



Dynamic relationship between stock prices and exchange rates for G-7 countries

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Abstract

There are two major findings from our time-series estimations. First, we find that there is no long-run significant relationship between stock prices and exchange rates in the G-7 countries. This result interfaces with Bahmani-Oskooee and Sohrabian's (1992) finding, but contrasts with the studies that suggest there be a significant relationship between these two financial variables. Our second finding is that the short-run significant relationship has only been found for one day in certain G-7 countries. For instance, currency depreciation often drags down stock returns in the German financial market, but it stimulates the Canadian and UK markets on the following day. However, an increase in stock price often causes currency depreciation the next day in Italy and Japan. In addition, we also find that the record of stock price and the value of the dollar cannot be depended on when predicting the future in the US, either in the short-run or long-run. © 2001 Board of Trustees of the University of Illinois. All rights reserved.

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1. Introduction

The dynamic relationships between stock prices and foreign exchange rates have drawn the attention of numerous economists, both for theoretical and empirical reasons, because

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they both play crucial roles in influencing the development of a country's economy. The relationships between stock prices and foreign exchange rates have frequently been utilized in predicting the future trends for each other by fundamentalist investors.

In an open economy, the expectations of relative currency values influence the levels of domestic and foreign interest rates (as explained in the theory of "Uncovered Interest Rate Parity"), which in turn affect the present value of a firm's assets. This suggests that exchange rates play a considerable role in the movements of stock prices, especially for internationally held financial assets.¹

Macroeconomic fundamentals are seen by economists as providing the robust media to link stock prices and foreign exchange rates. Among all the monetary models of exchange rate determination (Chicago, Keynesian, or interest-differential), money supply, interest rate, price level, and inflation are taken into account to predict the exchange rate movement.² Branson, et al.'s (1977) portfolio-balance model further incorporates assets of portfolios to describe the "stock-oriented" exchange rate movement. Among empirical studies, Meese and Rogoff (1983), Wolff (1988), Baillie and Selover (1987), and Gharthey (1998) have found certain relationships among macro-fundamentals and exchange rates,³ whereas the empirical evidence for the relationships among macro-fundamentals and stock prices are found in Bailay (1990), Sadeghi (1992), and Kwon and Shin (1999).

Studies have also examined firms' exchange rate "exposure." As Adler and Dumas (1984) point out, the concept of exposure is arbitrary in the sense that stock prices and exchange rates are determined jointly.⁴ By assuming that capital markets react fully and instantaneously to changes in a country's currency, these studies have encountered limited success in identifying a significant correlation between stock prices and a currency's fluctuations. (See: e.g., Bodnar and Gentry (1993), Barton and Bodnar (1994), and Choi (1995).)

Nonetheless, the relationships between stock prices and exchange rates have been empirically analysed for the past three decades. The results are somewhat mixed as to the significance and the direction of influences between stock prices and exchange rates. The significant interactions between these two financial variables are described in various papers, such as Aggarwel (1981), and Ayarslan (1982) by traditional statistical methods. Other studies conducted, since 1987, have employed newly developed time-series methodologies to investigate the dynamic relationship between these two financial variables [e.g., Dropsy and Nazarian-Ibrahimi (1994), and Ajayi and Mougoue (1996).] However, the studies of Bahmani-Oskooee and Sohrabian (1992), etc. suggest no co-movement between stock prices and exchange rates.

Unlike most studies in the literature that only estimate the contemporaneous relationship among time series, this paper explores the dynamic relationships between the stock prices and the exchange rates for each G-7 country. Both the Engle-Granger (EG) two steps and the Johansen maximum likelihood cointegration tests are employed. The appropriate framework of the vector error correction model (VECM) is further applied to assess both the short-run intertemporal comovement between these two financial variables and their long-run equilibrium relationship. This paper also differs from previous studies in that, in order to capture the comoving trend between stock prices and exchange rates, it employs Johansen's (1988, 1990, and 1994) five VECM models.⁵ Johansen's five VAR models fully consider the

determinant of cointegrating ranks in the presence of a linear trend and a quadratic trend [See: Johansen (1992 and 1994).]

Our empirical work rejects most of the previous studies that suggest a significant relationship between stock prices and exchange rates. The result supports Bahmani-Oskooee and Sohrabian's (1992) finding that there is no long-run equilibrium relationship between these two financial variables. Nonetheless, from VECM, significant short-run findings show the one-day predicting power of the two financial assets for certain countries. For instance, currency depreciation will drag the stock return in the German financial market and stimulate the Canadian and UK markets on the following day. On the other hand, an increase in the stock price today causes currency depreciation tomorrow for Italy and Japan. The estimation of VECM also indicates a notable finding: among the G-7 countries, for all test statistics (*t*-statistics and *F*-statistics), the US fails to show any significant correlation—implying that the two financial variables within the US are exogenous and not affected by each other at all.

The remainder of this paper is organized as follows: Section 2 describes the data. Section 3 presents the econometrics models and discusses the empirical findings. Section 4 summarizes and concludes this paper.

