BEBR
FACULTY WORKING
PAPER NO. 89-1595

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September 1989

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ABSTRACT

This paper finds a high correlation between the open to close returns in U. S. stocks in the previous trading day and the performance in the Japanese equity market in the current period. In contrast, the Japanese market has only a small impact on the U. S. return in the current period. High correlations among open to close returns are a violation of the efficient market hypothesis; however, in trading simulations, the excess profits in Japan vanish when transactions costs and transfer taxes are included.

THE INTERTEMPORAL RELATION BETWEEN THE U.S. AND JAPANESE STOCK MARKETS

The two largest stock markets in the world in terms of capitalization, volume, and shares listed are the Tokyo Stock Exchange (TSE) and the New York Stock Exchange (NYSE). Because Tokyo is 14 hours ahead of New York, there is an eight hour difference between the close of the TSE and open of the NYSE. Since there is no overlap between the two markets, traders or technical analysts may look to the TSE as a predictor of market movement on the NYSE and/or examine changes on the NYSE as indicators of performance on the TSE.

As shown in Figure 1, the TSE opens at 7:00 p.m. Eastern Standard Time (EST) and closes at 1:00 a.m. EST.[1] The NYSE opens at 11:00 p.m. Japanese time (9:00 a.m., EST) and closes at 5:00 a.m. Japanese time (3:00 p.m., EST). Thus, there is no common time interval in which both markets are open.

Insert Figure 1 about here

High correlations between the respective open to close returns are a violation of the efficient market hypothesis because public information about the performance in one market could be used to profitably

trade in another market. If the markets are efficient, information about the open to close performance in one market (for example, the U.S. return in period t-1) will be fully reflected in the open price in the other market (Japan in period t, for example). Since new information flows randomly into the market, subsequent price changes should be random and the open to close returns in Japan will be uncorrelated with the U.S. returns. Thus, the performance in the U.S. should affect the open price in Japan and the correlation between the open to close returns in the two markets will be zero.

Early research on the synchronization among stock prices across countries [Grubel (1968), Levy and Sarnat (1970), Agmon (1972), Ripley (1973), Lessard (1976), Panton, Lessiq, and Joy (1976), and Hilliard (1979)] focused on the benefits of international diversification in reducing systematic portfolio risk.[2] Most of the studies used weekly or monthly return data for a number of years and found that correlations across countries were statistically insignificant or very low.

Recent research on this topic investigated international equity market linkages. Using daily closing market prices for five countries, Jaffe and Westerfield (1985a) found that correlations between the U.S. and the other market returns for each day of the week were generally positive and significant. Schollhammer and Sand (1985) and Eun and Shim (1989) employed daily market closing data in the 1980s for several countries and discovered a substantial amount of interdependence among national stock markets.

Bennett and Kelleher (1988), Dwyer and Hafer (1988), Goodhart (1988), King and Wadhwani (1988), Neumark, Tinsley, and Tosini (1988),

and Roll (1988) investigated international equity market linkages around the October 1987 crash. King and Wadhwani (1988) and Goodhart (1988) used hourly data for the New York, London, and Tokyo markets. They found strong cross-exchange linkages after the crash. Neumark, Tinsley, and Tosini (1988) focused on U.S. stocks that were also traded in London and Tokyo. Using opening and closing prices in New York and closing prices in London and Tokyo for eight months after the crash, they discovered that the predictive ability of after-hours pricing in foreign equity markets was strong after the crash, but declined sharply in later months.

This paper employs opening and closing data for market averages in the U.S. and Japan for a longer time period, from 1985 to 1988, to study the synchronization of stock price movements. Therefore, our focus is not the transmission of stock prices and volatility during the crash. There are two advantages of opening and closing prices over only closing data. First, direct tests of market efficiency can be conducted in which a simulated trader in Japan buys or sells at the opening price, depending on the performance in the U.S. market the previous day. Second, the influence of the daily return in one market on the overnight return of the other market can be investigated.

The results indicate that the performance in the U.S. greatly influences open to close stock returns in Japan the next day and the change in the TSE has only a slight impact on the NYSE performance the same day. Large movements in the U.S. predict open to close returns in Japan the next day remarkably well. However, when Japanese transactions costs and taxes are included, the excess returns from following

the U.S. vanish. In addition, the overnight return in Japan is greatly affected by the U.S. performance. In contrast, the Japan open to close return does not have an impact on the U.S. overnight return.

