INTERNATIONAL JOURNAL OF BUSINESS, 11(4), 2006 ISSN: 1083–4346

The Relationship between Exchange Rate and Stock Prices during the Quantitative Easing Policy in Japan

Yutaka Kurihara
Faculty of Economics
Aichi University
kurihara@vega.aichi-u.ac.jp

ABSTRACT

Japan experienced unprecedented recession and deflation for more than 10 years. The Bank of Japan enforced quantitative monetary easing at a level never seen before. One purpose is to influence stock prices for economic recovery. Recently, the Japanese economy has been in recovery, and stock prices have increased. However, there is much dispute over whether quantitative easing has been effective. This paper investigates the relationship between macroeconomic variables and stock prices. Exchange rate is the main target variable and finds that interest rates have not impacted Japanese stock prices but exchange rates and U.S. stock prices have. Furthermore, the Bank of Japan's policy for overcoming recession and deflation has been effective.

JEL Classification: *F31, G15*

Keywords: *Exchange rate; Interest rate; Japan; Stock market; U.S.A.*

I. INTRODUCTION

Japan experienced unprecedented recession and deflation for more than 10 years. During that period, Japan enforced very aggressive fiscal policies, and the Bank of Japan (BOJ) performed unprecedented quantitative monetary easing. Since 2001, the BOJ has conducted quantitative easing (Kurihara, 2006).

One of the purposes of BOJ's policy seems to be to influence stock prices, although BOJ has not admitted to this purpose. The governor of BOJ has reiterated again and again the importance of increasing the transfer of funds from "safe" to "risky" assets. The quantitative easing policy is related to this purpose.

This paper analyzes the relationship between Japanese stock prices and macroeconomic factors. In most developed countries, the most important factor in determining stock prices has been interest rates. However, in Japan, interest rates have been close to zero since the quantitative easing policy was implemented in 2001. The effect of interest rates changes on stock prices seems to have decreased to the point of being negligible. Other macroeconomic factors, such as exchange rates and U.S. stock prices, may affect stock prices. This paper finds that exchange rates and U.S. stock prices have been significant determinants of Japanese stock prices.

This paper is structured as follows. The next section provides a theoretical exploration of the relationship between the stock market and other macroeconomic factors. Empirical analysis is followed by the theoretical analysis. Finally, the paper concludes with a brief summary.

II. RELATIONSHIP BETWEEN STOCK MARKET AND MACROECONOMIC FACTORS

The relationship between stock prices and macroeconomic factors has been discussed all over the world. This paper considers the determinants of 'daily' stock prices in Japan. Daily stock prices are determined by many factors, including enterprise performance, dividends, stock prices of other countries, gross domestic product (GDP), exchange rates, interest rates, current account, money supply, employment, their information and so on. Countless factors have an impact on daily stock prices. It should be also noted that previous studies have used monthly or quarterly data whereas this paper relies on daily data.

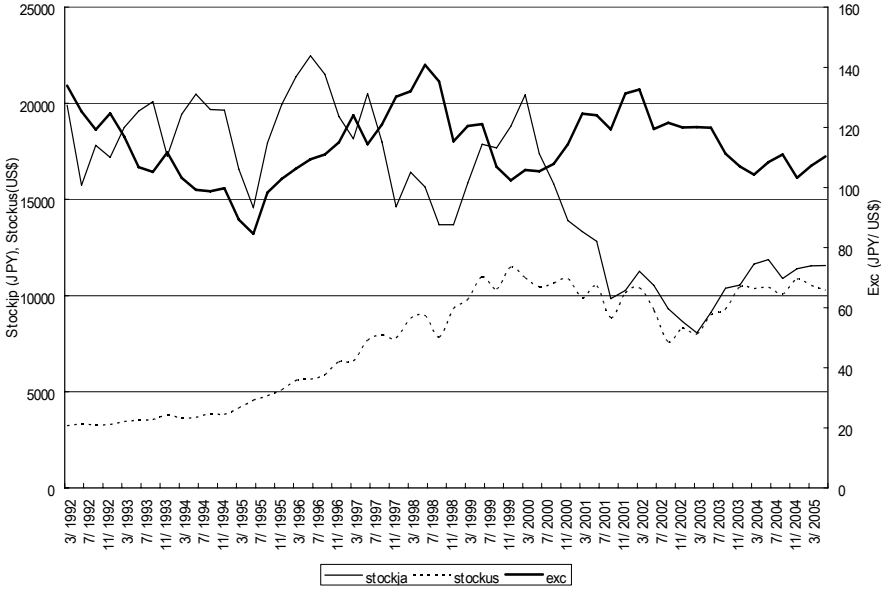
The factors that influence stock prices change over time. For example, in the 1970s and early 1980s, inflation rates were high, which in turn affected stock prices. However, that inflation rate has been stable since then. In general, since that time, interest rates have continued to have much influence on stock prices.