2. Data

The data, obtained from Dow Jones News/Retrieval provided by Dow Jones, Inc., consists of 618 observations, for the sample period from October 1, 1993 to February 15, 1996, of daily closing stock market indices and foreign exchange rates for the G-7 countries: Canada, France, Germany, Italy, Japan, UK and the US.⁶ The stock market index for each country of these G-7 countries except the US is the Dow Jones World Index (CNUSI, FRUSI, GEUSI, ITUSI, JAUSI, and UKUSI). For the US, however, I used the local stock market index, the Dow Jones Industrial Average (IND). The foreign exchange rate series, CDY, FRF, DMY, ITLY, JYY and BPY, are spot rates from International Monetary market (IMM), which are indices in the form of units of foreign currency per US dollar (FC/\$); whereas, the US dollar index (DXY) is Financial Instrument Exchange (FNX). Table 1 presents the symbols of stock market indices and foreign exchange rates used in this paper for each G-7 country.

3. The econometric models

3.1. Unit roots

According to Schwert (1989) that the ADF test by Dickey and Fuller (1981) with long lags is superior to the others, this paper simply employs ADF test. The model used in this study includes a drift and a time trend.

$$\Delta y_t = \alpha + \phi y_{t-1} + \gamma t + \sum_{i=2}^p \beta_i \Delta y_{t-i+1} + \varepsilon_t \quad (1)$$

Table 1
Symbols used for each country of G-7

Country	Stock Index (DJ World Index)	Exchange Rate (Spot rate (IMM))	Currency
Canada	CNUSI	CDY (CD\$ per \$)	Canadian Dollar
France	FRUSI	FRF (FF per \$)	French Franc
Germany	GEUSI	DMY (DM per \$)	Deutsche Mark
Italy	ITUSI	ITLY (Lira per \$)	Lira
Japan	JAUSI	JYY (YEN per \$)	Yen
United Kingdom	UKUSI	BPY (Pound per \$)	Pound Sterling
United States	IND	DXY (\$ index)	U.S. Dollar

Notes: 1. Abbreviations: IMM for International Monetary Market; xxUSI for Dow Jones World Index for country xx.

2. IND is the local stock index, Dow Jones Industrial Average.

3. DXY is Dollar index, which is the daily spot rate of Financial Instrument Exchange (FNX)

The null hypothesis for ADF test is: $H_0: \phi = 0$, with the alternative $H_1: -2 < \phi < 0$. To insure the “stationarity” for the higher order of integration, this paper again employs the multiple-unit-root test suggested by Dickey and Pantula (1987). As long as it is possible not to reject the null hypothesis that the various values of the ϕ_i are zero, the multiple unit roots, say r , continue toward the equation:

$$\Delta^r y_t = \phi_1 \Delta^{r-1} y_{t-1} + \phi_2 \Delta^{r-2} y_{t-1} + \phi_3 \Delta^{r-3} y_{t-1} + \dots + \phi_r y_{t-1} + \varepsilon_t \quad (2)$$

The estimation might be biased if the lag length is pre-designated without rigorous determination. We, thus, use Akaike’s information criterion (AIC) to determine the optimal number of lags based on the “principle of parsimony.”

Table 2 shows the results that the level of all the fourteen series are in the cases of “non-rejection” of a unit root at least at the 1% significant level. However, results from Dickey-Pantula’s multiple unit roots test tells us that all difference series, one or higher orders, are stationary (e.g., Test for the null hypotheses of two unit roots and three unit roots are all rejected significantly). Therefore, only single unit-root is argued for all the stock prices and exchange rates of G-7 countries.

3.2. Cointegration

To avoid the “spurious regression” problem,⁷ we apply the newly developed cointegration test to capture the long-run equilibrium relationship between exchange rates and stock prices for each G-7 country. Two methodologies are employed:

3.2.1. Engle and Granger (1987) two-step methodology⁸

Engle-Granger technique estimating the long-run equilibrium relationship by applying ADF unit root tests for the estimated residuals is first applied in this study.

Here we use notations S and F to denote the stock market index and foreign exchange rate, respectively. We thus have: $S_t = \beta_0 + \beta_1 F_t + e_t$

Table 2
Tests for the order of integration based on Dickey-Pantula test

Variables	$\tau_{\tau}(1)$	$\tau_{\tau}(2)$	$\tau_{\tau}(3)$
FOREIGN EXCHANGE RATES:			
CDY	-2.2429	-15.0296***	-24.0039***
FRF	-2.4254	-16.0489***	-26.0381***
DMY	-2.2360	-14.4675***	-25.0431***
ITLY	-2.5308	-16.5474***	-26.4136***
JYY	-0.6508	-14.6358***	-25.2024***
BPY	-2.5188	-14.9022***	-24.6666***
DXY	-1.9746	-14.4352***	-24.0029***
STOCK MARKET INDICES:			
CNUSI	-1.9022	-13.9406***	-26.6910***
FRUSI	-2.9075	-15.5120***	-25.1284***
GEUSI	-3.8150**	-14.7884***	-25.2283***
ITUSI	-2.0397	-13.5236***	-25.0272***
JAUSI	-2.4339	-15.8245***	-25.6388***
UKUSI	-2.4934	-14.1844***	-22.9640***
IND	-0.4572	-14.4115***	-23.2867***

Notes: 1. $\tau_{\tau}(1)$: test for single unit root; $\tau_{\tau}(2)$: test for two unit roots; $\tau_{\tau}(3)$: test for three unit roots.

2. The unit roots tests are based on the equation (2) with two lags, the 1%, 5%, and 10% critical values are -3.9742, -3.4180, and -3.1313, respectively.