I. DATA AND METHODOLOGY

Daily opening and closing data for the Nikkei Index, S&P 500, and the yen/dollar exchange rate from October 5, 1985 to December 28, 1988 were obtained. It is believed that this period is more meaningful than a longer time period because of the structural changes in both the U.S. and Tokyo markets. Data for the Nikkei Index, which is a price-weighted index of 225 stocks on the TSE, were acquired from Nihon Keizai Shimbun (Japan Economic Journal). Opening and closing spot rates for the yen were gathered from the International Monetary Market Yearbooks. Arithmetic returns for the Nikkei Index and S&P 500 are calculated on a local and common currency basis. Common currency returns are computed by converting the opening and closing S&P 500 levels to yen equivalents.

October 1987 was a very unusual period in the recent history of the stock market. To ensure that the results are not being driven by the data from the crash, two data sets are used in this study: the first with the crash month, October 1987, and the second without.

Correlations between the open to close returns are computed for (1) $TSE_t o\text{-}c$ and $S\&P_t o\text{-}c$, which tests whether the Japanese market leads the U.S., and (2) $TSE_t o\text{-}c$ and $S\&P_{t-1} o\text{-}c$, a test of the U.S. equities leading the Japanese. To determine how the open to close result in one market relates to the close to open in the other, the following

correlations are calculated: (1) $S\&P_{t-1}$o-c and TSE_tc-o to determine how the performance in the U.S. market affects the TSE close to open returns and (2) $S\&P_t$c-o and TSE_to-c.[3]

Regressions are estimated to determine the relation between the two markets. As a test of the Japan market leading the U.S., a regression is estimated with TSE_to-c as the independent variable and $S\&P_t$o-c as the dependent variable. As a test of the U.S. leading Japan, a regression is run with $S\&P_{t-1}$o-c as the independent variable and TSE_to-c as the dependent variable.

Thus, the correlations and regressions are calculated on the local and common currency returns, with and without October 1987.

In addition, simulated trading strategies are implemented on the data set without October 1987. In the simulation, a trader buys in the Japanese market when the local S&P 500 increases by .5%, 1%, 1.5% or 2%, the previous day and sells when the index decreases by the same percentages.[4] The positions are closed at the end of the day. Returns with round-trip transactions costs of 0%, .50%, and 1% are calculated. Profitable trading days are counted along with mean returns.

II. EMPIRICAL RESULTS

The results show that the performance in the U.S. strongly influences Japanese returns while the Japan market has only a slight impression on the S&P 500. Tables 1 and 2 present the regressions and correlations between the open to close returns. The correlation between the Nikkei and S&P 500 return in the current period, which is a test of the Japanese market leading the U.S., is significant for the

local returns with and without October 1987, and the common currency returns for the whole data set. The correlations range from .0463 to .1171. Thus, the Japanese performance in the current period explains only about one percent of the fluctuations in the U.S. returns.

Insert Tables 1 and 2 about here

In contrast, the performance in the U.S. in the previous trading day has a major impact on the Japanese return in the current day. All correlations between the lagged U.S. return and the current Nikkei return, which range from .2667 to .4963, are significant at a 1% level. Again, the correlations for the common currency returns are slightly lower than the local currency returns. In addition, the correlations for the entire data set are much higher than for the data set without the crash month.

As expected, the open to close returns in the U.S. affect the close to open in Japan. From Tables 3 and 4, correlations between the lagged U.S. return open to close and the Nikkei close to open returns are all significant at a 1% level, ranging from .3407 to .4205. In addition, the Japanese open to close performance does not have an impact on the U.S. overnight return. This result is surprising, since the same Japan daily return has a slight impact on the subsequent daily U.S. return. In effect, information which affects the Japanese market has little or no influence on the U.S. market.

Insert Tables 3 and 4 about here

For the data sets without the crash month, the lagged U.S. return has more impact on the overnight Japanese return than on the following open to close return. When October 1987 is included, the correlation between the lagged U.S. performance and the Tokyo daily return is higher.[5]

The simulated trading strategies, presented in Table 5, reveal that, in the absence of transactions costs, the filter rules do a remarkable job of predicting up and down returns in Japan. The up triggers predict profitable trading days 72% to 81% of the time.[6] Looser up triggers are better able to predict profitable Japanese trading days, with the exception of the 2% method.

