Why Do Markets Move Together?
An Investigation of U.S.-Japan
Stock Return Comovements

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Abstract

This study explores the fundamental factors that affect cross-country stock return correlations. Using transactions data from 1988 to 1992, we construct overnight and intraday returns for a portfolio of Japanese stocks using their NYSE-traded American Depository Receipts (ADRs) and a matched-sample portfolio of U.S. stocks. We find that U.S. macroeconomic announcements, shocks to the Yen/Dollar foreign exchange rate and Treasury bill returns, and industry effects have no measurable influence on U.S. and Japanese return correlations. However, large shocks to broad-based market indices (Nikkei Stock Average and Standard and Poor's 500 Stock Index) positively impact both the magnitude and persistence of the return correlations.

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Comments welcome.

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Stock return cross-country covariances play a key role in international finance. Changes in these covariances affect the volatility of portfolios and asset prices. As these covariances increase, one expects that: (a) fewer domestic risks are internationally diversifiable, so portfolio volatility increases; (b) the risk premium on the world market portfolio increases;[1] (c) the cost of capital increases for individual firms; and, (d) the domestic version of the CAPM becomes increasingly inadequate.[2] Despite the important economic consequences of changes in cross-country covariances, the determinants of the levels and dynamics of these covariances have been little studied from an academic or from a practical perspective. Convincing evidence of our lack of knowledge in this area is the fact that the leading model of risk management, Riskmetrics™, models expectations of daily cross-country covariances as a simple weighted sum of past daily cross-country covariances.[3] Such an approach implicitly assumes that no other information can help forecast these covariances.

In this paper, we investigate daily return comovements between Japanese and U.S. stocks. We derive an expression for asset return covariances that allows us to explore their determinants. In particular, we distinguish between "global" and "competitive" shocks for asset returns. Global shocks are those that affect the value of all firms in the same direction. Competitive shocks increase the market value of firms in one country relative to firms in another country. Given these definitions, global shocks are associated with high return covariances, whereas competitive shocks are associated with low covariances.

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[1] See Harvey (1991) and Chan, Karolyi and Stulz (1992) for evidence of a positive relation between the variance of the world market portfolio and the risk premium on that portfolio.

[2] See Stulz (1995) for further discussion of these issues.

[3] See JPMorgan's Riskmetrics Technical Documents (1995).

Using high-frequency, intraday stock returns on portfolios of U.S. and Japanese stocks, we document that U.S. and Japanese cross-country return covariances exhibit a number of predictable patterns. In particular, there are strong day-of-the-week effects in these covariances. The covariances are higher for Monday returns than for other days. Covariances, however, are not higher on days of U.S. macroeconomic announcements and adjusting for industry effects is not helpful in explaining the dynamics of covariances. We interpret these findings as evidence that the global component of national macroeconomic announcements or industry shocks is small. Alternatively, it could be that the global component of national macroeconomic announcements or industry shocks on covariances is offset by their competitive effect.

We further find strong evidence that covariances are higher when there are large contemporaneous return shocks in the national markets. A confounding problem with this finding is that, conditioning on larger market shocks, we should find larger covariances if, for instance, returns are jointly normally distributed. We demonstrate, however, that there is a nonlinear relation between covariances and large market shocks. We interpret this result as evidence that large shocks to indices are more likely to be global shocks. The joint dynamics of U.S. and Japanese stock returns are also affected in that large shocks have "spillover" effects on covariances; namely, a large overnight returns shock in Japan leads to a higher covariance measure the next day during the U.S. trading period. Overall, we find there is information other than past returns that helps to predict future covariances.

We focus on daily and intraday comovements for several reasons. First, the daily horizon is important for risk management purposes and for portfolio managers whenever dynamic hedging strategies are used. Focusing on daily comovements also allows us to implement more powerful tests of cross-country comovements, a problem which has limited a number of earlier studies using longer return horizons. A recent paper by King, Sentana and Wadhwani (1994) uses monthly stock returns to document that these covariances indeed change over time. Relating asset returns to factors derived from macroeconomic variables enables the authors to explain only a trivial part of the covariance dynamics. Other authors have come to similar conclusions. In particular, after investigating the impact of macroeconomic variables, von Furstenberg and Jeon (1989) look at industry effects using weekly data and find little evidence that industry effects help us understand these covariances better.[4] Using a different approach, Ammer and Mei (1995) find that most of the covariance between national indices is explained by comovement across countries in common stock risk premia rather than by comovement in fundamental variables. Longin and Solnik (1995) are somewhat more successful focusing on correlations rather than covariances. They use monthly excess returns for seven major countries from 1960 to 1990 and find that correlations increase over time, are larger when large shocks occur, and are related to dividend yields and interest rates. They do not investigate the impact of macroeconomic variables other than interest rates. The evidence

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[4] The relative importance of industry factors in explaining international equity returns is an unsettled issue in the international finance literature. Roll (1992) finds that industry effects are important in explaining covariances using daily FT-Actuaries indices from 1988 to 1991. Heston and Rouwenhorst (1994) report results similar to those of von Furstenberg and Jeon (1989) using monthly data for individual European securities over a long sample period. Finally, Griffin and Karolyi (1995) using the new Dow Jones World Stock Index data corroborate Roll's original findings with weekly and daily returns.

for monthly and weekly returns suggests that exposure to macroeconomic and industry factors is not helpful in understanding levels or changes in cross-country covariances.

Why is it then that markets move together? One possibility is "market contagion." Contagion effects result when enthusiasm for stocks in one market brings about enthusiasm for stocks in other markets, regardless of the evolution of market fundamentals. In this case, loadings on fundamental variables would have little explanatory power for returns or for covariances. Another possibility is that monthly unexpected changes in macroeconomic variables are not very informative for monthly returns. There is evidence that longer horizon returns are more closely related to macroeconomic variables, but there is also evidence that macroeconomic announcements have information content for daily and intraday returns.[5] Longer horizons are not very practical in international finance research because data typically is not available and also because the degree of integration of international financial markets changes over time.[6] As a result, daily returns represent an alternative avenue for obtaining a better understanding of cross-country covariances. A third possibility is that the determinants of the cross-country covariances change over time, so that longer samples might be inappropriate to study these covariances without modeling how and why these covariances change over time. A reason to take this third possibility seriously is that barriers to international investment have become less important over time.

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[5] See Fama (1990) for references to long-horizon return results and an explanation for why long-horizon returns can lead to different results than short-horizon returns. Ederington and Lee (1993) and McQueen and Roley (1994) provide evidence on the impact of macroeconomic announcements.

[6] Several papers examine the dynamics of financial market integration, including Harvey (1991), Chan, Karolyi and Stulz (1992), Engle and Susmel (1993), Bekaert and Harvey (1995), Longin and Solnik (1995), DeSantis and Gerard (1995) and Errunza, Hogan and Hung (1995).

The major problem with the use of daily returns across countries is the non-synchronous trading periods for different markets around the globe. This institutional feature of markets has been the focus of the now large literature on international returns and volatility spillovers.[7] This issue is particularly important when focusing on links between Japan and the U.S. since the two markets are never open at the same time. For these markets, therefore, one might fail to find an impact of macroeconomic announcements simply because returns of the two countries reflect information revealed over different time intervals (von Furstenberg and Jeon (1988)). In this paper, we avoid this problem in a novel way. Instead of focusing on the returns of indices of national markets, we construct an index of interlisted Japanese stocks trading in New York as American Depository Receipts (ADRs). Using this index, we therefore observe Japanese returns which trade perfectly contemporaneously with American stock returns and can investigate the covariance between these returns without concerns about the imperfect synchronous trading hours. The cost of our approach is that interlisted stocks trade less in the foreign market than they do in their home market. We do not think, however, that this cost is important for the purpose of this paper.[8]

In addition to using ADRs, we also provide corroborating results using Nikkei stock index futures prices for the contract that has been trading on the Chicago Mercantile Exchange (CME) since 1990. We employ open and closing futures prices to replicate our

[7] See Hamao, Masulis and Ng (1990), Lin, Engle and Ito (1994), Bae and Karolyi (1995) and Connolly and Wang (1995). Lin (1995) examines the sensitivity of the return and volatility spillovers between Japan and the U.S. to money supply announcements by the Federal Reserve Board.

[8] The main concern is that close-to-open returns might be computed on only part of the trading day because of infrequent trading. Chan, Fong, Kho and Stulz (1995) find they can reliably measure intra-day returns of sample of Japanese and U.K. ADRs even for the last five minutes of trading.

analysis with ADRs from 1990 to 1992. Since the sample period is half the sample period we use with the ADRs, the results with the futures prices are weaker, but, in general, consistent with the ADR findings.

The paper is organized as follows. In Section I, we introduce our simple model of the determinants of comovements. In Section II, we present our data. An analysis of correlations is discussed in Section III. In Section IV, we provide latent variable regression tests of the return on the Japanese portfolio on a matching U.S. portfolio, allowing for the shocks in information variables to affect the correlation between the two portfolios. In Section V, we model more formally the dynamics of covariances and how they are affected by information shocks. Section VI concludes the paper.

I. A Simple Framework for Understanding Cross-country Comovements

One would expect some shocks to affect stock returns in the same direction in all countries, some shocks to benefit some countries at the expense of others, and finally some shocks to be purely idiosyncratic. Consider a portfolio of U.S. firms in, for example, the car industry, and a portfolio of Japanese firms in the same industry. An economic shock that affects all firms in the car industry could benefit all firms, hurt all firms, or have mixed effects across firms. We define "global" shocks to be those that affect all firms in an industry irrespective of their country of location, leaving market shares constant. For instance, an unexpected increase in the price of tires would have an adverse global effect on car sales. By contrast, a competitive shock is one that causes shifts in market shares between countries, making firms in one country better off at the expense of firms in another country. An example of a competitive shock would be an unexpected increase in the dollar price of the Japanese Yen. This would make the Japanese car producers worse off and the U.S. producers better off. If global economic shocks dominate, then one would expect the covariance between the stock returns of Japanese car producers and U.S. car producers to be high. In contrast, if competitive shocks are important, it could well be that portfolios of firms with similar activities have a lower covariance than portfolios of firms with different activities.

This distinction between global and competitive shocks can be formalized. Consider the return from date t-1 to date t on security i, denoted $r_{i,t}$. Let a superscript t-1 denote that an expectation is formed based on information available at t-1, so that $E^{t-1}(r_{i,t})$ is the expectation of the return formed at t-1. We assume that this return satisfies the following model:

$$r_{i,t} = E^{t-1}(r_{i,t}) + \beta^{t-1}{}_{i,t}\, e_{G,t} + \gamma^{t-1}{}_{i,t}\, e_{C,t} + \varepsilon_{i,t} \tag{1}$$

where $\beta^{t-1}{}_{i,t}$ is the loading of security i on the global shock conditional on information available at t-1, $e_{G,t}$ denotes a global shock occurring from t-1 to t, $\gamma^{t-1}{}_{i,t}$ is the loading of security i on the competitive shock conditional on information available at t-1, $e_{C,t}$ is a competitive shock from t-1 to t, and $\varepsilon_{i,t}$ denotes a firm-specific, idiosyncratic shock. We define the competitive and global shocks to be uncorrelated, so that most observable economic shocks are mixtures of pure competitive and global shocks.