We then estimate $\Delta \hat{e}_t = a_1 \hat{e}_{t-1} + \sum_{i=1}^n a_{i+1} \Delta \hat{e}_{t-j} + \epsilon_t$ (the augmented Dickey-Fuller test)

If $-2 < a_1 < 0$, we can conclude that the residual series is stationary and variables S_t (stock price) and F_t (exchange rate) are $CI(1, 1)$.

The results of the EG tests are presented in Table 3. The only observation of a cointegration relationship between stock price and exchange rate exists in the German market, but

Table 3
Engle-Granger Test for the cointegration

Country	VL	Cointegrating Vector			ADF τ -statistic for residual
Canada	4	1.0000	1.4392	-2.6793	-2.8446
France	4	1.0000	-0.1096	-0.2513	-2.6247
Germany	3	1.0000	0.0629	-4.1123	-3.7235*
Italy	7	1.0000	1.3670	1.6094	-2.5793
Japan	2	1.0000	0.2857	0.7204	-2.3755
United Kingdom	2	1.0000	-0.9908	-3.6068	-3.3121
United States	12	1.0000	0.3213	-3.4656	-1.6575

Notes: 1. All cointegration vectors are normalized with respect to first variable.

2. The critical values for the ADF t -statistics are from the MacKinnon (1991) table.

3. VL is defined as VAR Lag length which is selected by AIC.

4. The symbol ***, **, and *, represent the significant at 1%, 5%, and 10% levels and the critical values are -4.3496, -3.7952, and -3.5073, respectively.

this exhibits a weak support of a long-run equilibrium relationship, owing to its significance at the 10% level. All other six countries present features that no cointegration relationship exists between these two financial assets since the ADF τ -statistics for residual are all insignificant.

3.2.2. Johansen Multivariate Maximum Likelihood cointegration test

Second, we applied the more powerful Johansen Multivariate Maximum Likelihood cointegration test to investigate the long-run relationship between stock prices and exchange rates.⁹

The test hypothesis is formulated as the restriction for the reduced rank of Π : $H_0(r)$: $\Pi = \alpha\beta'$ for the reduced form error correction model (ECM):

$$\begin{aligned} \Delta X_t = & \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-(k-1)} + \Pi X_{t-1} + \Psi D_t \\ & + \epsilon_t \text{ (where } \epsilon_t \text{ is white noise)} \end{aligned}$$

where α and β are both $p \times r$ matrices, and represent the speed of the adjustment parameter and cointegrating vector, respectively.

The likelihood ratio test statistic for the hypothesis that there are at most r cointegrating vector (i.e. $H(r)$: $\text{rank}(\Pi) \leq r$) is: $-2 \ln Q(H(r)/H(p)) = -T \sum_{i=r+1}^p \ln(1 - \hat{\lambda}_i)$

This elaborate work has been developed from Johansen (1988) to Johansen (1994).¹⁰ There are total five Johansen VAR models with ECM, which are summarized as following forms:¹¹

$$\begin{aligned} H_0(r): \Delta X_t = & \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-(k-1)} + \alpha\beta' X_{t-1} + \Psi D_t \\ & + \epsilon_t \quad (1988) \end{aligned} \quad (3)$$

$$\begin{aligned} H_1^*(r): \Delta X_t = & \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-(k-1)} + \alpha(\beta', \beta_0)(X'_{t-1}, 1)' + \Psi D_t \\ & + \epsilon_t \quad (1990) \end{aligned} \quad (4)$$

$$\begin{aligned} H_1(r): \Delta X_t = & \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-(k-1)} + \alpha\beta' X_{t-1} + \mu_0 + \Psi D_t \\ & + \epsilon_t \quad (1990) \end{aligned} \quad (5)$$

$$\begin{aligned} H_2^*(r): \Delta X_t = & \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-(k-1)} + \alpha(\beta', \beta_1)(X'_{t-1}, t)' + \mu_0 + \Psi D_t \\ & + \epsilon_t \quad (1994) \end{aligned} \quad (6)$$

$$\begin{aligned} H_2(r): \Delta X_t = & \Gamma_1 \Delta X_{t-1} + \dots + \Gamma_{k-1} \Delta X_{t-(k-1)} + \alpha\beta' X_{t-1} + \mu_0 + \mu_1 t + \Psi D_t \\ & + \epsilon_t \quad (1994) \end{aligned} \quad (7)$$

To analyze the deterministic term, Johansen decomposed the parameters μ_0 and μ_1 in the directions of α and $\alpha_\perp$ as $\mu_i = \alpha\beta_i + \alpha_\perp\gamma_i$, thus we have $\beta_i = (\alpha'\alpha)^{-1}\alpha'\mu_i$ and $\gamma_i = (\alpha'_\perp\alpha_\perp)^{-1}\alpha'_\perp\mu_i$. The nested sub-models of the general model of null hypothesis $\Pi = \alpha\beta'$ are, therefore, defined as:

$$H_0(r): \quad Y = 0$$

$$H_1^*(r): \quad Y = \alpha\beta_0$$

$$H_1(r): \quad Y = \alpha\beta_0 + \alpha_{\perp}\gamma_0$$

$$H_2^*(r): \quad Y = \alpha\beta_0 + \alpha_{\perp}\gamma_0 + \alpha\beta_1 t$$

$$H_2(r): \quad Y = \alpha\beta_0 + \alpha_{\perp}\gamma_0 + (\alpha\beta_1 + \alpha_{\perp}\gamma_1)t$$