Insert Table 5 about here

The down triggers foretell negative returns the next day with slightly less precision, 59% to 75%. Similarly, the looser down triggers are more effective at detecting negative returns. Whatever method is implemented, the resulted demonstrate that next day market performance in Japan is predicted by the U.S. market performance.

However, the presence of transactions costs and taxes eliminate the profits and predictive ability of the filters. Trading costs are higher in Japan than in the U.S., over 1% round-trip for large institutions when commissions and taxes are included.[7] Table 5 presents mean returns for the various triggers; following the U.S. is not profitable when transactions costs are 1%, with profitable trading days well below 50%. When transactions costs are .5%, the percentage of profitable trading days is about 50% for the up 1.5% and 2% triggers.

Although the lagged U.S. return predicts performance in Japan remarkably well, it is impossible to profit from following the U.S. because of the high trading costs in Japan.

III. CONCLUSION

From October 5, 1985 to December 28, 1988, the performance of the U.S. market had a great impact on Japanese equities. The S&P 500 returns in the previous day explain from 7-25% of the fluctuations in the Nikkei Index open to close returns the next day, demonstrating that the U.S. market greatly influences Japan. In addition, the performance in the U.S. in the previous day explains between 11-18% of the fluctuations in the Japan overnight returns.

In contrast, the Japanese market has a small impact on U.S. equities, explaining only one percent of the fluctuations in U.S. open to close returns. Although this result is statistically significant, it is probably not high enough to profitably trade on in the U.S. In addition, there is no relation between the performance of the Japanese market and the close to open return in the U.S.

Trading simulations are performed on the Japanese market based on U.S. performance. Various filters are implemented; all are successful in selecting profitable Japanese trading days with great regularity. However, high trading costs in Japan prevent Japanese arbitrageurs from profiting from this strategy.

FOOTNOTES

[1]The TSE takes a lunch break from 11:00 a.m. to 1:00 p.m. Tokyo time.

[2]See Madura (1985) for a review of literature dealing with the co-movement of international stock prices, particularly in an equity portfolio context.

[3]When prices could not be obtained for a lagged or current trading day due to a closed market in one country, the observation is deleted from the sample. For example, assume that both markets are open Thursday, Friday, and Monday, and the Japanese market is open Saturday. For the test of Japan leading the U.S., returns are taken from Thursday, Friday, and Monday. For the test of the U.S. leading Japan, observations are taken from Friday and Saturday. A Monday return could not be calculated because the U.S. market was not open Saturday. For the U.S. affecting Japanese overnight returns, observations are taken for Friday and Saturday. Only the Friday U.S. overnight return is obtained for the test of Japan on the U.S. close to open returns.

[4]Inclusion of the crash month would have yielded more dramatic results because the S&P 500 open to close return decreased by 20.43% on October 19, followed by a fall of 14.90% in Japan the next day. The U.S. return increased 5.34% on October 20 and the Nikkei Index followed by rebounding 9.29%.

[5]After the S&P 500 declined by 20.43% on October 19, 1987, the overnight return in Japan was -.0066%. This outlier affects the results. If only this return is deleted, the correlation between the lagged common currency U.S. returns and the Japanese open to close is .3846 and .3945 for the local currency U.S. returns.

[6]For the time period of this study, 56.6% of the U.S. open to close returns were up (464 U.S. up trading days and 356 down). In Japan, 58.5% of open to close returns were up (522 returns greater than zero and 371 down).

[7]The scale of commission rates established by the TSE is set out below:

Value of Transaction (in Yen)	Commission Rate	One Way % (of highest value)
less than 1,000,000 Yen	1.2%	1.20%
1,000,001 to 3,000,000	1.00% + 2,000 Yen	1.07%
3,000,001 to 5,000,000	.80% + 5,000	.90%
5,000,001 to 10,000,000	.75% + 12,500	.88%
10,000,001 to 30,000,000	.60% + 27,500	.69%
30,000,001 to 50,000,000	.40% + 87,500	.58%
50,000,001 to 100,000,000	.25% + 182,500	.41%
100,000,001 to 1,000,000,000	.20% + 212,500	.22%
over 1,000,000,000	.15% + 712,500	.17% for 3 Billion Yen

In addition, a transactions tax between .18% to .50% is imposed on the seller.