To understand better the decomposition of returns given in equation (1), it is useful to look at two possible applications. First, suppose that we want a decomposition of returns that can be used for each security in the world. If the world CAPM holds (see

Stulz (1995)), then the global shock in equation (1) is the unexpected return of the world market portfolio. Second, suppose that we consider a decomposition of returns that applies to the automobile industry of the U.S. and Japan. In this case, the global shock captures the component of shocks that benefit both U.S. and Japanese firms in that industry, the competitive shock reflects the shocks that benefit firms in one country and hurt firms in the other country, and the idiosyncratic shock is a shock that affects firms in one country but has no impact on firms in the other country.

Using this representation of returns, we now consider the relation between the unexpected return of a portfolio of Japanese stocks, subscripted by JA, and the unexpected return of a portfolio of U.S. stocks, subscripted by US. These portfolios can be national industry portfolios or can be broader portfolios. Let $e_{US,t}$ be the unexpected return on the U.S. portfolio conditional on expectations based on the information available at t-1. Define the unexpected return on the Japanese portfolio, $e_{JA,t}$, in the same way. We think of the world market portfolio as the sum of the market portfolio of Japanese stocks and of the market portfolio of U.S. stocks. Shocks that have only a competitive effect benefit stocks in one country at the expense of stocks in the other country, so that one country's loading on the competitive shock is positive and the other country's loading is negative. With this representation of returns, we have the following expression for the cross-product of unexpected returns of the JA and US portfolios:

$$[r_{US,t} - E^{t-1}(r_{US,t})]\,[r_{JA,t} - E^{t-1}(r_{JA,t})] = e_{US,t}\, e_{JA,t}$$

$$= \beta^{t-1}{}_{US,t}\beta^{t-1}{}_{JA,t}\, e_{G,t}{}^{2} + \gamma^{t-1}{}_{US,t}\gamma^{t-1}{}_{JA,t}\, e_{C,t}{}^{2} + \varepsilon_{US,t}\varepsilon_{JA,t}$$

$$+ \beta^{t-1}{}_{US,t}\, e_{G,t}\,[\gamma^{t-1}{}_{JA,t}\, e_{C,t} + \varepsilon_{JA,t}] + \gamma^{t-1}{}_{US,t}\, e_{C,t}\,[\beta^{t-1}{}_{JA,t}\, e_{G,t} + \varepsilon_{JA,t}]$$

$$+ \quad \varepsilon_{US,t} [\beta^{t-1}_{JA} e_{G,t} + \gamma^{t-1}_{JA,t} e_{C,t}] \tag{2}$$

With our definition of competitive shocks, the product of the loadings of returns on the competitive shocks, $\gamma^{t-1}_{US,t}\gamma^{t-1}_{JA,t}$, must be negative. In contrast, the product of the loadings of returns on the global shocks, $\beta^{t-1}_{US,t}\beta^{t-1}_{JA,t}$, is positive. Consider the impact of a large global shock on the cross-product of unexpected returns assuming that the other shocks are at their conditional mean of zero. This impact is measured as $\beta^{t-1}_{US,t}\beta^{t-1}_{JA,t}e_{G,t}^2$ and is positive. Consequently, the greater the shock, the greater the absolute value of the cross-product. The opposite is true when the competitive shock is large. The impact of a large competitive shock on the cross-product, assuming that the other shocks are at their conditional mean of zero, is given as $\gamma^{t-1}_{US,t}\gamma^{t-1}_{JA,t}e_{C,t}^2$ and is necessarily negative since the product of the loadings is negative. Hence, it is not the case that a large return in one country implies a large cross-product of returns: it could be that a return in a country is large because of a large competitive shock.

We now turn to the conditional and unconditional covariances. Define the expectation of the left-hand side of equation (2) conditioned on the information available as the conditional covariance at t-1. All terms, except for the first two, have an expectation of zero. It follows that the conditional covariance is:

$$E^{t-1}[e_{US,t}\, e_{JA,t}] = \beta^{t-1}_{US,t}\beta^{t-1}_{JA,t} E(e_{G,t})^2 \;+\; \gamma^{t-1}_{US,t}\gamma^{t-1}_{JA,t} E(e_{C,t})^2 \tag{3}$$

Equation (3) therefore implies that the conditional covariance is high when the conditional volatility of global shocks is high. Since the global shock is the unexpected return of the world market portfolio, it immediately follows that there is a positive relation between the conditional volatility of the world market portfolio and the conditional volatility of the global shock. In addition, the conditional covariance between the Japanese and the U.S. portfolios is high when the conditional loadings of the returns on the global shocks are large, when the conditional variance of the competitive shocks is low, and when the conditional loadings of the returns on the competitive shocks are small.

With our framework, the conditional variances of portfolio returns can increase when the conditional covariance of portfolio returns falls. To see this, note that the conditional variances of these portfolios are, respectively:

$$E^{t-1}[e_{US,t}^{2}] = (\beta^{t-1}_{US,t})^2\, E^{t-1}(e_{G,t})^2 + (\gamma^{t-1}_{US,t})^2\, E^{t-1}(e_{C,t})^2 + E^{t-1}(\varepsilon_{US,t})^2$$

$$E^{t-1}[e_{JA,t}^{2}] = (\beta^{t-1}_{JA,t})^2\, E^{t-1}(e_{G,t})^2 + (\gamma^{t-1}_{JA,t})^2\, E^{t-1}(e_{C,t})^2 + E^{t-1}(\varepsilon_{JA,t})^2 \qquad (4)$$

It is clear from (4) that the conditional variance of a portfolio's return increases in the volatility of the shocks and in the portfolio's loadings on the shocks. Further, comparing (3) and (4), it is possible for the conditional variance of returns to increase while the conditional covariance of returns falls. For example, this could happen if either the conditional loadings on the competitive shocks increase in absolute value or the conditional volatility of the competitive shocks increases.

To explore further the relation between conditional covariances and conditional variances, consider a linear projection of the conditional covariance on the conditional variance:

$$E^{t-1}[e_{US,t}e_{JA,t}] = a + b\, E^{t-1}[e_{US,t}]^2 + \eta_t \qquad (5)$$

Using a linear regression model to estimate the slope coefficient b, we have:

$$E\,[b] = \frac{E[(E^{t-1}(e_{US,t}e_{JA,t}) - E(e_{US,t}e_{JA,t}))(E^{t-1}(e_{US,t})^2 - E(e_{US,t})^2)]}{E[(E^{t-1}(e_{US,t})^2 - E(e_{US,t})^2)]^2} \qquad (6)$$

Note that the estimate of b is zero if either the conditional variance or the conditional covariance are constant. Two useful benchmark cases where the estimate of b is -1 and +1 should be considered. First, suppose that the conditional loadings are constant, there are no competitive shocks, and the conditional volatility of the idiosyncratic component of the US return is constant. In this case, the estimate of b is $\beta_{JA,t} / \beta_{US,t}$. The superscript t-1 is omitted since there is no difference between conditional and unconditional loadings. Hence, in this case, if both countries have the same loadings on the global factor, the estimate of b is one. Second, suppose that the conditional loadings are constant, there are no global shocks, and the conditional volatility of the idiosyncratic component of the US return is constant. In this case, the estimate of b is $\gamma_{JA,t} / \gamma_{US,t}$, which is negative. If the two portfolios have identical exposures to competitive shocks in absolute value, then the estimate of b is -1.

It immediately follows from this discussion that a necessary and sufficient condition for the conditional covariance between the US and JA portfolios to be positively related to the conditional variance of the US portfolio is that:

$$E(E^{t-1}(e_{US,t}^2)-E(e_{US,t}^2))[E^{t-1}(\beta^{t-1}_{US,t}\beta^{t-1}_{JA,t}e_{G,t}^2) - E(\beta^{t-1}_{US,t}\beta^{t-1}_{JA,t}e_{G,t}^2)] +$$
$$E(E^{t-1}(e_{US,t}^2)-E(e_{US,t}^2))[E^{t-1}(\gamma^{t-1}_{US,t}\gamma^{t-1}_{JA,t}e_{C,t}^2) - E(\gamma^{t-1}_{US,t}\gamma^{t-1}_{JA,t}e_{C,t}^2)] > 0 \qquad (7)$$

The important feature of this result is that it is not necessarily the case that a higher conditional variance in one market or the other implies a higher conditional covariance between these markets. If the competitive shock component in the conditional covariance dominates, a high conditional variance of the competitive shock is associated with a low conditional covariance. Since the conditional variance of the portfolio return increases with the conditional variance of the competitive shock, it follows that in this case there would be a negative relation between the conditional variance of the portfolio and the conditional covariance. Hence, a negative relation between conditional covariance and conditional variance would indicate that changes in the competitive exposures and in the conditional volatility of the competitive shocks are dominant factors in the dynamics of the conditional covariance.

Since much attention has been paid to industry effects in cross-country covariances, we consider the implications of our framework for these effects. If competitive effects within an industry are important, it could be the case that within industry cross-country covariances are lower than cross-country covariances using broad-based indices. In contrast, if global shocks are mostly industry-wide shocks rather than shocks that are common to many industries, it could be that the within-industry cross-country covariance is higher than the cross-country covariance using broad-based indices. Finally, in a conditional setting, it is possible for the conditional volatility of shocks to change over time, so that *intra*-industry cross-country conditional covariances might sometimes be higher than *inter*-industry cross-country conditional covariances and the opposite might be true at other times. In our empirical analysis to follow, we consider both intra-industry and inter-industry cross-country covariances.

We cannot observe the global and competitive shocks, but only components of these shocks. Consider an economic variable whose unanticipated changes are predicted to have a competitive effect. With our framework, we could use equation (2) to investigate whether the cross-products of the returns are low when that variable has a large unanticipated component in absolute value. We could use equation (3) to relate the conditional volatility of this economic variable to the conditional covariance. If we identify a variable that has a competitive effect, the conditional volatility of that variable should be associated negatively with the conditional covariance. After defining our sample of Japanese ADRs and U.S. stocks and the economic variables of interest, we investigate the effect of macroeconomic shocks on their conditional covariance.