Johansen (1994) emphasized the role of the deterministic term, $Y = \mu_0 + \mu_1 t$, which includes constant and linear terms in the Gaussian VAR. Applying the idea of Johansen (1992), the decision procedure among the hypotheses $H(r)$ and $H^*(r)$ for five different models is presented in the following order:

$$\begin{aligned} H_0(0) &\rightarrow H_1^*(0) \rightarrow H_1(0) \rightarrow H_2^*(0) \rightarrow H_2(0) \rightarrow H_0(1) \rightarrow H_1^*(1) \\ &\rightarrow H_1(1) \rightarrow H_2^*(1) \rightarrow H_2(1) \rightarrow \dots \rightarrow \dots \rightarrow H_0(p-1) \\ &\rightarrow H_1^*(p-1) \rightarrow H_1(0-1) \rightarrow H_2^*(0-1) \rightarrow H_2(p-1) \end{aligned}$$

Table 4 represents the empirical findings from the Johansen methodology for the long-run relationship with the consideration of a linear trend and a quadratic trend between stock prices and exchange rates for each G-7 country.

These empirical findings again show the features of no cointegration relationship for each G-7 country. The null hypothesis $H(r): r = 0$ of a zero cointegration rank for each of the G-7 countries, except the US, is not rejected for the case without a drift (a linear trend in the level) and a time trend (a quadratic trend in the level). The exception is that in the US market, the IND (US local stock index-Dow Jones Industrial Average) and DXY (Dollar index) co-move with an intercept in the level. The Johansen test reinforces the EG test that the two financial variables (stock prices and exchange rates) do not hold a long run equilibrium relationship: they are not moving together and might drift far apart in the long run. This phenomenon exists in all these G-7 countries.

3.3. Vector error correction model

An important concept of ECM is stated in the “Granger representation theorem” that for any set of $I(1)$ variables, error correction and cointegration are equivalent representations [as explained in Engle and Granger (1987)].

Since the ECM can capture both the short-run dynamic and the long-run equilibrium relationship between variables, we use it to estimate the relationship between stock price, S , and exchange rate, F .

$$\Delta S_t = \alpha_1 + \alpha_S \hat{e}_{t-1} + \sum_{i=1}^{n_1} \alpha_{11}(i) \Delta S_{t-i} + \sum_{j=1}^{n_2} \alpha_{12}(j) \Delta F_{t-j} + \epsilon_{st} \quad (8)$$

Table 4
Determination of cointegration rank in the presence of a linear trend and a quadratic trend

1. CANADA (CNUSI & CDY)										
Rank	T ₀ (r)	C ₀ (5%)	T ₁ [*] (r)	C ₁ [*] (5%)	T ₁ (r)	C ₁ (5%)	T ₂ [*] (r)	C ₂ [*] (5%)	T ₂ (r)	C ₂ (5%)
r = 0	6.12	12.53	9.96	19.96	7.25	15.41	14.79	25.32	14.67	18.17
r ≤ 1	2.62	3.84	3.21	9.24	1.78	3.76	5.12	12.25	5.03	3.74
AIC:	4		4		4		4		4	
2. FRANCE (FRUSI & FRF)										
Rank	T ₀ (r)	C ₀ (5%)	T ₁ [*] (r)	C ₁ [*] (5%)	T ₁ (r)	C ₁ (5%)	T ₂ [*] (r)	C ₂ [*] (5%)	T ₂ (r)	C ₂ (5%)
r = 0	5.92	12.53	16.38	19.96	15.35	15.41	22.19	25.32	21.37	18.17
r ≤ 1	0.78	3.84	3.69	9.24	3.39	3.76	6.96	12.25	6.30	3.74
AIC:	4		4		4		3		3	
3. GERMANY (GEUSI & DMY)										
Rank	T ₀ (r)	C ₀ (5%)	T ₁ [*] (r)	C ₁ [*] (5%)	T ₁ (r)	C ₁ (5%)	T ₂ [*] (r)	C ₂ [*] (5%)	T ₂ (r)	C ₂ (5%)
r = 0	2.82	12.53	7.72	19.96	6.29	15.41	21.62	25.32	21.44	18.17
r ≤ 1	0.68	3.84	1.56	9.24	1.45	3.76	3.35	12.25	3.20	3.74
AIC:	3		3		3		3		3	
4. ITALY (ITUSI & ITLY)										
Rank	T ₀ (r)	C ₀ (5%)	T ₁ [*] (r)	C ₁ [*] (5%)	T ₁ (r)	C ₁ (5%)	T ₂ [*] (r)	C ₂ [*] (5%)	T ₂ (r)	C ₂ (5%)
r = 0	6.93	12.53	15.11	19.96	15.10	15.41	20.91	25.32	19.47	18.17
r ≤ 1	0.00	3.84	6.67	9.24	6.67	3.76	6.69	12.25	6.42	3.74
AIC:	7		7		7		7			7
5. JAPAN (JAUSI & JYY)										
Rank	T ₀ (r)	C ₀ (5%)	T ₁ [*] (r)	C ₁ [*] (5%)	T ₁ (r)	C ₁ (5%)	T ₂ [*] (r)	C ₂ [*] (5%)	T ₂ (r)	C ₂ (5%)
r = 0	3.49	12.53	7.65	19.96	7.65	15.41	8.48	25.32	6.56	18.17
r ≤ 1	0.00	3.84	1.26	9.24	1.26	3.76	2.02	12.25	0.27	3.74
AIC:	2		2		2		3		3	
6. UNITED KINGDOM (UKUSI & BPY)										
Rank	T ₀ (r)	C ₀ (5%)	T ₁ [*] (r)	C ₁ [*] (5%)	T ₁ (r)	C ₁ (5%)	T ₂ [*] (r)	C ₂ [*] (5%)	T ₂ (r)	C ₂ (5%)
r = 0	4.95	12.53	7.33	19.96	6.14	15.41	20.44	25.32	19.71	18.17
r ≤ 1	1.06	3.84	2.27	9.24	1.10	3.76	2.77	12.25	2.06	3.74
AIC:	2		2		2		3		3	
7. UNITED STATES (IND & DXY)										
Rank	T ₀ (r)	C ₀ (5%)	T ₁ [*] (r)	C ₁ [*] (5%)	T ₁ (r)	C ₁ (5%)	T ₂ [*] (r)	C ₂ [*] (5%)	T ₂ (r)	C ₂ (5%)
r = 0	12.88	12.53	16.34	19.96	7.86	15.41	18.22	25.32	11.62	18.17
r ≤ 1	1.34	3.84	2.31	9.24	0.01	3.76	6.41	12.25	0.05	3.74
AIC:	12		12		12		12		12	