Many studies have investigated the relationship between stock prices and interest rates. Campbell (1987); Cutler, Poterba, and Summers (1989); and Hodrick (1992) showed that short- and long-term interest rates have a modest degree of forecasting power for excess stock returns. Similarly, other studies, such as Campbell and Shiller (1991) and Fama (1984), have shown that the slope of the term structure of interest rates helps to forecast excess stock returns. Campbell and Ammer (1993) and Hamori and Honda (1996) also showed that short-term interest rates affect stock prices.

This study analyzes the period since March 19, 2001, when quantitative easing was implemented in Japan. One reason is that there is little recent study analyzing stock prices in Japan; however, the main reason is that it is uncertain whether the interest rate has had an effect on stock prices since then because the interest rates have been almost zero. Some important factors, such as exchange rate and U.S. stock prices, should be noted in addition to domestic interest rates.

In the United States, the information technology (IT) boom contributed strongly to increasing stock prices. On the other hand, the Japanese economy has had many structural problems and has experienced recession. Stock prices in Japan decreased during the mid-1990s and after the bubble economy of the 1980s. However, as shown in Figure 1, movement of stock prices in the two countries seems similar after 2001, when quantitative easing policy was implemented in Japan. Fluctuations in exchange rates seem to occur in parallel with Japanese stock prices.

Figure 1
Japanese stock market, U.S. stock market, and exchange rate.



Note: Japanese stock market figures are from the Nikkei Stock Average, and the U.S. figures are the Dow Jones Industrial Average.

Little research exists on the effect of the exchange rate on stock prices, which has been analyzed from the view of Arbitrage Pricing Theory (APT). Most existing studies have examined whether the arbitrage condition can be explained in relation to the exchange rate. It is interesting that many studies deny the explanatory power of the exchange rate (Jorion, 1991). Hamao (1988) investigated this relationship and found that the effect of exchange rate fluctuation was insignificant for Japan, but Choi, Hiraki, and Takezawa (1998) reported that the exchange rate was an important factor. Since the 1980s, capital movement across countries has increased rapidly. In spite of the reduction in fluctuations of the exchange rate in the 1990s compared to the 1980s, this movement should not be ignored along with the development of IT, especially in the field of financial instruments and payment systems (Kurihara and Ohtsuka, 2005). The target of investments has expanded greatly from domestic to worldwide. Because interest rates have been quite low, other factors must be affecting stock prices. There is a high likelihood that exchange rate has been influencing the Japanese stock prices.

III. EMPIRICAL ANALYSIS OF STOCK PRICES IN JAPAN

A. Data and Its Unit Root Test

As mentioned above, one purpose of this study is to analyze stock prices in Japan since the quantitative easing policy was implemented on March 19, 2001. The analysis spans from then to now.