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Figure 1

Trading Hours for TSE and NYSE

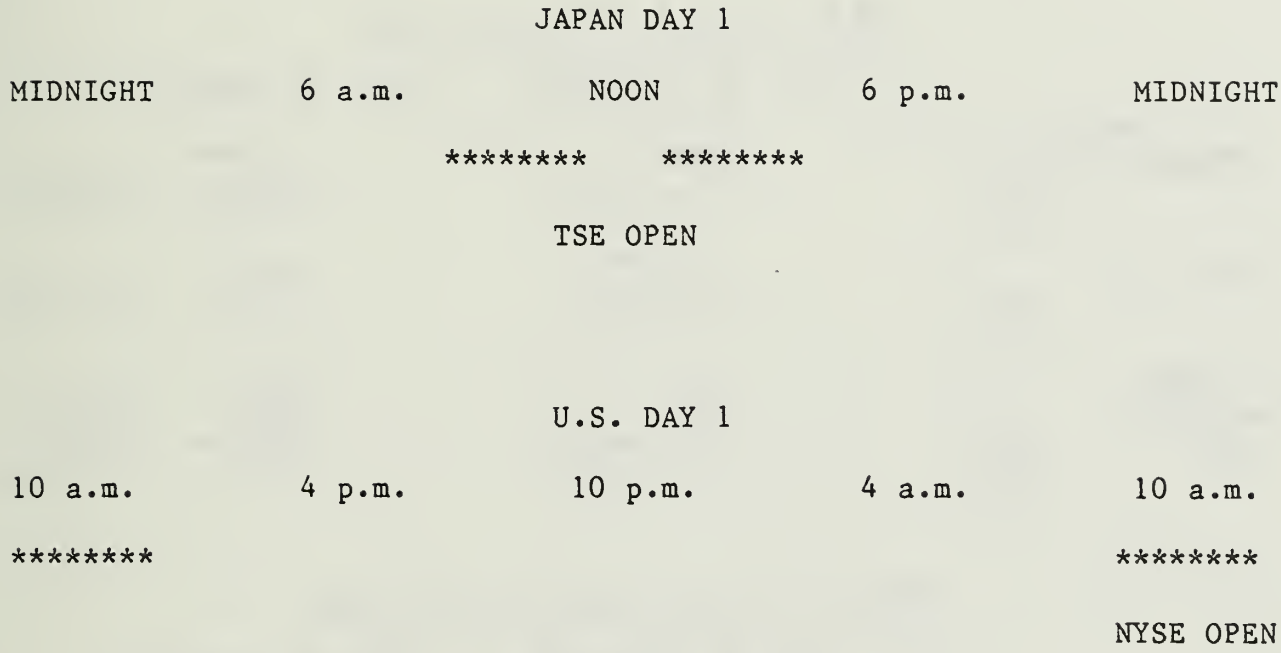

Table 1

Regression and Correlation Results-Local Currency Returns
T Value in Parentheses

$$S\&P_t^{o-c} = \alpha_J + \beta_J TSE_t^{o-c} + \varepsilon_J$$

	Oct. 87 Included	Oct. 87 Excluded
INTERCEPT (α_J)	.0007	.0010***
	(1.34)	(2.58)
TSE_t (β_J)	.1475***	.1000**
	(3.27)	(2.28)
F VALUE	10.71	5.18
R SQUARE	.0137	.0069
CORR	.1171***	.0829**

$$TSE_t^{o-c} = \alpha_{US} + \beta_{US} S\&P_{t-1}^{o-c} + \varepsilon_{US}$$

	Oct. 87 Included	Oct. 87 Excluded
INTERCEPT (α_{US})	.0009**	.0010***
	(2.51)	(3.29)
$S\&P_t$ (β_{US})	.3894***	.2270***
	(15.9)	(7.87)
F VALUE	253.60	61.89
R SQUARE	.2453	.0759
CORR	.4963***	.2756***

*** Significant at a 1% level
** Significant at a 5% level
* Significant at a 10% level

Table 2

Regression and Correlation Results-Common Currency Returns
T Value in Parentheses

$$S\&P_t^{o-c} = \alpha_J + \beta_J TSE_t^{o-c} + \varepsilon_J$$

	Oct. 87 Included	Oct. 87 Excluded
INTERCEPT (α_J)	.0003 (0.48)	.0006 (1.39)
TSE_t (β_J)	.1226** (2.49)	.0642 (1.27)
F VALUE	6.20	1.61
R SQUARE	.0080	.0021
CORR	.0893**	.0463

$$TSE_t^{o-c} = \alpha_{US} + \beta_{US} S\&P_{t-1}^{o-c} + \varepsilon_{US}$$

	Oct. 87 Included	Oct. 87 Excluded
INTERCEPT (α_{US})	.0010*** (2.86)	.0011*** (3.51)
$S\&P_t$ (β_{US})	.3404*** (15.1)	.1885*** (7.60)
F VALUE	229.49	57.83
R SQUARE	.2280	.0711
CORR	.4775***	.2667***