Notes: 1. T₀(r), T₁^{*}(r), T₁(r), T₂^{*}(r), and T₂(r) denote the likelihood ratio test statistics for all the null hypotheses of H(r) versus the alternative of H(p) which include all the cases with or without the linear trend and quadratic trend.

2. The numbering of the rank is from left to right and top to bottom and decide to reject a hypothesis if all hypotheses with smaller number are also rejected.

3. C₀(5%) denotes 95% critical value from table-0; C₁^{*}(5%) denotes 95% critical value from table-1*; C₁(5%) denotes 95% critical value from table-1; C₂^{*}(5%) denotes 95% critical value from table-2*; C₂(5%) denotes 95% critical value from table-2. All tables are from Osterwald-Lenum (1992).

4. The bold number with double underline indicates the selection of the rank in the presence of linear trend and quadratic trend.

5. VAR length is selected based on the smallest number of AIC (Akaike's Information Criterion).

$$\Delta F_t = \alpha_2 + \alpha_f \hat{e}_{t-1} + \sum_{i=1}^{n_3} \alpha_{21}(i) \Delta S_{t-i} + \sum_{j=1}^{n_4} \alpha_{22}(j) \Delta F_{t-j} + \epsilon_{ft} \tag{9}$$

The error correct term, $\hat{e}_{t-1}$, represents the previous period's disequilibrium ($S_{t-1} - \beta_1 F_{t-1}$). The ϵ_{st} and ϵ_{ft} are stationary random processes intended to capture other pertinent

information not contained in lagged values of F_t and S_t . Nonetheless, we use Akaike's Information Criterion (AIC) to determine the optimal lag length based on the Principle of "Parsimony" to avoid the biased estimation.

The traditional test statistics (e.g., t -test and F -test) for the VAR analysis are employed for estimating the parameters of all α s (α_s , α_f , $\alpha_{11}(i)$, $\alpha_{12}(j)$, $\alpha_{21}(i)$, and $\alpha_{22}(j)$). The short-run dynamics relationship between the stock prices and the exchange rates can be captured by the coefficients of α_{12} and α_{21} . The existence of a long-run relationship between the two financial variables is secured from the statistically significant finding of one or both of the speed of adjustment coefficients (i.e., α_s and α_f). Nonetheless, we examine the lagged influence of each variable by estimating coefficients of α_{11} and α_{22} .

As we can see in Table 5, with the exception in the stock price of France, all the two coefficients of long-run disequilibrium terms for ΔS and ΔF , α_s and α_f , are not statistically significant at least at the 1% significant level.¹² This finding confirms again that no long-run co-movement exists between these two financial variables. Moreover, applying partial F -distribution, we jointly tested the null hypotheses $H_0: \alpha_s = \alpha_{11}(i) = \alpha_{12}(j) = 0$ ($i = 1, \dots, n_2$) and $H_0: \alpha_f = \alpha_{21}(i) = \alpha_{22}(j) = 0$ ($i = 1, \dots, n_3$ and $j = 1, \dots, n_4$) for the short-run dynamic relationships between these two financial variables.¹³ The lagged length is taken two for our ECM. The simultaneously zero null hypotheses (F -statistic) are rejected for these two financial variables among most countries, which implies that either contemporaneously or one or two lead-lagged influence exists for these two variables. However, some exceptions exist among the exchange rates of Canada, Germany, and the US and the stock price of the US, which exhibit insignificant F -statistics. Table 5 also shows equivocal findings for the short-run intertemporal comovements [e.g., the t -statistic of $\alpha_{12}(j)$ ($j = 1, 2$) and $\alpha_{21}(i)$ ($i = 1, 2$)]. Taking the 1% significant level, the coefficients of $\alpha_{12}(2)$ (ΔF_{t-2} on ΔS) and $\alpha_{21}(2)$ (ΔS_{t-2} on ΔF) for each G-7 country is insignificant. This suggests that there is no short-run impact for more than two-lagged length. However, one lagged influence is found within certain countries. The positive finding of the estimation of $\alpha_{21}(1)$ (ΔS_{t-1} on ΔF) for Italy and Japan implies that an increase in the stock price will have a one-day positive effect on exchange rate value (the depreciation of the domestic currency). The negative finding for Germany and the positive finding for Canada and the United Kingdom of $\alpha_{12}(1)$ (ΔF_{t-1} on ΔS) indicate that currency depreciation will drag the stock return in the German financial market and stimulate the Canadian and UK markets on the following day.¹⁴