II. Sample Design and Preliminary Statistics

In this paper, we use a sample of all Japanese firms traded on the American and New York Stock Exchanges as ADRs. Intraday stock and ADR prices are drawn from the Institute for the Study of Securities Markets (ISSM) database from May 31, 1988 to May 29, 1992. This provides us with 900 opening and closing quote observations for each firm. Daytime returns are computed as log changes in the bid-ask midpoint quotes, using the first and last available quotes within the day. Overnight returns are computed from the previous day's last quote or transaction and today's first available quote or transaction up to 10:30 a.m.. If no quote or transaction is available by 10:30, the overnight return is declared a missing observation. The sample has 8 Japanese ADRs. For each ADR, we select three matching American firms of comparable size within the Japanese firm's industry and three matching American firms of comparable size outside the Japanese firm's industry. Industries are defined using two-digit SIC codes.[9] We then form three portfolios.

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[9] An appendix is available from the authors which provides a complete list of Japanese ADR and U.S. matching firms and some of the trading characteristics of their shares. The ADR list includes Hitachi (HIT), Honda (HMC), Kubota (KUB), Kyocera (KYO), Matsushita Electric (MC), Mitsubishi Bank (MB), Pioneer (PIO), Sony (SNE) and TDK (TDK).

One portfolio is an equally-weighted portfolio of Japanese ADRs. The second portfolio is an equally-weighted portfolio that includes only the matching firms that belong to the same industries as the ADRs. Finally, the third portfolio is an equally-weighted portfolio that includes the matching firms that do not belong in the same industry as the ADRs.

An alternative to using a portfolio of ADRs is available for part of our sample period. The CME started trading a Nikkei futures contract in September, 1990. The Nikkei futures contract has a dollar payoff that corresponds to changes in the level of the Nikkei in Yen. One can therefore think of percentage changes in the Nikkei futures price as percentage returns in an investment in the Nikkei in Yen (for given U.S. interest rates). The returns on the Nikkei futures contract are therefore not exactly comparable to the returns on ADRs. Returns on ADRs are dollar returns on Japanese shares using current exchange rates, whereas returns on the Nikkei futures contract are dollar returns on the Nikkei using a constant exchange rate. Since indices exhibit little correlation with exchange rates, one would expect a lower covariance between the dollar return on the Nikkei and U.S. indices than one would expect between the return on the Nikkei futures contract and U.S. indices.[10] We use the nearest-maturing Nikkei futures contract prices over half of our sample period to see whether results with this contract yield similar conclusions as our ADR results. These data are obtained directly from the CME.

Because of differences in time zones, the overnight return overlaps with the Japanese trading day return. In calendar time, last night's Japanese return is the Japanese day return for today's calendar date. With our timing convention, the Japanese market

[10] We could use exchange rates to obtain dollar returns on the Nikkei from Nikkei futures returns, but we do not have exchange rates that are contemporaneous to the opening and closing of futures markets. Consequently, we make no exchange rate adjustment to the return on the Nikkei futures returns.

opens first during a calendar day and the U.S. market opens only after the Japanese market has closed. Figure 1 provides a diagram of the overnight and daytime return definitions and trading periods for a 24-hour clock.

Table I provides summary statistics for the intraday and overnight returns for the whole sample period. The daytime returns for all portfolios are substantially higher than the overnight returns. The daytime return volatility is higher for the portfolios of U.S. securities than for the ADR portfolio, but this relation is reversed for the overnight returns. Similar to findings in earlier studies (MacKinlay and Ramaswamy, 1988), the futures return has the highest volatility during intraday and also overnight periods. The cross-correlations between the portfolios are also interesting. We expect a greater correlation for the industry-matched portfolios if industries are more exposed to common global shocks. The non-industry cross-correlations are lower than the industry cross-correlations during the day, but the relation is reversed overnight. The cross-country correlations are substantially higher overnight than during the day. Interestingly, the two portfolios of U.S. securities also have a higher correlation overnight. This is consistent with the view that there is a higher proportion of global shocks overnight than during the daytime, but it is also supportive of the view that trading creates noise in returns. The cross-correlations between daytime and overnight returns of different portfolios are low.

The last part of Table I provides correlations of other data we use in this study with the returns of the three portfolios. These data include daily open and close stock index quotes and trading volume for the Nikkei Stock Average from the *Nihon Keizai Shimbun* and for the S&P 500 stock index quotes from the Chicago Mercantile Exchange directly. S&P volume data is drawn from the *Standard and Poor's Daily Stock Price Record.* The close-to-close returns on the value-weighted NYSE and AMEX stock index were from the Center for Research in Security Prices (CRSP). Finally, the CME also supplied daily close-to-close returns on the Yen/Dollar futures contract, the U.S. Treasury bill futures contract. The overnight correlation of the ADR portfolio with the Nikkei index's open-to-close return is 0.594. The overnight correlation of the Nikkei index with our two U.S. matching portfolios is very similar to the overnight correlation of the ADR portfolio with the two matching U.S. portfolios.[11] The Nikkei's daytime or overnight returns exhibit little correlation with the U.S. daytime returns since the Nikkei's daytime and overnight returns for a calendar day have already occurred when the U.S. market opens. In contrast, the next day's overnight return for the Nikkei index is correlated with the daytime U.S. return since these two returns are computed from overlapping time periods. A surprising result is that the daytime ADR portfolio return is more highly correlated with the close-to-open Nikkei index return than the futures return. The opposite is the case for the open-to-close Nikkei index return.

III. When is the Correlation Higher between U.S. Stocks and Japanese ADRs?

In this section, we show that correlations differ significantly across various subsamples related to information variables, such as the return on the Yen/Dollar

[11] This finding is somewhat reassuring. Though the ADRs inherit the characteristics of the underlying Japanese stocks, they do trade less frequently and tend to be large firms in manufacturing industries. If one uses them to construct a portfolio that mimics an index, one has to be willing to take the risk of having some tracking error. Bertlotti and Enyeart (1995) of BARRA examine the characteristics of a global ADR portfolio in reference to the Morgan Stanley EAFE index to show about a 50 basis point tracking error for a 200-stock ADR portfolio over 1993-94.

exchange rate, the U.S. Treasury bill futures or the Nikkei and Standard and Poor's (S&P) 500 index returns. To evaluate these hypotheses, we employ Fisher Z tests of the equality of return correlations across different subsamples (Anderson, 1984, Chapter 4).

Table II shows the daytime (Panel A) and overnight (Panel B) return correlations. The second column of the Table shows the cross-country correlations by day of the week. Tuesday and Thursday daytime cross-country correlations are significantly lower than the Monday daytime cross-country correlations. Further, the Wednesday and Friday overnight cross-country correlations are also significantly lower than the Monday overnight cross-country correlations. For both daytime and overnight returns, the correlations are high on Monday. Daytime correlations are low on Tuesdays and Thursdays, high on Wednesdays, and in between on Fridays. The overnight correlations are lowest on Fridays, high on Thursdays, and in-between on Tuesdays and Wednesdays. The pattern shown in Table I that correlations are greater overnight than during the day holds here also with two exceptions. On Wednesday and Friday, the overnight correlations are lower. There is substantial variation in cross-country correlations across days of the week, as compared with the correlations between the two matching U.S. portfolios which exhibit little, if any, variation.

The third column of the table shows the correlations for days with news announcements (morning and afternoon announcements) and days without announcements. Ederington and Lee (1993) show that these monthly news announcements related to the Consumer Price Index, Durable Goods Orders, Gross National Product, Employment and the Treasury Budget are important predictors of the returns on interest rate and foreign exchange rate futures returns in the first fifteen minutes of the trading day.[12] For our cross-country correlations, there seems to be no clear message. For the industry matched portfolios, the correlations are higher but not significantly so compared to no-news days. The opposite is the case for non-industry matched portfolios. For morning news, one would expect the announcement to be incorporated in the opening prices. The difference between overnight correlations on no-news days and morning news days is trivial. For overnight returns, news days have a higher correlation with the industry-matched portfolio but not with the size-matched portfolio. The overnight difference in correlations for news days and non-news days for the industry-matched portfolio is surprising since it has the opposite sign from the daytime difference.

The evidence shown in the first two columns of Table II indicates that days of the week are more important for correlations than whether macroeconomic announcements take place. One hypothesis that we do not test is that some macroeconomic announcements are more surprising than others and that these announcements are associated with larger correlations. However, the point of the result just discussed is that on average correlations are not higher on news days. This result is further supported by the evidence for the U.S. portfolios where the correlations exhibit less variation across news and no news days than they do across days of the week.

In the remaining columns of Table II, we classify individual shocks to asset prices and volume into quartiles for each type of shock. A shock is defined here as the absolute

[12] The macroeconomic announcement data are obtained directly from Louis Ederington and Jae Ha Lee. They include nineteen monthly announcements whose upcoming release is regularly covered in "The Week Ahead" colum of *Business Week*. The sample comprises 543 news days, divided into 500 morning announcements and 43 afternoon announcements. See Appendix in Ederington and Lee (1993).

percentage change of a variable. For foreign exchange and Treasury Bill futures prices, we compute only close-to-close percentage changes, given availability. For foreign exchange, the absolute percentage close-to-close changes for the Yen/Dollar futures price on the nearby contract are divided into quartiles. The first quartile corresponds to those days with the 25% highest absolute percentage changes. One would expect foreign exchange shocks to have competitive effects. In other words, changes in exchange rates make one country better off and the other worse off. If this is the case, correlations should be lower for large foreign exchange shocks. We find, however, that the correlation for the first quartile is typically not the lowest correlation. Our inability to find a monotone relation between exchange rate shocks and correlations may be due to the fact that close-to-close returns are a noisy measure of the exchange rate changes contemporaneous with the correlation measurement interval. For Treasury Bill futures, the results are inconclusive also, but there is weak evidence that the correlations are highest for the first quartile overnight, which would be consistent with the view that interest rate shocks have a global effect.

The next two columns of Table II show the effects of shocks to the Nikkei. In the first of these two columns, the evidence is for Nikkei open-to-close returns. These returns are contemporaneous with the overnight return correlations and precede the daytime correlations in New York. Despite the fact that the shock took place earlier, it seems to carry over to the daytime returns in that the correlations for the fourth quartile are significantly lower than for the first quartile. The overnight correlations are sharply decreasing in the Nikkei open-to-close absolute return; the average correlation for the highest quartile of absolute returns is almost five times higher than for the lowest quartile.

These differences are significant at the 1% level. The next column concerns the Nikkei close-to-open absolute returns. These returns are contemporaneous with the daytime returns in the U.S. The daytime correlations are sharply declining in the magnitude of the absolute Nikkei returns, but so are the following overnight correlations. Again, therefore, we see a spillover effect: a high shock in one period is accompanied by a high correlation in that period and the adjacent period. The same patterns hold for the S&P absolute returns. Finally, we present evidence on volume shocks. There is only weak evidence of a negative relation between S&P or Nikkei volume and return correlations.