In the analysis, unit root tests of each macroeconomic variable related to stock prices are conducted before analyzing the determinant factors of stock prices. The variables estimated are Japanese stock prices (Jstock), U.S. stock prices (Ustock), exchange rate (yen/U.S. dollar; EX), the Japanese call (interest) rate (Call), and the FF rate (FF). 'R' means rate. The test method is ADF. The sample period is between March 19, 2001 and September 30, 2005. Quantitative easing was first conducted on March 19. As shown in Table 1, all of the lagged variables and variable rates are significant at 1%.[1]

Table 1
Unit root tests of each variable

Variable	t value	Lagged First Difference	t value	Rate of Variable	t value	Lagged rate of variable	t value
Jstock	-1.80	ΔJstock	-32.33*	RJstock	-32.71*	ΔRJstock	-18.05*
Ustock	-1.84	ΔUstock	-33.44*	RUstock	-32.16*	ΔRUstock	-19.89*
EX	-1.30	ΔEX	-18.63*	REX	-1.52	ΔREX	-22.08*
Call	-18.39*	ΔCall	-6.23*				
FF	-4.13*	ΔFF	-19.18*				

Note. * denotes significant level at 1%

B. OLS Test

From this view, we can see that Japanese stock prices regressed as an exchange rate, interest rates, and U.S. stock price. The variables used in this calculation are Nikkei Stock Average, Dow, yen-dollar exchange rate, call rate, and FF rate. The Nikkei Stock Average represents the main stock market prices in Japan.[2]

The coefficient of exchange rates should be positive because Japan has been an export-oriented country. The coefficient of interest rates should be negative according to standard economic theory. The coefficient of U.S. stock price should be positive because economic activity and the link between Japan and the U.S. are strong.

The estimated results using rates by OLS are shown in Table 2. The sample period is from March 19, 2001 to September 30, 2005.

Table 2
Deterministic elements of the Japanese stock price: rate

C	-5.37E-05
	(-0.114)
RJstock(-1)	-0.530
	(-21.671)
RUstock(-1)	0.340
	(12.103)
REX	0.116
	(1.735)
ΔFF(-1)	-0.018
	(-2.062)
ΔCall	0.006
	(0.105)
D.W.	2.403
adj.R^2	0.370

Note: Parenthetical figures in the table are t values

The results are interesting. The rate of change in the exchange rate is positive and significant, and interest rates did not influence stock prices. As previously mentioned, the Japanese economy is export-oriented. Depreciation of the domestic currency promotes exports and leads to increasing stock prices. The domestic interest rate has been quite low and has not a great influence on stock prices. Further, the coefficient is not significant.[3]

The one-day difference (due to time difference) of the FF rate has a negative influence on stock prices. The rising one-day difference brings down the U.S. stock price and has a negative effect on Japanese economic activities. U.S. stock prices strongly affect Japanese stock prices. The coefficient is significant. This shows the existence of interdependence between Japanese and U.S. stock prices.

I also performed the Granger Causality test. The results suggest that I must reject

the hypothesis that the U.S. stock price does not affect the Japanese stock prices. On the other hand, U.S. interest rates also significantly influence Japanese stock prices.

Next, a one-time difference is taken in each equation. The endogenous variable is ΔJstock - ΔJstock(-1). The exogenous variables and the results of the estimated equation are shown in Table 3.

Table 3 also shows some interesting results. If ΔJstock is large, the one-day difference of change of stock price (ΔJstock (-1) - ΔJstock (-2)), would be adjusted to decrease. Table 4 shows the result using 'rate'. The coefficient of FF is negative, but the finding is not significant. ΔREX is positive. ΔRUstock(-1) -ΔRUstock(-2) is negative and significant. The equation has a high value of adj.R^2.

Note the impact of the exchange rate. The rate influences Japanese stock prices, but difference does not exert the same influence. The rates of macroeconomic variables significantly influence stock prices. Not only scholars in academic fields but also investors are interested in rates of economic variables.