*** Significant at a 1% level
** Significant at a 5% level
* Significant at a 10% level

Table 3

Regression and Correlations Results-Local Currency Returns
T Value in Parentheses

$$S\&P_t^{o-c} = \alpha_J + \beta_J TSE_t^{o-c} + \varepsilon_J$$

	Oct. 87 Included	Oct. 87 Excluded
INTERCEPT (α_J)	-.0001	-.0002
	(1.33)	(1.33)
TSE_t (β_J)	.0097	.0001
	(0.18)	(0.05)
F VALUE	.034	.000
R SQUARE	.000	.000
CORR	.0071	.0002

$$TSE_t^{o-c} = \alpha_{US} + \beta_{US} S\&P_{t-1}^{o-c} + \varepsilon_{US}$$

	Oct. 87 Included	Oct. 87 Excluded
INTERCEPT (α_{US})	.0001	.0001
	(6.00)	(5.62)
$S\&P_t$ (β_{US})	.0154***	.0258***
	(9.87)	(12.4)
F VALUE	97.55	154.41
R SQUARE	.1161	.1768
CORR	.3407***	.4205***

*** Significant at a 1% level
** Significant at a 5% level
* Significant at a 10% level

Table 4

Regression and Correlations Results-Common Currency Returns
T Value in Parentheses

$$S\&P_t^{o-c} = \alpha_J + \beta_J TSE_t^{o-c} + \varepsilon_J$$

	Oct. 87 Included	Oct. 87 Excluded
INTERCEPT (α_J)	-.0003 (-1.35)	-.0003 (-1.28)
TSE_t (β_J)	.0071 (0.35)	.0338 (1.24)
F VALUE	.119	1.54
R SQUARE	.0002	.0024
CORR	.0133	.0486

$$TSE_t^{o-c} = \alpha_{US} + \beta_{US} S\&P_{t-1}^{o-c} + \varepsilon_{US}$$

	Oct. 87 Included	Oct. 87 Excluded
INTERCEPT (α_{US})	.0001 (6.32)	.0001 (6.17)
$S\&P_t$ (β_{US})	.0142*** (9.94)	.0213*** (11.7)
F VALUE	98.86	136.9
R SQUARE	.1174	.1600
CORR	.3427***	.4000***

*** Significant at a 1% level
** Significant at a 5% level
* Significant at a 10% level

Table 5

Performance of Nikkei Index in Day t Inclusive
of Round Trip Transactions Costs (TC)
After S&P 500 Local Return Trigger in Day t-1
(Data Without October 1987)

	ROUND TRIP TC		
	0%	.50%	1%
$S\&P_{t-1}$ UP by .5% (226 TIMES)			
MEAN TSE_t RETURN	.341	-.160	-.658
% UP	72%	37%	17%
$S\&P_{t-1}$ DOWN by .5% (151)			
MEAN TSE_t RETURN	.234	-.267	-.769
% DOWN	59%	28%	18%
$S\&P_{t-1}$ UP by 1% (114)			
MEAN TSE_t RETURN	.507	.006	-.493
% UP	78%	46%	24%
$S\&P_{t-1}$ DOWN by 1% (83)			
MEAN TSE_t RETURN	.350	-.150	-.652
% DOWN	63%	35%	25%
$S\&P_{t-1}$ UP by 1.5% (53)			
MEAN TSE_t RETURN	.665	.163	-.337
% UP	81%	60%	30%
$S\&P_{t-1}$ DOWN by 1.5% (46)			
MEAN TSE_t RETURN	.535	.036	-.465
% DOWN	70%	43%	30%
$S\&P_{t-1}$ UP by 2% (25)			
MEAN TSE_t RETURN	.733	.230	-.270
% UP	76%	60%	36%
$S\&P_{t-1}$ DOWN by 2% (20)			
MEAN TSE_t RETURN	.699	.201	-.299
% DOWN	75%	40%	30%