The evidence presented in Table II shows that: (a) there is substantial variation in correlations across days; (b) there is no systematic pattern in correlations between days with macroeconomic announcements and days without such announcements; (c) S&P and Nikkei absolute returns are strongly positively related to correlations, (d) there is no evidence that the correlations are different when using a size-matched U.S. portfolio instead of an industry-matched U.S. portfolio.

IV. Estimating the Impact of Shocks on the Comovement of Returns.

The previous section provides evidence that the correlations between the ADR portfolio and U.S. portfolios vary with some information variables. We now try to understand better why these correlations vary using a regression model that allows us to evaluate better the nature of this relation. Our approach is very similar to the latent variable regression model of Pindyck and Rotemberg (1990).[13] One concern with the

[13] Pindyck and Rotemberg (1990) apply a regression-based latent variable model to measure the excess comovement of commodity prices, after accounting for the effects of common macroeconomic shocks. Their formulation estimates a conditioning first-pass regression of commodity price changes on lagged

evidence of the previous section is that if portfolio returns are jointly normally distributed with a constant positive correlation coefficient, one expects the correlation coefficient conditioned on the size of shocks to increase with the magnitude of the shocks to the information variables if these shocks are associated with larger returns in absolute value. In this section, our regression model explicitly allows for an effect of the information variables on the comovement between the ADR and U.S. portfolio returns, even after accounting for their direct effects on the return of the U.S. portfolio and the Japanese portfolio. Indeed, after accounting for the change in the U.S. return and the shock in the information variable, the shocks generally have a significant impact on the comovement. We interpret the results from this diagnostic test as evidence in favor of some higher-order nonlinear effects in the cross-country correlations.

We estimate our latent variable regression model in two steps. The first model conditions the U.S. and Japanese overnight and daytime portfolio returns, R_{it}, on a set of information variables, Z_{t-1}:

$$R_{it} = E(R_{it} \mid Z_{t-1}) + \varepsilon_{it} \tag{8a}$$

$$E(R_{it} \mid Z_{t-1}) = \delta_{i0} + \Sigma_k \, \delta_{ik} \, z_{k,t-1} \tag{8b}$$

Our conditioning information includes some of the variables studied in Table II: the lagged return on the Yen/Dollar exchange rate futures, on the CME Treasury bill futures, the CRSP value-weighted portfolio of NYSE and AMEX stocks, the macroeconomic news announcement dummy, a Monday dummy and preceding returns on the S&P and Nikkei

instrumental variables. The residuals are then extracted from the first-pass model and a residual covariance matrix is constructed. Multivariate (Wald) tests then evaluate the null hypothesis that the matrix is diagonal. They easily reject this hypothesis indicating 'excessively' large correlations.

indexes. The second pass regression model then extracts the residuals series from equation (8) and estimates:

$$\varepsilon_{JA,t} = \alpha(Z_{t-1}) + \beta(Z_{t-1})\, \varepsilon_{US,t} + \eta_t \tag{9}$$

where $\alpha(Z_{t-1})$ and $\beta(Z_{t-1})$ allow the coefficients to be linear functions of the instrumental variables. For example, we specify that:

$$\alpha(Z_{t-1}) = \alpha_0 + \Sigma_k \alpha_k z_{k,t-1} \tag{10b}$$

$$\beta(Z_{t-1}) = \beta_0 + \Sigma_k \beta_k z_{k,t-1} \tag{10b}$$

where the coefficient β_0 can be interpreted as the average 'normalized' conditional correlation coefficient between the Japanese and U.S. portfolios and β_k are the response coefficients of the conditional correlation with respect to the information variables in Z_{t-1}. The $\alpha(Z_{t-1})$ function can be similarly interpreted. We use the same instrumental variables for the Z_t "shocks" as in Table II: a news announcement dummy, returns on the Yen/Dollar exchange rate futures, Treasury bill futures, Nikkei and S&P returns and volume, and so on. For each information variable, $z_{k,t-1}$, however, we introduce two terms with associated coefficients: β_1 measures the impact on the Japanese portfolio return residual of the increase in comovement resulting from the *level* of the shock itself, and β_2, measures the impact from an increase in comovement from the *absolute value* of a shock. Hence, if shocks affect the comovement between the return of the U.S. and the ADR portfolio only through their level or through their impact on the U.S. return, β_2 is equal to zero. If a shock is a global shock, one expects the comovement to be increasing in the shock, so that β_2 is positive. In contrast, if a shock is a competitive shock, β_2 is negative.

Table III shows estimates of the conditional mean equation (8) for the Japanese ADR and two U.S. portfolios in addition to the CME Nikkei index futures contract (1990-92 subperiod only). Results are presented separately for daytime and overnight returns.[14] First, we note that the explanatory power of the conditional mean equation for overnight returns is greater than for daytime returns: the adjusted R^2 are on average 6% to 9% whereas those for the daytime period are less than 3%. Second, the most important conditioning variables for both daytime and overnight returns on the Japanese and U.S. portfolios are the preceding returns from the Nikkei and S&P indices; the Nikkei is not surprisingly more important for the Japanese ADR portfolio and the S&P return, for the U.S. portfolios, although there is a weak spillover effect from the Nikkei in the latter case (Hamao, Masulis and Ng, 1990). Thirdly, the news announcement dummy has a measurable effect on the U.S. daytime returns, consistent with Ederington and Lee (1993). Finally, the Monday dummy variable has a significant negative impact on the overnight returns but that typically is recovered for the daytime returns across most U.S. and even Japanese portfolios.

Table IV reports the second stage latent variable regressions (equations 9 and 10) that focus on the covariations. Results are presented in four panels contrasting daytime and overnight correlations and those of the Japanese ADR portfolio with the industry-matched and size-matched U.S. portfolios. The key finding that holds for all panels of that table is that the absolute values of shocks matter when we control for the return of the matching portfolio and for the level of the information variable. This impact is most

[14] All first and second-stage regression standard errors and inference tests are based on robust standard errors computed with Newey and West (1987) heteroscedasticity and serial-correlation corrections, up to five lags. Different lag lengths were attempted with no important changes in our conclusions.

obvious in the case of the S&P return. In both panels, the overnight comovement between the U.S. portfolio and the Japanese portfolio is significantly related to the absolute value of the S&P 500 overnight return. In addition, however, there are comovement spillover effects: the daytime comovement between the U.S. portfolio and the Japanese portfolio is significantly positively related to the previous night absolute return on the S&P 500. Whereas the S&P 500 daytime absolute return does not seem to have a contemporaneous effect on the comovement, it has an effect on the overnight comovement. The contemporaneous and previous trading period absolute returns on the Nikkei impact the comovement between the ADR and the U.S. portfolio returns. We find that the contemporaneous Nikkei absolute return always has a significant effect on the comovement and in addition has a spillover effect on the next period's comovement. The shocks generally have an impact on the Japanese portfolio return in addition to their impact on the U.S. portfolio return.

Using our distinction between competitive shocks and global shocks, the results in Table IV show that generally our information variables represent global shocks. This is because large shocks are accompanied by higher comovement. The only significant negative β_2 coefficients are for foreign exchange when the U.S. portfolio return is the daytime return on a size-matched portfolio and for the S&P 500 volume for the industry-matched portfolio daytime return and the size-matched portfolio overnight return. We estimated all the regressions presented in Table IV without the level of the shocks and the results were similar.

Table V repeats the same two-stage regression model experiment for the intraday and overnight return correlations between the CME Nikkei futures contract with the S&P index, as the U.S. portfolio. Our results are qualitatively similar to those in Table IV, except that the results are somewhat weaker, possibly because the sample size is reduced by half. For example, we find that the coefficient for the absolute returns shock from the contemporaneous overnight Nikkei shock is the only significant at conventional levels for daytime returns. The preceding daytime shock from the Nikkei for the overnight return is significant, although surprisingly with a negative β_2 coefficient. This, of course, has to be related to the fact that the β_k coefficients for the covariations interact with the lagged Nikkei shock which enters in the regression in levels (α_1 is significant with value of 0.891 for the overnight CME Nikkei return residual).[15] The S&P shocks are statistically important in levels for the daytime shocks, which is expected because at this aggregate level the S&P returns residuals series from equation (8) is also the independent variable in equation (9).

V. Covariance Dynamics

We extend our analysis to a framework in which the conditional expected returns, variances and covariances can be modeled dynamically and estimated in a joint simultaneous system. Our objectives are twofold. First, we want to understand how shocks to our information variables affect comovement over time. In particular, we would

[15] This finding is consistent with that of Craig, Dravid and Richardson (1995) in which the CME Nikkei index futures contract is shown to provide complete information about contemporaneous overnight Japanese returns.

like to know if there are spillover effects, in the sense that a shock at one point in time carries over into higher correlation the next period. Second, we want to investigate the impact of shocks on the correlations taking fully into account of the impact of shocks on variances. In this way, we can test whether our results are consistent with a model where conditional variances change over time but conditional correlations do not. Expected returns processes across countries have been shown to depend on a set of information variables such as exchange rates and interest rates,[16] and conditional variances of national equity markets have been modeled successfully using multivariate ARCH methods. These models are based on the original work of Engle (1982) and generalized by Bollerslev (1986) and have been shown to capture reasonably well the time variation in the volatility of monthly, daily and even intraday stock returns (Bollerslev, Chou and Kroner, 1992). Multivariate ARCH models have been particularly important as a modeling framework for numerous studies of short-term dynamics of international stock returns and volatility, including studies by Hamao, Masulis and Ng (1990), Lin, Engle and Ito (1994) and Bae and Karolyi (1995).

To conduct our investigation, we specify the following joint returns generating process for the Japanese ADR and U.S. industry-matched portfolios,[17]

$$R_{it} = E[R_{it} \mid Z_{t-1}] + \varepsilon_{it} \tag{11a}$$

[16] Important studies modeling time variation in conditional expected returns in the U.S. include Campbell (1987), Fama and French (1988), Ferson and Harvey (1991), and, for global markets, include Bekaert and Hodrick (1992), Campbell and Hamao (1992) and Solnik (1993).