Table 3
Deterministic elements of Japanese stock prices

Sample Period:	3/19/2001–9/30/2005
C	-0.845 (-0.196)
ΔJstock(-1)	-1.052 (-23.122)
ΔJstock(-1) – Δjstock(-2)	-0.033 (-1.190)
ΔUstock(-1)	0.498 (7.764)
ΔUstock(-1) - ΔUstock(-2)	0.015 (0.344)
ΔEX	10.274 (1.531)
ΔFF(-1)	-104.695 (-2.412)
ΔCall	-360.105 (-0.676)
D.W.	2.01
adj.R^2	0.580

Note. Parenthetical figures in the table are t values.

Table 4
Deterministic elements of Japanese stock prices

Sample Period:	3/19/2001–9/30/2005
C	-6.02E-05 (-0.120)
ΔRJstock(-1)	-2.121 (-39.237)
ΔRJstock(-1) -ΔRJStock(-2)	0.312 (10.845)
ΔRUstock(-1)	0.588 (9.715)
ΔRUstock(-1) -ΔRUstock(-2)	-0.180 (-5.099)
ΔREX	0.102 (1.693)
ΔFF(-1)	-0.036 (-1.058)
ΔCall	-0.015 (-0.222)
D.W.	2.153
adj.R^2	0.818

Note. Parenthetical figures in the table are t values.

C. Cointegration Test

As indicated in the unit root tests above, variables other than interest rates are not stationary. The finding that many macro time series may contain a unit root has spurred the development of the nonstationary time series analysis. A linear combination of two or more nonstationary series are said to be cointegrated. The stationary linear combination may be interpreted as a long-run equilibrium relationship among the variables. This section provides an unrestricted cointegration test. The lag interval is four according to Akaike Info Criterion (AIC) test. The sample period is during the quantitative easing policy. The results are shown in Table 5.

The results show trace test indices cointegration at 5%, which confirms that the Japanese and the U.S. stock price can be interpreted as having a long-run equilibrium relationship between the variables. Both variables are nonstationary. Note, however, that the relationship between the two variables is significant. Rising U.S. stock prices influence Japanese stock prices as previously confirmed.

D. Impulse Responses

An impulse response function traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous variables. The model and the results are shown in Tables 6 (one-time difference) and 7 (rate).

Table 5
Cointegration rank test

	Eigenvalue	Trace Statistics	5% Critical Value	Max Eigenvalue	5% critical Value
None	0.017	19.904	15.490	16.743	14.236
At most 1	0.003	3.155	3.888	3.121	3.868

Table 6
VAR model for impulse response function: difference

	Jstock - Jstock(-1)	Ustock - Ustock(-1)
C	-0.844 (-0.201)	0.808 (0.234)
ΔJstock(-1)	-0.084 (-2.566)	-0.018 (-0.496)
ΔJstock(-2)	0.037 (1.214)	-0.013 (-0.512)
ΔUstock(-1)	0.508 (12.195)	-0.030 (-0.945)
ΔUstock(-2)	-0.016 (-0.352)	0.016 (0.433)
ΔEX	10.183 (1.502)	1.619 (0.308)
ΔFF(-1)	-102.466 (-2.250)	16.123 (0.448)
ΔCall	-354.329 (-0.690)	-401.407 (-1.017)
adj.R^2	0.130	-0.004
F value	22.878	0.399

Note. Parenthetical figures in the table are the t values.

Table 7
VAR model for impulse response function: rate

	RJstock -R Jstock(-1)	RUstock - RUstock(-1)
C	-6.01E-05 (-0.120)	2.25E-05 (0.046)
ΔRJstock(-1)	-0.737 (-24.686)	-0.036 (-1.485)
ΔRJstock(-2)	-0.301 (-10.832)	-0.088 (-3.632)
ΔRUstock(-1)	0.405 (12.069)	-0.695 (-23.328)
ΔRUstock(-2)	0.182 (5.142)	-0.324 (-10.305)
ΔREX	0.105 (1.693)	-0.004 (-0.088)
ΔFF(-1)	-0.011 (-2.232)	0.002 (0.612)
ΔCall	-0.012 (-0.220)	-0.076 (-1.539)
adj.R^2	0.437	0.356
F value	113.169	82.208

Note: Parenthetical figures in the table are the t values.