4. Conclusion

Unlike most studies in the literature that only estimate the contemporaneous relationship among time series, this paper explores the dynamic relationships between the stock prices and the exchange rates for each G-7 country. Both the EG two steps and the Johansen maximum likelihood cointegration tests are employed. The appropriate framework of VECM is further applied to assess both the short-run intertemporal comovement between these two financial variables and their long-run equilibrium relationship. This paper also differs from previous studies in that it incorporates Johansen's (1988, 1990, and 1994) five VECM

Table 5
Estimation of error correction model for stock market indices and foreign exchange rates

<i>Stock Market Indices (ΔS)</i>							
	c (α_1)	$\hat{e}_{t-1}$ α_s	ΔS_{t-1} $\alpha_{11}(1)$	ΔS_{t-2} $\alpha_{11}(2)$	ΔF_{t-1} $\alpha_{12}(1)$	ΔF_{t-2} $\alpha_{12}(2)$	$F\text{-}stst$
Canada	-7.34 (-0.65)	-0.01 (-1.23)	-0.26 (-5.73) ***	-0.08 (-1.88) *	0.63 (3.39) ***	0.26 (1.40)	$\langle 7.72 \rangle$ ***
France	306.29 (3.08) ***	-0.03 (-3.07) ***	0.01 (0.27)	0.00 (0.08)	-0.00 (-1.05)	-0.01 (-2.27) **	$\langle -2.76 \rangle$ **
Germany	41.75 (2.20) **	-0.02 (-1.96) **	-0.02 (-0.50)	0.11 (2.36) **	-0.68 (-5.15) ***	-0.21 (-1.55)	$\langle 10.39 \rangle$ ***
Italy	-41.81 (-0.80)	-0.01 (-0.81) ***	0.13 (-2.99) **	-0.09 (-2.19)	-0.12 (-0.95)	-0.01 (-0.07)	$\langle 2.73 \rangle$ **
Japan	201.53 (2.34) **	-0.02 (-2.34) **	-0.06 (-1.39)	-0.02 (-0.36)	-0.05 (-0.63)	-0.05 (-0.69)	$\langle 1.99 \rangle$ *
U.K.	24.91 -1.38	-0.01 (-1.23)	0.06 (-1.34)	0.08 (-1.85) *	0.15 (-3.29) ***	-0.02 (-0.52)	$\langle 3.10 \rangle$ **
U.S.	-1661.46 (-0.59)	0.00 (0.70)	0.07 (1.78) *	0.02 (0.44)	-1.97 (-0.83)	0.87 (0.37)	$\langle 0.99 \rangle$
<i>Foreign Exchange Rates (ΔF)</i>							
	c (α_1)	$\hat{e}_{t-1}$ α_f	ΔS_{t-1} $\alpha_{21}(1)$	ΔS_{t-2} $\alpha_{21}(2)$	ΔF_{t-1} $\alpha_{22}(1)$	ΔF_{t-2} $\alpha_{22}(2)$	$F\text{-}stst$
Canada	-1.62 (-0.60)	-0.00 (-0.54)	-0.00 (-0.36)	-0.01 (-1.12) **	0.09 (2.12)	-0.04 (-0.87)	$\langle 1.63 \rangle$
France	-899.46 (-0.61)	0.09 (0.62)	0.50 (0.83)	-0.48 (-0.80)	-0.66 (-17.17) ***	-0.34 (-8.83) ***	$\langle 61.57 \rangle$ ***
Germany	3.24 (0.46)	0.00 (-0.35)	0.01 (0.87)	0.03 (1.92)	-0.07 (-1.33)	-0.02 (-0.39)	$\langle 1.12 \rangle$
Italy	35.28 (1.96) **	0.00 (1.98) **	0.05 (3.06) ***	-0.02 (-1.38)	-0.48 (-11.37) ***	-0.18 (-4.22) ***	$\langle 28.50 \rangle$ ***
Japan	-14.36 (-0.31)	-0.00 (0.31)	0.20 (9.07) ***	0.01 (0.50)	-0.06 (-1.55)	0.02 (0.55)	$\langle 17.13 \rangle$ ***
U.K.	14.93 (0.83)	-0.00 (-0.85)	0.06 (1.30)	0.08 (1.69) *	-0.22 (-4.88) ***	0.05 (1.05)	$\langle 7.31 \rangle$ ***
U.S.	0.81 (0.02)	-0.00 (-0.03)	-0.00 (-1.25)	0.00 (-0.47)	-0.05 (-1.18)	0.06 (1.50)	$\langle 1.29 \rangle$

Notes: 1. The numbers inside parentheses below the estimated coefficients are the t -statistics.
 2. The symbol ***, **, and *, represent the significant at 1%, 5%, and 10% levels, respectively.
 3. The 1%, 5%, and 10% critical values are 2.576, 1.960, and 1.645 for t -statistic with 2 degrees of freedom.
 4. The 1%, 5%, and 10% critical values for F -statistic with d.o.f. of 5 (for numerator $n1 = 6 - 1$) and 612 (for denominator $n2 = 618 - 6$) are 3.02, 2.21, and 1.85.

models to consider the determinant of cointegrating ranks in the presence of a linear trend and a quadratic trend.