[17] Our specification is similar to that of Longin and Solnik (1995) who study the changes in conditional correlations across national stock markets using monthly returns. The instrumental variables on which the expected returns and variances are projected are different, however, given the returns horizons.

$$E[R_{it} \mid Z_{t-1}] = \delta_{i0} + \Sigma_k \delta_{ik} z_{k,t-1} \qquad (11b)$$

$$\varepsilon_t \mid Z_{t-1} \sim N(0, H_t) \qquad (11c)$$

where the returns for each portfolio, R_{it}, are projected on the same set of instrumental variables, as in Table III. The joint vector of residuals, ε_t, is now specified to be a conditionally zero-mean Gaussian process with time-varying conditional covariance matrix, H_t. Several parsimonious multivariate specifications are available for the covariance process (Kroner and Ng, 1994). We choose the constant conditional correlation model as it captures the null hypothesis that there is no incremental information that can be extracted from economic variables to influence the dynamics of conditional correlations after controlling for the conditional means and variances. The joint variance process for the Japanese ADRs and U.S. portfolios is assumed to be a linear function of past squared innovations and past conditional variances from each portfolio, as well as information variables,

$$h_{ii,t} = c_i + a_i h_{ii,t-1} + b_i \varepsilon_{i,t-1}^2 + \Sigma_k d_{ik} z_{k,t-1} \qquad (12a)$$

$$h_{ij,t} = \rho_{ij} (h_{ii,t} h_{jj,t})^{1/2} \qquad (12b)$$

where the i,jth elements of H_t are given by $\{h_{ij,t}\}$. We choose a GARCH (1,1) specification in the estimations presented below although other lag lengths for the variance process were considered. Given a sample of T observations of the returns vector, the parameters of the bivariate system above, denoted Θ, are estimated using the conditional log-likelihood function for each time period,

$$L_t(\Theta) = -\log 2\pi - {}^1/_2 \log |H_t| - {}^1/_2 \varepsilon_t' H_t^{-1} \varepsilon_t \qquad (13a)$$

$$L(\Theta) = \Sigma_t L_t(\Theta) \qquad (13b)$$

Numerical maximization of the function follows the algorithm of Berndt, Hall, Hall and Hausman (1974) which yields estimates and associated asymptotic standard errors. We, however, report the standard errors, t-values and other test statistics computed using the quasi-maximum likelihood methods of Bollerslev and Wooldridge (1992) which are robust to changes in the density function underlying the residuals. To perform residual diagnostics, standardization is based on a Cholesky decomposition of the conditional covariance matrix for each observation.

To evaluate the influence of a set of factors or determinants for the conditional variance-covariance dynamics, we allow the conditional correlation equation to be extended by a set of parameters related to the interaction between the covariance process and a set of information variables, which are those used in Table IV. Specifically, we estimate our model with the covariance dynamics,

$$h_{ii,t} = c_i + a_i\, h_{ii,t-1} + b_i\, \varepsilon_{i,t-1}^2 + \Sigma_k d_{ik}\, z_{k,t-1} \tag{14a}$$

$$h_{ij,t} = [\rho_{ij,0} + \Sigma_k\, \rho_{ij,k}\, z_{k,t-1}]\, (h_{ii,t}\, h_{jj,t})^{1/2} \tag{14b}$$

We test whether the $\rho_{ij,k}$ coefficients for the interactive components are jointly significant using conventional likelihood ratio tests. The expression for the conditional correlation process represents a formalization of the latent variable regression models of equations (8)-(10) in Section IV.[18]

[18] Similar to Longin and Solnik (1995), our specification risks the event of non-positive definiteness of the covariance matrix, especially if the coefficients of the information variables are freely estimated. Constraining the values of the instrumental variables to be non-negative is one solution, but it is unacceptable from an economic perspective. We allowed the coefficients to be freely estimated and found no problem of negative conditional variances in our sample for any plausible values of the instrumental variables.

Table VI provides the estimates for the daytime returns using the Japanese ADR portfolio and the U.S. industry-matched portfolio. The results with the Japanese ADR portfolio and the U.S. size-matched portfolio, though not reported, are similar. The conditional mean returns are presented in Panel A, the conditional variance and covariance equations in Panel B, and the likelihood ratio tests in Panel C. The columns represent different estimations with various specifications of the conditional correlation process; the base model is presented in the first column. For the expected returns process with daytime returns, the coefficients for the instrumental variables are similar in magnitude to those of Table III and are generally statistically insignificant using the robust quasi-maximum likelihood procedures. The exceptions are the previous close-to-open return of the S&P, the closing return on the CRSP value-weighted portfolio, and the Monday dummy coefficient for the Japanese ADR portfolio and the U.S. stock portfolio. The previous night's open-to-close Nikkei index return is not statistically important for the mean returns.

The parameters of the variance-covariance process for intraday returns are as expected: the sum of the lagged $h_{ii,t}$ and $\varepsilon_{i,t-1}^2$ coefficients is close to 0.78 on average for the Japanese ADRs, but much lower for the U.S stocks (almost 0.55). This suggests that these return innovations have some degree of persistence, but less than that observed for closing returns data (Bollerslev, Chou and Kroner, 1992). This may stem from the fact that we allow the absolute return shocks from the Nikkei index (open-to-close) and the S&P index (close-to-open) to "spillover" in the specification of the conditional variances. These latter coefficients are significant for the Japanese ADRs (0.08) for the absolute

Nikkei return and -0.045 for the absolute S&P return) and that of the absolute S&P return (0.25) for the U.S. stock volatility process. The Monday dummy variable appears to impact the variance of the Japanese ADRs negatively (-0.10).

The coefficients for the conditional correlation process are shown at the bottom of panel B. The average conditional correlation measure is approximately 0.28 and we find that the Monday dummy is significantly positive, confirming the earlier findings in Table II. Studying the results across columns which extend the base model by including one of the instrumental variables at a time, we find supportive evidence for our earlier results. The macroeconomic news announcement dummy variable has no additional explanatory power. Similar conclusions obtain for the T-bill shock. We find surprisingly stronger evidence of a foreign exchange shock to the conditional correlation, with a significant positive coefficient of 0.107, which was not identified in earlier diagnostics. Finally, the spillovers of own-market shocks from the previous day's Nikkei and S&P index returns are significant and positive influences on the conditional correlation with coefficients of 0.101 and 0.233, respectively, even after accounting for their impact on the conditional variances for the Japanese ADRs and U.S. stocks. Likelihood ratio tests for the null hypothesis that the conditional correlation process is constant demonstrate that the foreign exchange and own-market shocks are significant. Though not reported, residual diagnostics for the Japanese ADR and U.S. stock returns indicate that the Bollerslev-Wooldridge robust estimation methods are important given lingering excess skewness and kurtosis in the standardized residuals.

Table VII presents the results for the overnight returns. For the conditional mean returns, we find that the Nikkei close-to-open return shock is a significantly positive influence for the Japanese ADRs (0.468) and, though less so, for the U.S. stocks (0.055). The previous day's S&P index daytime return has a statistically significant though smaller coefficient for the overnight Japanese ADR return of 0.308, and it impacts the U.S. stocks with a coefficient of 0.125. The Monday dummy variable is negative for both returns series, but only statistically significantly for the ADR returns.

The conditional variance and covariance dynamics for the overnight returns in panel B of Table VII show that the lagged squared innovations and past conditional variances, $h_{ii,t-1}$, and $\varepsilon_{i,t-1}^2$, have significant coefficients but imply much lower persistence. The sum of the coefficients, a + b, equals less than 0.40 and 0.65 for the Japanese ADRs and the U.S. stocks, respectively. This is much lower than the 0.95 we typically observe in the conditional variance models for daily returns and even lower than the open-to-close returns inTable VI. Again, this may stem from the fact that the absolute overnight Nikkei return and the absolute previous day return on the S&P 500 are allowed to enter the variance specification and have significantly positive coefficients. The conditional correlation equation for the basic model (in column 1) implies an average correlation of about 0.28 and also indicates that the correlations are indeed higher on Mondays (ρ_1 coefficient of 0.1166). We find that coefficients for the additional instrumental variables, such as the macroeconomic news dummy, foreign exchange rate shock, and T-bill rate shock, are not significant. However, as in Table VI, the own-market shocks are pervasively strong in all specifications. The coefficient on the Nikkei shock (overnight return) is much larger in magnitude (0.293) than for daytime return correlations, and that of the S&P previous day's shock is much smaller (0.107). Residual diagnostics again indicated significant excess skewness and kurtosis in the standardized residuals (though less severe than for daytime returns).

In light of the model of Section II, the results in this section imply that shocks to foreign exchange and stock index returns are global shocks. While others have argued that large index returns are correlated across countries using different data and sample periods, the result that large exchange rate shocks are accompanied by higher correlations once one accounts for variance effects is new to this study. This is surprising since one would have expected exchange rate shocks to have competitive effects rather than global effects. One interpretation of the lack of impact of macroeconomic announcements on the correlations is that macroeconomic announcements have both global and competitive effects. Finally, the only shocks accompanied by reductions in correlations are U.S. volume shocks. This is consistent with U.S. volume shocks being domestic liquidity shocks that create temporary components in returns as argued by Campbell, Grossman and Wang (1993).

To investigate how sensitive our results are to the use of ADRs, we re-estimate the equation systems of Tables VI and VII using the Nikkei futures contract as the Japanese portfolio and the S&P 500 as the U.S. portfolio. As already discussed in the data section, Nikkei futures prices are only available for the second half of our sample period, 1990-1992. In Table VIII, we contrast our results for the ADR and Nikkei futures results for overnight and daytime returns. Moreover, we estimate a benchmark constant correlation model and one in which each of five information variables (macroeconomic announcement dummy, absolute returns on Yen/Dollar currency futures, Treasury bill futures and Nikkei and S&P index) enter the conditional correlation process jointly. The overnight results with the Nikkei futures are in general consistent with the ADR results. The impact of the foreign exchange shocks and interest rate shocks on the correlation coefficient differs in the Nikkei futures estimates, but this may be due to the fact that futures prices are directly related to interest rates through the cost-of-carry equation and to the fact that Nikkei futures prices assume a constant exchange rate whereas the ADR prices reflect the current exchange rate. The estimates for the intra-day returns, by contrast, are not as significant as the estimates for the overnight returns. This seems to be due to the fact that the daytime returns on the Nikkei futures contract are noisy compared to the daytime returns on the ADRs.[19]

VI. Conclusions

This paper investigates the properties of cross-country stock return comovements. Using dollar-denominated returns of U.S. and Japanese shares trading in the U.S., we show that neither macroeconomic announcements nor interest rate shocks significantly affect comovements between U.S. and Japanese share returns. Controlling for industry effects also has little or no impact on the magnitude of stock return comovements. In contrast, stock return comovements exhibit day-of-the-week effects, with Monday comovements being higher than on other days. Further, and more importantly, using a

[19] One way to see this is to regress the return on the Nikkei futures contract on a constant and the contemporaneous return on the Nikkei index. The R^2 of that regression is much larger overnight than during the daytime.

variety of methods, we show that comovements are high when contemporaneous absolute returns of national market indices are high. For example, the daytime correlations and covariances between returns of Japanese and U.S. shares are high when the S&P index has a high absolute return. We show that this empirical regularity cannot be explained by the fact that if returns are jointly normally distributed and co-move positively, conditioning on a large absolute return implies a large estimate for the correlation and the covariance. There is also evidence that high absolute returns in the previous trading period carry over into high correlations and covariances in the current trading period.