Table 8
Quantitative easing policy and stock price (TSLS)

Variable	C	RJstock (-1)	RUstock (-1)	REX	RFF(-1)	RCall	BOJ
coefficient	0.0004	-0.083	0.446	0.128	-0.038	1.190	0.017
	(0.534)	(-2.788)	(12.506)	(1.740)	(-0.763)	(0.230)	(4.133)

Note: D.W., 1.993; adjR^2: 0.149. Parenthetical figures in the table are t values.

Positive movement of ΔJstock(-1) would decrease the one-day difference in stock prices. On the other hand, positive movement of ΔJstock(-2) would increase them. ΔUstock(-1) would increase the one-day difference in stock prices. If ΔEX moves to depreciation, the one-day difference in stock prices would be large.

ΔRJstock(-1) and ΔRJstock(-2) will cause drops in (RJstock -R Jstock(-1)). The effect on U.S. figures is opposite. The effect of exchange and interest rates on the Japanese stock price is the same as shown in Table 6.

Based on Tables 6 and 7, the impulse response function is as shown in Figures 2 and 3.

The results indicate that the effect exists for one or two days with the response disappearing after that. Eight days later, the shock mostly disappears. It takes longer for the shock in Figure 3 to extinguish than in the case shown in Figure 2.

E. Has Quantitative Easing Been Effective?

The BOJ enforced unprecedented easing, which reduced interbank interest rates to almost zero. However, because that policy was not enough to end deflation, since 2001, the BOJ has implemented quantitative easing. That is, on March 19, 2001, the BOJ decided to increase the outstanding balance of the current accounts by one trillion yen to around five trillion yen. This is called *quantitative easing*. In this scheme, the main

operating target for money market operations changed from the uncollateralized overnight call rate to the outstanding balance of current accounts at the BOJ. The target of the current account balance has been increased several times since then, and the current upper limit level is 30–35 trillion yen.[4]

Taking this into account, Table 8 presents an additional calculation that adds one policy-related dummy variable (BOJ in the table). If quantitative easing is in effect on that day, the dummy variable is one, and it is zero for the all other cases. The empirical method is the same as shown in Table 2.

