, "Inference and Causality in Economic Time Series Models," in Handbook of Econometrics, Vol. 2, ed. by Zvi Griliches and Michael D. Intriligator (Amsterdam, North Holland, 1984), pp. 1101-1144.
- \_\_\_\_\_, R. Meese, and W. Dent, "Comparing Alternative Tests of Causality in Temporal Systems: Analytical Results and Experimental Evidence," Journal of Econometrics, Vol. 21 (1983), pp. 161-194.
- Gill, Daniel, and Peter Tropper, "Emerging Stock Markets in Developing Countries," Finance and Development, Vol. 25 (December 1988), pp. 28-31.
- Granger, Clive W.J., "Investigating Causal Relations by Econometric Models and Cross Spectral Methods," Econometrica, Vol. 37 (May 1969), pp. 424-438.

- \_\_\_\_\_, "Developments in the Study of Co-integrated Economic Variables," Oxford Bulletin of Economic and Statistics, Vol. 48 (1986), pp. 213-228.
- \_\_\_\_\_, and P. Newbold, "Spurious Regressions in Econometrics," Journal of Econometrics, Vol. 2 (1974), pp. 111-120.
- \_\_\_\_\_, and A.A. Weiss, "Time Series Analysis of Error Correction Models," in Econometrics, Time Series and Multivariate Statistics, ed. by S. Karlin, T. Amemiya, and L.A. Goodman (New York: Academic Press, 1986).
- Grossman, Sanford J., and Joseph E. Stiglitz, "On the Impossibility of Informationally Efficient Markets," The American Economic Review, Vol. 70 (1980), pp. 393-408.
- Guilkey, David K., and Peter Schmidt, "Extended Tabulations for Dickey-Fuller Tests," Economics Letters, Vol. 31 (December 1989), pp. 355-357.
- Hamburger, Michael J., and Levis A. Kochin, "Money and Stock Prices: The Channels of Influence," Journal of Finance, Vol. 27 (May 1972), pp. 231-249.
- Hancock, D.G., Fiscal Policy, Monetary Policy and the Efficiency of the Stock Market," Economics Letters, Vol. 31 (November 1989), pp. 65-69.
- Hannan, E.J., and B.G. Quinn, "The Determination of the Order of an Autoregression," Journal of the Royal Statistical Society (Series B), Vol. 41 (1979), pp. 190-195.
- Harvey, A.C., The Econometric Analysis of Time Series (Oxford: Phillip Alan, 1981).
- Hashemzadeh, Nozar, and Phillip Taylor, "Stock Prices, Money Supply, and Interest Rates: The Question of Causality," Applied Economics, Vol. 20 (December 1988), pp. 1603-1611.
- Hendry, David F., "Econometric Modeling with Co-integrated Variables: An Overview," Oxford Bulletin of Economics and Statistics, Vol. 48 (1986), pp. 201-212.
- \_\_\_\_\_, "The Econometrics of PC-GIVE," in D.F. Hendry, PC-GIVE: An Interactive Menu-Driven Econometric Modelling Program, Oxford: Oxford University Press, (1989).
- Homa, Kenneth E., and Dwight M. Jaffee, "The Supply of Money and Common Stock Prices," The Journal of Finance, Vol. 26 (December 1971), pp. 1045-1066.
- International Finance Corporation, Emerging Stock Markets Factbook 1990 (Washington, D.C.: International Finance Corporation, 1990).

- Jones, Jonathan D., and Noel D. Uri, "The Money Supply, Stock Returns and Causality," Economic Notes, 1:1987, pp. 39-51.
- Khambata, Farida, and Dara Khambata, "Emerging Capital Markets: A Case Study of Equity Markets in India," The Journal of Developing Areas, Vol. 23 (April 1989), pp. 425-438.
- Kraft, John, and Arthur Kraft, "Determinants of Common Stock Prices: A Time Series Analysis," The Journal of Finance, Vol. 32 (May 1977), pp. 417-425.
- Mookerjee, Rajin, "Monetary Policy and the Informational Efficiency of the Stock Market: The Evidence from Many Countries," Applied Economics, Vol. 19 (1987), pp. 1521-1532.
- \_\_\_\_\_, "The Stock Market and the Economy: The Indian Experience 1949-1981," The Indian Economic Journal, Vol. 36 (Oct./Dec. 1988), pp. 30-43.
- Rogalsjki, Richard J., and Joseph D. Vinso, "Stock Returns, Money Supply and the Directions of Causality," The Journal of Finance, Vol. 32 (September 1977), pp. 1017-1030.
- Rozeff, Michael S., "Money and Stock Prices. Market Efficiency and the Lag in Effect of Monetary Policy," Journal of Financial Economics, Vol. 1 (1974), pp. 245-302.
- Sharma, J.L., and Robert E. Kennedy, "A Comparative Analysis of Stock Price Behavior on the Bombay, London, and New York Exchanges," Journal of Financial and Quantitative Analysis, Vol. 12 (September 1977), pp. 391-413.
- Sims, Christopher A., "Money, Income, and Causality," The American Economic Review, Vol. 62 (September 1972), pp. 540-552.
- Stock, J.H., Asymptotic Properties of Least Squares Estimators of Co-integrating Vectors, (Harvard University, mimeo).
- Strong, Norman, and Martin Walker, Information and Capital Markets (Oxford: Basil Blackwell, 1987).
- Tanner, J. Ernest, and John M. Trapani, "Can the Quantity Theory be Used to Predict Stock Prices - Or is the Stock Market Efficient?" Southern Economic Journal, Vol. 44 (October 1977), pp. 261-270.
- The World Bank, World Development Report 1989, (New York: Oxford University Press, 1989).
- Wai, U. Tun, and Hugh T. Patrick, "Stock and Bond Issues and Capital Markets in Less Developed Countries," Staff Papers, International Monetary Fund, Vol. 20 (June 1973), pp. 253-275.

World Institute for Development Economics Research, Foreign Portfolio  
Investment in Emerging Equity Markets, (Helinski, 1990).

Yalawar, Yalaguresh, "Bombay Stock Exchange: Rates of Return and  
Efficiency," The Indian Economic Journal, Vol. 35 (1987), pp. 68-121.