Our evidence shows that correlations and covariances are high when markets move a lot. This suggests that international diversification does not provide as much diversification against large shocks to national indices as one might have thought. In risk analysis, one should allow for the fact that large return shocks propagate more internationally than small return shocks. Our analysis also suggests that covariances change over time and can be forecasted using various instrumental variables. It is therefore not appropriate to assume that covariances between countries are constant either because one believes them to be so or because one views covariances as unforecastable.

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Table I. Summary Statistics for Intraday and Overnight Returns of the Japanese ADR and U.S. Stock Portfolios, 1988-1992.

Returns are measured as log changes in the bid-ask midpoint quotes from May 31, 1988 to May 29, 1992 (900 obs). Overnight returns are computed from the previous day's last quote or transaction and today's first available quote or transaction up to 10:30am, otherwise missing observation. The Japanese ADR portfolio consists of 8 NYSE-listed American Depository Receipts. The U.S. portfolios comprise 24 U.S. stocks matched on Japanese company's size and SIC for "US Industry" and size but outside industry for "US Size." Q_k (Q_k^2) is the Box-Ljung Portmanteau test for the k-th autocorrelations for raw (squared) returns. Daily open and close stock index quotes and trading volume (NKVOL) for the Nikkei Stock Average are from the Nihon Keizai Shimbun and for the S&P 500 Stock Index directly from the Chicago Mercantile Exchange (CME). Overnight timing conventions (Figure 1) for a 24-hour period (Day "t") set the trading day in Tokyo to precede that of New York: Tokyo's open-close return (NKOC), is contemporaneous with New York's overnight return (SPCO), and both precede Tokyo's overnight return (NKCO), contemporaneous with New York's open-close return (SPOC). Daily Yen/Dollar exchange rate returns (RFX) and Treasury bill returns (RTB) are based on closing CME futures prices. The close-to-close returns for the value-weighted U.S. stock index (RVW) is from CRSP and daily NYSE volume (SPVOL) is from the S&P's Daily Stock Price Record. From September 1990 (424 obs), intraday and overnight returns on the CME's Nikkei futures contracts are computed. Significance at the 95% level is denoted by ** and at the 90% level by *.

	Daytime Returns				Overnight Returns			
Statistics	*Japan ADRs*	*US Industry*	*US Size*	*Nikkei Futures*	*Japan ADRs*	*US Industry*	*US Size*	*Nikkei Futures*
Mean Returns (%)	0.0342	0.0449	0.0369	0.0535	-0.0553	0.0064	0.0123	-0.1142
Standard Deviation	0.5400	0.8205	0.7338	0.8561	1.2633	0.4325	0.3726	1.6684
t-value (mean=0)	1.90*	1.64*	1.51	1.28	-1.31	0.44	0.98	-1.40
Skewness (p-value)	0.01	-0.32**	-0.58**	1.72**	0.08	-0.64**	-1.04**	-0.79**
Excess Kurtosis	17.00**	4.95**	8.31**	23.23**	3.98**	9.46**	10.94**	6.07**
Q_k Box-Ljung	10.65*	10.41**	2.95	3.52	15.92**	8.96	12.13**	4.83
Q_k^2 Box-Ljung	5.69	49.44**	71.25**	5.31	45.65**	43.69**	35.59**	4.64
Cross-correlations:								
Japan ADR (OC)	1.000							
US Industry (OC)	0.343	1.000						
US Size (OC)	0.372	0.811	1.000					
Nikkei Futures (OC)	0.537	0.538	0.562	1.000				
Japan ADR (CO)	0.039	-0.009	0.039	-0.011	1.000			
US Industry (CO)	0.036	-0.039	-0.002	-0.047	0.427	1.000		
US Size (CO)	0.042	-0.050	-0.005	-0.008	0.393	0.869	1.000	
Nikkei Futures (CO)	0.084	-0.034	0.049	-0.190	0.662	0.414	0.415	1.000
With Instruments:								
NKOC	0.020	0.003	0.024	-0.085	0.594	0.341	0.322	0.785
NKCO	-0.019	0.009	0.009	-0.021	0.267	0.186	0.173	0.254
NKCO (t+1)	0.452	0.328	0.349	0.392	0.265	0.218	0.196	0.336
NKVOL	-0.022	-0.022	-0.055	0.001	-0.166	-0.035	-0.048	-0.238
SPOC	0.379	0.848	0.880	0.653	0.034	-0.007	0.002	0.006
SPCO	0.110	0.000	0.071	0.003	0.411	0.828	0.819	0.478
SPVOL	-0.097	-0.113	-0.096	-0.049	0.038	-0.061	-0.008	-0.031
RFX	0.290	0.009	0.059	0.198	0.296	0.090	0.055	0.169
RTB	-0.053	0.029	-0.040	-0.074	0.030	-0.114	-0.132	0.099
RVW	0.385	0.740	0.799	0.577	0.252	0.435	0.437	0.253

Table II. Intraday and Overnight Return Correlations of the Japanese ADR and U.S. stock portfolios

Returns are measured as log changes in the bid-ask midpoint quotes from May 31, 1988 to May 29, 1992 (900 obs). News days denote 543 days on which 19 different types of macroeconomic news announcements were released from various government agencies, see Ederington and Lee (1993). These are separated into morning annoucements (500 obs), such as CPI, Durable Goods Orders, Employment, and afternoon announcements (43 obs), such as Treasury's Federal Budget statement. Correlations are reported separately for different subsamples of days sorted by quartiles of values of a series of instrumental variables (=Highest quartile; =Lowest quartile). These instrumental variables include: absolute returns of the daily Yen/Dollar foreign exchange futures (RFX), Treasury bill futures (RTB) and CRSP value-weighted portfolio (RVW), Nikkei daytime (NKOC) and overnight (NKCO) absolute returns and trading volume (NKVOL), and S&P 500 daytime (SPOC) and overnight (SPCO) absolute returns and trading volume (SPVOL). The overnight Nikkei return (NKCO) is denoted as "t+1" and, the daytime S&P returns (SPOC), as "t-1" because of 24-hour timing conventions adopted (Figure 1). Fisher Z statistics for differences in correlations are computed for each correlation and denoted as "*" for significance at the 5% level and "**", at the 1% level. Tests are computed for each day of week against that of Monday, for the different news subsamples against benchmark of days without news announcements, and for the quartiles against benchmark of the first quartile. Significance at the 95% is denoted by *.

Panel A. Daytime Returns Correlations

All Days	*By Day of Week*		*By Type of News Days*			*RFX Quartile*	*RTB Quartile*	*RVW Quartile*	*NKOC Quartile*	*NKCO Quartile*	*NKVOL Quartile*	*SPCO Quartile*	*SPOC Quartile*	*SPVOL Quartile*
						Japanese ADR Portfolio and U.S. Industry-Matched Portfolio								
0.337	Mon	0.407	Yes	0.317	Q1	0.331	0.327	0.463	0.389	0.481	0.449	0.438	0.464	0.199
	Tue	0.273*	No	0.366	Q2	0.315	0.481*	0.232*	0.350	0.314*	0.313*	0.256*	0.287*	0.171
	Wed	0.431	A.M.	0.327	Q3	0.430	0.361	0.199*	0.357	0.341*	0.354	0.172*	0.329*	0.359*
	Thu	0.262*	P.M.	0.267	Q4	0.317	0.181	-0.012*	0.240*	0.119*	0.255*	0.039*	0.204*	0.426*
	Fri	0.320												
						Japanese ADR Portfolio and U.S. Size-Matched Portfolio								
0.366	Mon	0.430	Yes	0.387	Q1	0.343	0.352	0.493	0.419	0.517	0.432	0.476	0.507	0.272
	Tue	0.270*	No	0.322	Q2	0.370	0.434	0.238*	0.361	0.314*	0.360	0.252*	0.328*	0.210
	Wed	0.461	A.M.	0.383	Q3	0.426	0.447	0.198*	0.413	0.392*	0.426	0.124*	0.350*	0.310
	Thu	0.247*	P.M.	0.450	Q4	0.367	0.252	0.012*	0.250*	0.159*	0.260*	0.146*	0.190*	0.474*
	Fri	0.390												
						U.S. Industry-Matched and U.S. Size-Matched Portfolio								
0.806	Mon	0.823	Yes	0.812	Q1	0.823	0.806	0.898	0.808	0.805	0.756	0.900	0.839	0.710
	Tue	0.759	No	0.796	Q2	0.787	0.852	0.778*	0.800	0.816	0.874*	0.776*	0.823	0.742
	Wed	0.752	A.M.	0.812	Q3	0.808	0.797	0.589*	0.792	0.793	0.800	0.564*	0.751*	0.808*
	Thu	0.811	P.M.	0.806	Q4	0.807	0.745	0.469*	0.829	0.807	0.747	0.244*	0.790	0.852*
	Fri	0.857												

Table II. Continued.

Panel B. Overnight Returns Correlations

All Days	*By Day of Week*		*By Type of News Days*			*RFX Quartile*	*RTB Quartile*	*RVW Quartile*	*NKOC Quartile*	*NKCO Quartile*	*NKVOL Quartile*	*SPCO Quartile*	*SPOC Quartile*	*SPVOL Quartile*
						Japanese ADR Portfolio and U.S. Industry-Matched Portfolio								
0.424	Mon	0.581	Yes	0.434	Q1	0.407	0.512	0.596	0.625	0.555	0.329	0.598	0.634	0.386
	Tue	0.395	No	0.409	Q2	0.442	0.449	0.226*	0.364*	0.495	0.337	0.300*	0.164*	0.241*
	Wed	0.347*	A.M.	0.439	Q3	0.418	0.292*	0.331*	0.139*	0.282*	0.577*	0.320*	0.216*	0.287
	Thu	0.501	P.M.	0.330	Q4	0.431	0.387*	0.284*	0.114*	0.087*	0.386	0.213*	0.058*	0.581*
	Fri	0.232*												
						Japanese ADR Portfolio and U.S. Size-Matched Portfolio								
0.388	Mon	0.585	Yes	0.387	Q1	0.397	0.433	0.583	0.619	0.531	0.308	0.580	0.609	0.336
	Tue	0.415	No	0.394	Q2	0.408	0.435	0.192*	0.264*	0.448	0.296	0.294*	0.114*	0.237
	Wed	0.219*	A.M.	0.389	Q3	0.265*	0.266*	0.250*	0.085*	0.249*	0.511*	0.216*	0.136*	0.148*
	Thu	0.458	P.M.	0.292	Q4	0.479	0.374	0.253*	0.119*	0.073*	0.389	0.217*	0.024*	0.568*
	Fri	0.233*												
						U.S. Industry-Matched Portfolio and U.S. Size-Matched Portfolio								
0.864	Mon	0.915	Yes	0.859	Q1	0.902	0.912	0.933	0.937	0.912	0.814	0.925	0.946	0.802
	Tue	0.750*	No	0.876	Q2	0.890	0.907	0.764*	0.814*	0.821*	0.899	0.842*	0.776	0.789
	Wed	0.809	A.M.	0.856	Q3	0.794*	0.784*	0.815*	0.849*	0.849*	0.902*	0.847*	0.554*	0.756
	Thu	0.863	P.M.	0.884	Q4	0.859	0.798*	0.743*	0.808*	0.808*	0.782	0.750*	0.334	0.926*
	Fri	0.914												

Table III. Intraday and Overnight Returns Regressions of the Japanese ADR, U.S. Matched-sample Portfolios, CME Nikkei Futures and S&P 500 Index on Informational Variables.