Figure 2
Impulse response function: difference

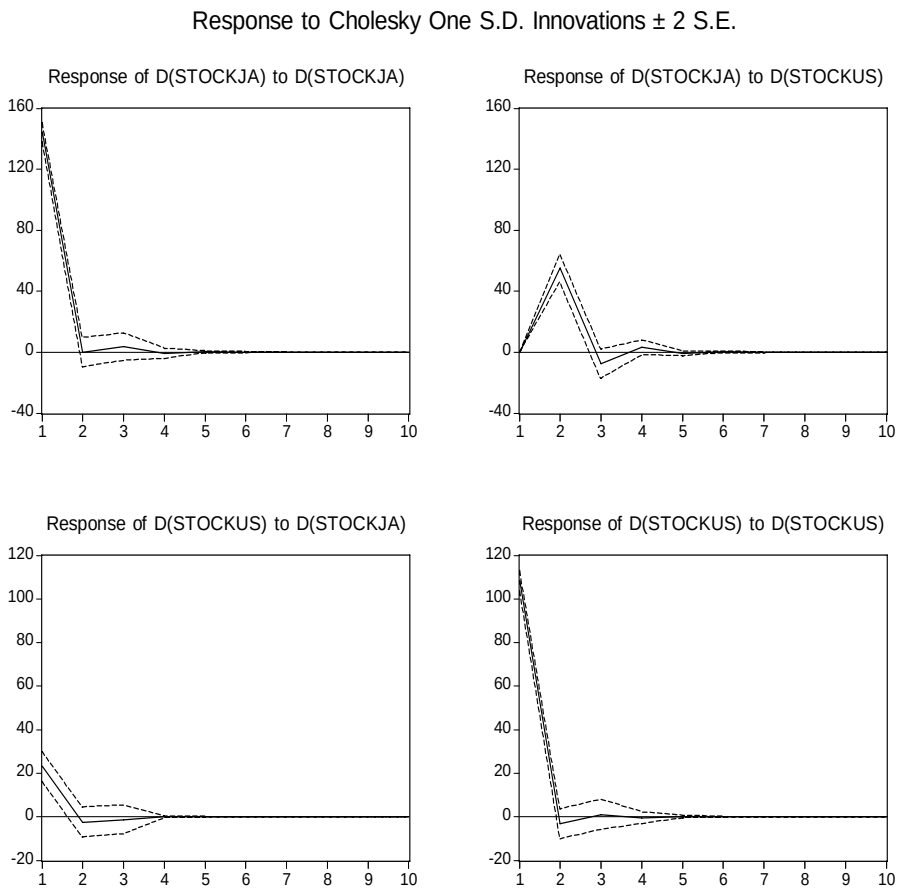
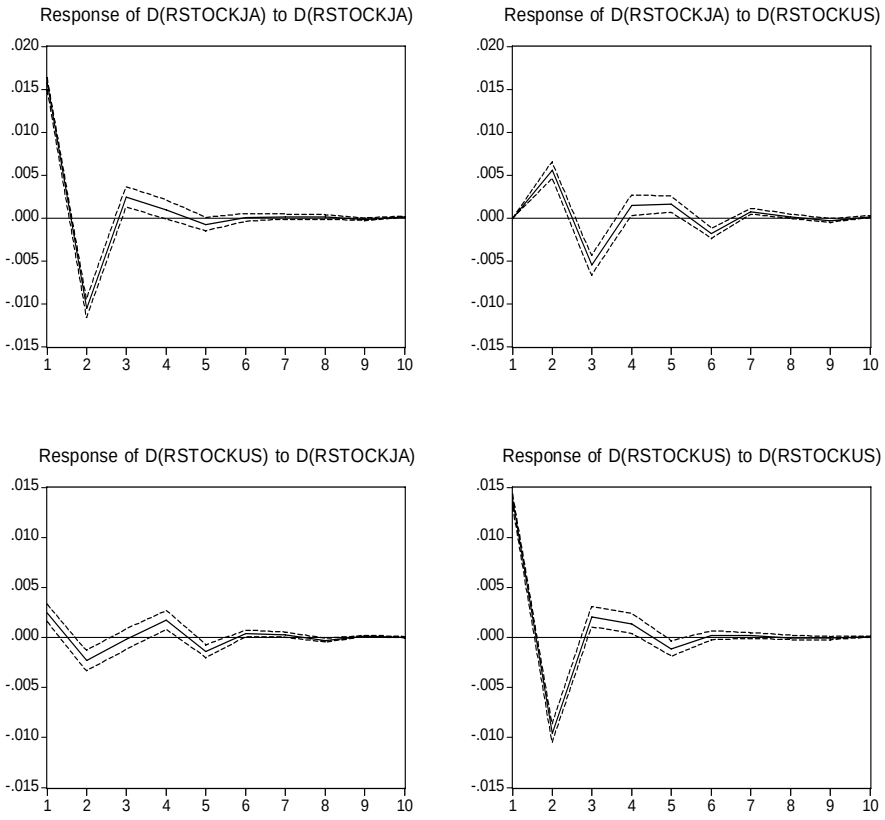


Figure3
Impulse response function: rate



The results are clear. Quantitative easing has influenced stock prices. Stock traders and policy authorities should take this into account in addition to the movement of exchange rate.[5]

IV. CONCLUSION

This study performed an empirical examination of the relationship between the Japanese stock prices and macro variables.