The interesting finding is that this paper rejects most of the previous studies that suggest a significant relationship between stock prices and exchange rates. Our time-series estimations support Bahmani-Oskooee and Sohrabian's (1992) finding that there is no long-run equilibrium relationship between these two financial variables for each G-7 country. This finding is obtained from both the EG two-steps and the Johansen multivariate maximum likelihood cointegration tests and is further reinforced by analyzing the coefficient of the disequilibrium term of the VECM. Another finding is that, based on the results from the VECM estimation, the two lead-lagged length of one financial variable has little power in predicting the other. This complies with the conclusion that these two financial variables do not have predictive capabilities for more than two consecutive trading days. Only one day's short-run significant relationship has been found in certain G-7 countries. For instance, in the short-run, currency depreciation will drag the stock return in the German financial market and stimulate the Canadian and UK markets on the following day. On the other hand, an increase in the stock price today causes currency depreciation tomorrow for Italy and Japan. The estimation of VECM shows another notable result that among the G-7 countries, for all test statistics (*t*-statistics and *F*-statistics), the US fails to show any significant correlation. This implies that the record of stock price (Dow-Jones Industrial Average) and the value of the dollar cannot be depended on when predicting the future in the US, either in the short-run or long-run.

From a practical view, most investors believe that both stock prices and exchange rates can serve as instruments to predict the future path of each other. However, our ambiguous findings question this belief. Our short-run analysis from VECM only shows the one-day predicting power of the two financial assets in certain countries. The different results among G-7 countries might be due to deeper causes, not merely from the observed financial factors. The ambiguous results might be influenced by each country's differences in economic stage, government policy, expectation pattern, etc. The differences in the degree of internationalization and liberalization and the degree of the capital control from country to country can also be crucial factors, which result in different predicting power of the two financial assets: stock prices and exchange rates. Moreover, the insignificant long-run outlook (no cointegration) for each of the G-7 countries implies that these two financial assets share no common trends in their economy system and hence they will move apart in the long run.

Notes

1. The stock prices explain the present values discounted from future cash flows of their firms.
2. See: Frenkel (1976), Bilson (1978), Dornbusch (1976), Frankel (1979), Dornbusch and Fisher (1980), and Hooper and Monton (1982).
3. Meese and Rogoff (1983) supported the naive random walk forecasting rule, which implies that there are certain relationships among fundamentals and exchange rates. However, Wolff (1988) obtained the opposite result.

4. Exposure describes the relationship between changes in the value of a country's currency and contemporaneous changes in the value of the firm in question as measured by stock prices.
5. As in Engle and Granger (1987), all the variables in the ECM model are treated as jointly endogenous.
6. The data are the daily closing indices for the sample period without covering the observations on Saturday, Sunday, and some major holidays. Thus, only 618 observations are obtained.
7. See Granger and Newbold (1974).
8. Granger (1981) first described the concept of cointegration. However, the test of cointegration was first developed by Engle and Granger (1987) which was later known as a two-step cointegration test plus another estimation for checking the existence of the error correction mechanism (ECM).
9. Gonzalo (1994) compared several methods of estimating cointegration which include ordinary least squares, nonlinear least squares, maximum likelihood in an error correction model, principle components, and canonical correlations and found to be the best method to proceed cointegration estimation.
10. Johansen (1992, 1994) developed a testing procedure based on the ideas developed by Pantula (1989) to determine the number of cointegrating rank in the presence of linear trend [Johansen (1992)] and quadratic trend [Johansen (1994)].
11. The equations (4) and (5) are indeed from Johansen and Juselius (1990).
12. For the 5% critical level, few more exceptions are presented. They are among the stock prices of Germany and Japan and the exchange rates of Italy.
13. The partial F -statistic is as the following form: $F_{k1,k2} = (SSE_r - SSE_{ur})/k1 / SSE_{ur}/k2$ where SSE_r and SSE_{ur} are sum of squared errors for restricted and unrestricted versions of equations (8) and (9), respectively. $k1$ and $k2$ are degrees of freedom for numerator and denominator. In this paper, I take two lagged changes for each series, thus $k1$ is 5 ($= 6 - 1$) and $k2$ is 612 ($= 618 - 6$), respectively.
14. Positive finding of the influence transmitted from the exchange rate market to the stock market implies that one lag domestic currency depreciation (increasing in the exchange rate) has a positive impact on the domestic stock price and vice-versa.

References

- Adler, M., & Dumas, D. (Summer 1984). Exposure to currency risks: definition and measurement. *Financial Management*, 13, 41–50.
- Aggarwal, R. (Fall 1981). Exchange rates and stock prices: a study of the U.S. capital markets under floating exchange rates. *Akron Business and Economic Review*, 7–12.
- Ajayi, R. A., & Mougoue, M. (Summer 1996). On the dynamic relation between stock prices and exchange rates, *The Journal of Financial Research*, 2, 193–207.
- Ayarlan, S. (Summer 1982). Foreign exchange rates and stock prices of U.S. multinational corporations. *Mid-Atlantic Journal of Business*, 13–27.
- Bahmani-Oskooee, M., & Sohrabian, A. (April 1992). Stock prices and the effective exchange rate of the dollar. *Applied Economics*, 24(4), 459–464.