Each returns series is regressed on a set of informational variables, including a lagged closing return on the CME Yen/Dollar exchange rate futures, RFX_{t-1}, on the CME Treasury bill futures, RTB_{t-1}, on the CRSP Value-weighted stock index, RVW_{t-1}, the returns on the Nikkei and S&P 500 stock indices immediately preceding the trading period ($NKOC_t$ and $SPCO_t$ for daytime returns; $NKCO_t$ and $SPOC_{t-1}$ for overnight returns), macroeconomic news announcment dummy variable (NWS_t) and a Monday dummy variable (MON_t). The t-statistics are computed using robust standard errors with Newey and West (1987) serial-correlation (5 lags) and heteroscedasticity correction. Statistical significant is denoted by ** at the 5% level and * at the 1% level.

Statistic	*Japanese ADRs*	*US Industry Portfolio*	*US Size Portfolio*	*S&P 500*	*CME Nikkei Futures*	*Statistic*	*Japanese ADRs*	*US Industry Portfolio*	*US Size Portfolio*	*S&P 500*	*CME Nikkei Futures*
		Daytime Returns						*Overnight Returns*			
Constant	-0.0120	-0.0731	-0.0432	-0.1521**	-0.2259**	Constant	-0.0478	0.0109	0.0222	0.0743	-0.0914
RFX_{t-1}	0.0256	-0.0138	0.0381	0.0124	-0.0236	RFX_{t-1}	0.0059	-0.0155	-0.0190	0.0100	0.1105
RTB_{t-1}	-0.0017	0.0243	0.0141	-0.0138	-0.0092	RTB_{t-1}	-0.0520	-0.0177	-0.0192	-0.0331	-0.1097
RVW_{t-1}	-0.0482*	0.0411	-0.0070	0.0076	0.0035	RVW_{t-1}	-0.3821**	-0.0569	-0.0501	-0.0604	-0.3359
NWS_t	0.0541	0.1404**	0.0933**	0.2145**	0.3658**	NWS_t	0.0468	-0.0064	-0.0088	-0.0282	0.0469
$NKOC_t$	-0.0116	0.0014	-0.0029	0.0075	-0.0591	$NKCO_t$	0.5474**	0.0804**	0.0691**	0.0751	0.6744**
$SPCO_t$	-0.1531**	0.0056	0.1300**	-0.0658	0.1361**	$SPOC_{t-1}$	0.3364**	0.1603**	0.1276**	0.0561	0.0637
MON_t	0.0162	0.1413**	0.1366**	0.2757**	0.2453**	MON_t	-0.2977**	-0.0414	-0.0535	-0.1397	-0.5333**
R^2	0.013	0.004	0.005	0.011	0.031	R^2	0.088	0.0679	0.0584	0.023	0.090
SSR	241.45	548.09	451.21	230.43	285.44	SSR	1275.5	150.88	115.72	76.26	1037.1
D.W.	2.041	1.996	2.081	1.996	2.006	D.W.	1.790	2.0531	2.0866	2.019	2.018
Obs.	834	834	834	388	388	Obs.	834	834	834	388	388

Table IV. Second-stage Instrumental Variables Regressions of Intraday and Overnight Returns of the Japanese ADR and U.S. Stock Portfolios.

The first stage regression estimates the conditional mean returns for intraday and overnight returns series for the Japanese ADR and U.S. matched-sample portfolios on information variables (Table III). In the second stage regression, intraday and overnight returns residuals series for the Japanese ADR portfolio are regressed on the returns residuals of the two U.S. matched-sample portfolios (industry- and size-match):

$$\varepsilon_{JA,t} = \alpha(Z_t) + \beta(Z_t)\,\varepsilon_{US,t} + \eta_t$$

where $\alpha(Z_{t-1})$, $\beta(Z_{t-1})$ are linear functions of an instrumental variable in levels, $z_{k,t-1}$, and in absolute terms $|z_{k,t-1}|$. Table II lists the instrumental variables and descriptions. Each regression also includes (not reported) day-of-week dummy variables and interactive day-of-the-week interactive variables with the U.S. portfolio returns to control for seasonality effects (Table II). Statistical significant is denoted by ** at the 5% level and * at the 1% level using robust standard errors with Newey and West (1987) serial-correlation (5 lags) and heteroscedasticity correction. The sample comprises 834 days from 1988-1992.

Variable	α_0	$\alpha_1\,(z_{t-1})$	$\alpha_2\,(\lvert z_{t-1}\rvert)$	β_0	$\beta_1\,(z_{t-1})$	$\beta_2\,(\lvert z_{t-1}\rvert)$	R^2
Daytime Returns Residuals with U.S. Industry-Matched Portfolio							
Const.	0.000			0.233**			0.114
NWS	-0.002	0.008		0.235**	-0.009		0.112
RFX	-0.012	0.210**	0.052	0.246**	0.027	-0.044	0.194
RTB	-0.030	-0.016	0.044	0.205**	-0.031*	0.019	0.119
RVW	-0.076*	0.119*	0.082	0.095	0.034	0.043*	0.142
$NKOC_t$	-0.073*	0.008	0.085**	0.174**	0.025	0.060**	0.135
$NKCO_{t+1}$	-0.055	0.266**	0.035	0.023	0.099**	0.167**	0.248
NKVOL	-0.051	-0.065*	0.109	0.242**	-0.068	-0.049	0.129
$SPCO_t$	-0.023	0.025	0.071	0.166**	0.047	0.173**	0.121
$SPOC_t$	-0.102*	0.235**	0.109	0.010	0.007	0.014	0.157
SPVOL	-0.040	-0.043	0.311**	0.179**	-0.091	0.247**	0.121
Daytime Returns Residuals with U.S. Size-Matched Portfolio							
Const	0.000			0.302**			0.139
NWS	-0.005	0.005		0.279**	0.054		0.138
RFX	-0.011	0.203**	0.044	0.345**	0.053*	-0.120*	0.213
RTB	-0.038	-0.008	0.048	0.297**	-0.045*	-0.011	0.145
RVW	-0.060	0.083*	0.017	0.131*	0.086**	0.065*	0.168
$NKOC_t$	-0.078*	0.014	0.083**	0.190**	-0.004	0.092**	0.167
$NKCO_{t+1}$	-0.059*	0.255**	0.019	0.011	0.124**	0.183**	0.271
NKVOL	-0.050	-0.059	0.108	0.311**	-0.062	-0.053	0.151
$SPCO_t$	-0.015	0.033	0.058	0.158**	0.099*	0.320**	0.159
$SPOC_t$	-0.080*	0.180**	0.047	0.066	0.043	0.023	0.169
SPVOL	-0.030	-0.091	0.206*	0.246**	-0.097	0.227*	0.144

Variable	α_0	$\alpha_1\,(z_{t-1})$	$\alpha_2\,(\lvert z_{t-1}\rvert)$	β_0	$\beta_1\,(z_{t-1})$	$\beta_2\,(\lvert z_{t-1}\rvert)$	R^2
Overnight Returns Residuals with U.S. Industry-Matched Portfolio							
Const.	0.000			1.592**			0.177
NWS	-0.011	-0.003		1.454**	0.412*		0.179
RFX	-0.028	0.435**	0.109	1.467**	0.057	0.024	0.242
RTB	-0.010	0.084**	0.000	1.481**	0.055	0.113	0.181
RVW	0.015	0.094*	-0.033	1.121**	0.030	0.236**	0.186
$NKOC_t$	0.188*	0.439**	-0.065*	0.541**	-0.004	0.225**	0.385
$NKCO_{t+1}$	-0.069	-0.018	0.177*	1.087**	-0.229*	0.531**	0.191
NKVOL	0.007	-0.392*	-0.012	1.270**	-0.173	0.740*	0.212
$SPCO_t$	0.025	0.366*	-0.107	1.044**	0.156	0.256**	0.188
$SPOC_{t-1}$	-0.045	-0.015	0.086	1.387**	-0.129	0.257**	0.181
SPVOL	-0.088	0.232	0.772**	1.558**	-0.104	0.185	0.184
Overnight Returns Residuals with U.S. Size-Matched Portfolio							
Const	0.000			1.883**			0.156
NWS	-0.005	0.002		1.785**	0.297		0.155
RFX	-0.025	0.461**	0.104	1.654**	0.016	0.169	0.230
RTB	-0.029	0.082**	0.025	1.817**	0.117*	0.109	0.160
RVW	-0.006	0.098*	-0.008	1.162**	0.080	0.370**	0.169
$NKOC_t$	0.183*	0.452**	-0.070*	0.540**	0.061*	0.300**	0.375
$NKCO_{t+1}$	-0.077	-0.015	0.189*	1.368**	-0.229*	0.595**	0.168
NKVOL	0.015	-0.418*	-0.024	1.554**	-0.143	0.769*	0.187
$SPCO_t$	0.011	0.557**	-0.011	0.989*	0.096	0.349**	0.176
$SPOC_{t-1}$	-0.046	-0.017	0.086	1.706**	-0.095	0.230*	0.156
SPVOL	-0.090	0.232	0.786**	1.782**	0.194	0.917	0.162

Table V. Second-stage Instrumental Variables Regressions of Intraday and Overnight Returns of the CME Nikkei Futures and S&P 500 Index.

The first stage regression estimates the conditional mean returns for intraday and overnight returns series for the Nikkei futures contract and the S&P 500 index on information variables (Table III). In the second stage regression, intraday and overnight returns residuals series for the Nikkei futures contract are regressed on the returns residuals of the S&P index returns residuals:

$$\varepsilon_{JA,t} = \alpha(Z_t) + \beta(Z_t)\, \varepsilon_{US,t} + \eta_t$$

where $\alpha(Z_{t-1})$, $\beta(Z_{t-1})$ are linear functions of an instrumental variable in levels, $z_{k,t-1}$, and in absolute terms $|z_{k,t-1}|$. Table II lists the instrumental variables and descriptions. Each regression includes (not reported) day-of-week dummy variables and interactive day-of-the-week interactive variables with the U.S. portfolio returns to control for seasonality effects (Table II). Statistical significant is denoted by ** at the 5% level and * at the 1% level using robust standard errors with Newey and West (1987) serial-correlation (5 lags) and heteroscedasticity correction. The sample includes 388 daily observations from 1990-1992.