From the results, I can conclude that the domestic interest rate does not influence Japanese stock prices. This finding is counter to traditional economic theory and some

existing studies. I might also conclude that the exchange rate influences Japanese stock prices. Investors may consider the characteristics of the enterprises such as their international trade behavior and net foreign positions. U.S. stock prices have also influenced Japanese stock prices, suggesting an interdependent relationship between them. Finally, empirical results show that quantitative easing has influenced stock prices. Market participants should take this into account in addition to the movement of exchange rate.

ENDNOTES

1. However, a KPSS test shows that stock prices and exchange rate are not significant.
2. When Japanese stock prices after the burst of the bubble economy are considered, the fragility of the financial system and the intervention by the government (e.g., the public money injection into the banking sector, the prohibition of bank deposit payoffs, etc.) should be also taken into account. Although I would like to incorporate these variables in the equation, the sample period is too short and the unit root test showed that there should be some time lags. The data in this paper are daily. I could not tackle these problems simultaneously.
3. Along with the previous analysis, I estimated the equations using the logarithm and difference; however, the results were not significantly different from the results obtained by this method. When sample period is from 1992 (when the bubble economy—that is, stock and land prices quite high—was over) to now, the coefficient of Japanese interest rate was negative but it was not significant.
4. The outstanding balance of bank reserves or current accounts should be considered an indicator of quantitative easing policy. These data are monthly, and I could not analyze daily stock prices at the same time appropriately. Monthly data are too short to be used as a sample period.
5. Consideration of the other exchange rate, such as yen-euro, is a necessary future task.

REFERENCES

Campbell, Y., 1987, "Stock Returns and the Term Structure," *Journal of Financial Economics,* 18, 373-399.

Campbell, Y., and J. Ammer, 1993, "What Moves the Stock and Bond Markets? A Variance Decomposition for Long-term Asset Returns," *Journal of Finance,* 48(1), 3-37.

Campbell, Y., and J. Shiller, 1991, "Yield Spreads and Interest Rate Movements, A Bird's Eye View," *Review of Economic Studies,* 58, 495-514.

Choi, J. J., T. Hiraki, and N. Takezawa, 1998, "Is Foreign Exchange Rate Risk Priced in the Japanese Stock Market," *Journal of Financial and Quantitative Analysis,* 33, 361-382.

Cutler, D. M., J. Poterba, and L. Summers, 1989, "What Moves Stock Prices," *Journal of Portfolio Management,* 15, 4-12.

Fama, E. F., 1984, "The Information in the Term Structure," *Journal of Financial*

Economics, 13, 509-528.

Hamao, Y., 1988, "An Empirical Examination of the Arbitrage Pricing Theory: Using Japanese data," *Japan and the World Economy,* 1, 45-61.

Hamori, S., and Y. Honda, 1996, "Interdependence of Japanese Macroeconomic Variables," in Yoshiro Ttutsui, *Japanese Capital Markets*, edited by Yoshiro Tsutsui, Nihon-Hyoronsha (in Japanese).

Hodrick, R. J., 1992, "Dividend Yields and Expected Stock Returns, Alternative Procedures for Inference and Measurement," *Review of Financial Studies,* 5, 357-386.

Jorion, P., 1991, "The Pricing of Exchange Rate Risk in the Stock Market," *Journal of Financial and Quantitative Analysis*, 26, 363-376.

Kurihara, Y., and S. Ohtsuka, 2005, "Payment Systems of Financial Institutions: Current State and Future Prospects," in Y. Kurihara et al., *Global Information Technology and Competitive Financial Alliances*, Idea Group Publishing.

Kurihara, Y., 2006, "Recent Japanese Monetary Policy: An Evaluation of the Quantitative Easing," *International Journal of Business,* 11(1), 79-86.