- Bailey, W. (September 1990). U.S. money supply announcements and Pacific rim stock markets: evidence and implications. *Journal of International Money and Finance*, 9(3), 344–356.
- Baillie, R. T., & Selover, D. D. (1987). Cointegration and model of exchange rate determination. *International Journal of Forecasting*, 3, 43–51.
- Barton, E., & G. Bodnar, M. (December 1994). Firm valuation, earning expectations, and the exchange rate exposure effect. *Journal of Finance*, 49(5), 1755–1786.
- Bilson, J. (1978). The monetary approach to the exchange rate: some empirical evidence. *IMF Staff Paper*, 25, 48–75.
- Bondar, G. M., & Gentry, W. M. (February 1993). Exchange rate exposure and industry characteristics: evidence from Canada, Japan and U.S. *Journal of International Money and Finance*, 12, 29–45.
- Branson, W., Halttunen, H., & Masson, P. (Dec. 1977). Exchange rate in the short run: the dollar Deutsche mark rate. *European Economic Review*, 10, 303–324.
- Choi, J. J., & Prasad, A. M. (1995). Exchange risk sensitivity and its determinants: a firm and industrial analysis of U.S. multinationals. *Financial Management*, 24(3), 77–88.
- Dickey, D. A., & Fuller, W. A. (1981). Likelihood ratio statistics for autoregressive time series with a unit root. *Econometrica*, 49, 1057–1072.
- Dickey, D. A., & Pantula, S. G. (1987). Determining the order of differencing in autoregressive processes. *Journal of Business and Economic Statistics*, 5, 445–461.
- Dornbusch, R. (1976). Expectations and exchange rate dynamics, *Journal of Political Economy*, 84, 1161–1176.
- Dornbusch, R., & Fischer, S. (1980). Exchange rates and the current account. *American Economic Review*, 70, 960–971.
- Dropsy, V., & Nazarian-Ibrahimi, F. (1994). Macroeconomic policies, exchange rate regimes and national stock markets, *International Review of Economics and Finance*, 3(2), 195–220.
- Engle, R., & Granger, C. (1987). Co-integration and error correction representation, estimation and testing. *Econometrica*, 55, 251–267.
- Frankel, J. A. (1979). On the Mark: a theory of floating exchange rates based on real interest differentials. *The American Economics Review*, 69(4), 610–622.
- Frenkel, J. (1976). (1976). A monetary approach to the exchange rate: doctrinal aspects and empirical evidence. *Scandinavian Journal of Economics*, 78(2), 220–224.
- Ghartey, E. E. (1998). Monetary dynamics in Ghana: evidence from cointegration, error correction modelling, and exogeneity. *Journal of Development Economics*, 57(2), 473–486.
- Gonzalo, J. (1994). Five alternative methods of estimating long-run equilibrium relationships. *Journal of Econometrics*, 60, 203–233.
- Granger, C. W. J. (1981). Some properties of time series data and their use in econometric model specification. *Journal of Economics*, 16, 121–130.
- Granger, C. W. J., & Newbold, P. (1974). Spurious regressions in econometrics. *Journal of Econometrics*, 2, 111–120.
- Hooper, P., & Morton, J. E. (1982). Fluctuations in the dollar: a model and real exchange rate determination. *Journal of International Money and Finance*, 1, 39–56.
- Johansen, S. (1988). Statistical analysis of cointegration vectors. *Journal of Economic Dynamics and Control*, 12, 231–254.
- Johansen, S. (1992) Determination of cointegration rank in the presence of a linear trend. *Oxford Bulletin of Economics and Statistics*, 54(3), 383–397.
- Johansen, S. (1994). The role of the constant and linear terms in cointegration analysis of nonstationary variables. *Econometric Reviews*, 13(2), 205–229.
- Johansen, S., & Juselius, K. (1990). Maximum likelihood estimation and inference on cointegration with applications to the demand for money. *Oxford Bulletin of Economics and Statistics*, 52, 169–210.
- Kwon, C. S., & Shin, T. S. (1999). Cointegration and causality between macroeconomic variables and stock market returns. *Global Finance Journal*, 10(1), 71–81.
- Mackinnon, J. E. (1991). Critical values for cointegration tests. In R. F. Engle and C. W. J. Granger, *Long run economic relationships*, (pp. 267–276). Oxford University Press.

- Meese, R. A., & Rogoff, K. (1983). Empirical exchange rate models of the seventies: are any fit to survive? *Journal of International Economics*, 14, 3–24.
- Pantula, S. G. (1989). Testing for unit roots in time series data. *Econometric Theory*, 5, 256–271.
- Sadeghi, M. (1992). Stock market response to unexpected macroeconomic news: the Australian evidence. *IMF Working Paper*, 61, 9.
- Schwert, G. W. (1989). Tests for unit roots: a Monte Carlo investigation. *Journal of Business and Economic Statistics*, 7, 147–159.
- Wolff, C. C. P. (1988). Exchange rates, innovations and forecasting. *Journal of International Money and Finance*, 7, 49–61.