Variable	α_0	$\alpha_1(z_{t-1})$	$\alpha_2(\lvert z_{t-1}\rvert)$	β_0	$\beta_1(z_{t-1})$	$\beta_2(\lvert z_{t-1}\rvert)$	R^2
			Daytime Returns				
Const.	0.000			0.552**			0.440
NWS	0.004	-0.012		0.559**	-0.015	0.000	0.437
RFX	0.054	0.129**	-0.071	0.510**	-0.071	0.041	0.448
RTB	0.028	-0.075*	-0.034	0.495**	-0.070*	0.023	0.450
RVW	0.065	-0.006	-0.093	0.586**	-0.020	-0.001	0.440
$NKOC_t$	-0.082	-0.018	0.072*	0.470**	-0.056*	-0.003	0.454
$NKCO_{t+1}$	-0.021	0.115*	0.033	0.334**	-0.089	0.242*	0.462
NKVOL	-0.024	-0.005	0.062	0.577**	0.233**	0.018	0.435
$SPCO_t$	0.061	0.022	-0.170	0.500**	-0.062	0.084	0.439
$SPOC_t$	-0.047	-0.010	0.222*	0.549*	-0.134*	0.015	0.441
SPVOL	-0.016	-0.262*	0.182	0.581**	0.011	-0.257	0.440

Variable	α_0	$\alpha_1(z_{t-1})$	$\alpha_2(\lvert z_{t-1}\rvert)$	β_0	$\beta_1(z_{t-1})$	$\beta_2(\lvert z_{t-1}\rvert)$	R^2
			Overnight Returns				
Const.	0.000			2.030**			0.191
NWS	0.005	-0.026		1.990**	0.157		0.187
RFX	-0.092	0.280**	0.174	2.183**	0.144	-0.237	0.203
RTB	0.026	0.144**	-0.086	2.117**	0.087	-0.243*	0.208
RVW	0.082	0.080	-0.195	1.825**	0.124	0.120	0.188
$NKOC_t$	0.478**	0.891**	-0.124	1.592**	-0.015	-0.285*	0.652
$NKCO_{t+1}$	-0.031	-0.020	0.073	2.051**	-0.143	0.002	0.184
NKVOL	-0.149	-0.685*	0.320	2.115**	-0.030	-0.314	0.234
$SPCO_t$	0.045	-0.227	-0.402	2.237*	0.412	0.026	0.186
$SPOC_{t-1}$	0.000	0.033	0.018	2.084**	-0.174	-0.058	0.185
SPVOL	0.020	0.234	-0.243	1.913**	-0.081	1.180	0.185

Table VI. Multivariate GARCH Model Estimates for Intraday Returns of the Japanese ADR and U.S. Stock Portfolios.

A bivariate GARCH system for the joint intraday returns generating process of the Japanese ADR portfolio and U.S. Industry-Matched portfolio is:

$$R_{it} = E[R_{it} \mid Z_{t-1}] + \varepsilon_{it} \qquad E[R_{it} \mid Z_{t-1}] = \delta_{i0} + \Sigma_k \delta_{ik} z_{t-1} \qquad \varepsilon_t \mid Z_{t-1} \sim N(0, H_t)$$

$$h_{ii,t} = c_i + a_i h_{ii,t-1} + b_i \varepsilon_{i,t-1}^2 + \Sigma_k d_{ik} z_{k,t-1} \qquad h_{ij,t} = [\rho_{ij,0} + \Sigma_k \rho_{ij,k} z_{k,t-1}] (h_{ii,t} h_{jj,t})^{1/2}$$

where R_{it} are the returns for the Japanese and U.S. portfolios, Z_{t-1} is the vector of information variables for the conditional mean returns, conditional variance ($h_{ii,t}$) processes, and conditional correlation processes. Information variables include a Monday dummy (MON_t), news announcement dummy (NWS_t), daily closing returns on the CME Yen/Dollar currency futures (RFX_t), on the CME Treasury bill futures (RTB_t) and on the CRSP value-weighted portfolio (RVW_t), preceding daytime returns on the Nikkei ($NKOC_t$) and overnight returns on the S&P 500 index ($SPCO_t$) and demeaned trading volume on Nikkei stocks ($NKVOL_t$) and S&P 500 stocks ($SPVOL_t$). Standard errors are computed with Quasi-MLE from Bollerslev-Wooldridge (1993). Significance at the 10% level is denoted by * and at the 5% level by **. Columns correspond to different specifications for the conditional correlation process. Likelihood ratio statistics test the null hypothesis that the conditional correlation process is constant (χ^2 with k degrees of freedom).

Panel A. Conditional Mean Returns Equations

Coefficient	*No Shock*	*News Shock*	*FX Shock*	*T-bill Shock*	*VW Shock*	*Nikkei Shock*	*Nikkei Volume*	*S&P Shock*	*S&P Volume*
				Japanese ADR Portfolio					
δ_{10} (Constant)	-0.011	-0.008	-0.010	-0.012	-0.008	-0.007	-0.008	-0.006	-0.009
δ_{11} (RFX_{t-1})	0.034	0.036	0.042*	0.041*	0.033	0.042*	0.041*	0.039*	0.038
δ_{12} (RTB_{t-1})	0.012	0.010	0.007	0.007	0.011	0.012	0.009	0.011	0.009
δ_{13} (RVW_{t-1})	-0.043**	-0.047**	-0.045**	-0.041**	-0.021	-0.037**	-0.042**	-0.040**	-0.043**
δ_{14} (NWS_t)	0.024	0.026	0.033	0.035	0.022	0.033	0.031	0.025	0.027
δ_{15} ($NKOC_t$)	0.010	0.008	0.009	0.004	0.003	0.020	0.008	0.009	0.009
δ_{16} ($SPCO_t$)	0.176**	0.171**	0.170**	0.179**	0.194**	0.175**	0.174**	0.187**	0.173**
δ_{17} (MON_t)	0.005	0.003	-0.005	0.004	-0.015	-0.007	-0.001	-0.005	0.001
				U.S. Industry-Matched Portfolio					
δ_{20} (Constant)	-0.056	-0.058	-0.050	-0.054	-0.050	-0.034	-0.053	-0.052	-0.054
δ_{21} (RFX_{t-1})	-0.016	-0.018	-0.013	-0.013	-0.020	-0.002	-0.013	-0.020	-0.017
δ_{22} (RTB_{t-1})	0.029	0.027	0.026	0.029	0.028	0.029	0.026	0.027	0.028
δ_{23} (RVW_{t-1})	0.066*	0.059	0.068*	0.066**	0.100**	0.052	0.066*	0.067*	0.065*
δ_{24} (NWS_t)	0.111*	0.113*	0.113*	0.108*	0.102*	0.087	0.110*	0.106*	0.111*
δ_{25} ($NKOC_t$)	0.010	0.008	0.011	0.009	0.005	0.033	0.009	0.009	0.008
δ_{26} ($SPCO_t$)	0.094	0.107	0.095	0.101	0.096	0.071	0.093	0.111	0.102
δ_{27} (MON_t)	0.144**	0.144**	0.134*	0.131**	0.117*	0.106	0.143**	0.129*	0.144**

Table VI - Continued.

Panel B. Conditional Variance and Correlation Equations

Coefficient	*No Shock*	*News Shock*	*FX Shock*	*T-bill Shock*	*VW Shock*	*Nikkei Shock*	*Nikkei Volume*	*S&P Shock*	*S&P Volume*
				Japanese ADR Portfolio					
c_1 (Constant)	0.039**	0.039**	0.042**	0.041**	0.046**	0.035**	0.040**	0.039**	0.040**
a_1 ($h_{11,t-1}$)	0.779**	0.773**	0.760**	0.764**	0.759**	0.800**	0.763**	0.762**	0.771**
b_1 (ε_{t-1}^2)	0.005	0.007	0.013*	0.013*	0.011	0.017**	0.014*	0.012	0.008
d_{11} ($\lvert NKOC_t \rvert$)	0.088**	0.085**	0.081**	0.081**	0.083**	0.062**	0.080**	0.085**	0.085**
d_{12} ($\lvert SPCO_t \rvert$)	-0.045**	-0.050**	-0.047**	-0.054**	-0.051**	-0.037**	-0.052**	-0.050**	-0.049**
d_{13} (MON_t)	-0.109**	-0.101**	-0.109**	-0.098**	-0.119**	-0.101**	-0.098**	-0.098**	-0.103**
				U.S. Industry-Matched Portfolio					
c_2 (Constant)	0.215**	0.223*	0.227**	0.227**	0.187**	0.246**	0.228*	0.219**	0.231*
a_2 ($h_{11,t-1}$)	0.582**	0.549**	0.504**	0.521**	0.615**	0.426*	0.510**	0.525**	0.527**
b_2 (ε_{t-1}^2)	-0.024**	-0.024**	-0.024**	-0.023	-0.022**	-0.023**	-0.023**	-0.023**	-0.024
d_{21} ($\lvert NKOC_t \rvert$)	0.028	0.035	0.049	0.039	0.044	0.101*	0.047	0.040	0.038
d_{22} ($\lvert SPCO_t \rvert$)	0.254**	0.256**	0.267**	0.269**	0.218**	0.247**	0.265**	0.303**	0.265**
d_{23} (MON_t)	-0.112*	-0.090	-0.056	-0.079	-0.148**	-0.037	-0.065	-0.103*	-0.086
				Conditional Correlation					
ρ_0 (Constant)	0.276**	0.335**	0.339**	0.341**	0.212**	0.211**	0.286**	0.202**	0.279**
ρ_1 (MON_t)	0.165**	0.134*	0.190**	0.164**	0.110	0.162**	0.161**	0.127*	0.170**
ρ_2 (NWS_t)		-0.075							
ρ_3 (RFX_t)			-0.108*						
ρ_4 (RTB_t)				-0.067					
ρ_5 (RVW_t)					0.107**				
ρ_6 ($\lvert NKOC_t \rvert$)						0.101**			
ρ_7 ($NKVOL_t$)							-0.066		
ρ_8 ($\lvert SPCO_t \rvert$)								0.233**	
ρ_9 ($SPVOL_{t-1}$)									0.051

Panel C. Likelihood Ratio Tests

Coefficient	*No Shock*	*News Shock*	*FX Shock*	*T-bill Shock*	*VW Shock*	*Nikkei Shock*	*Nikkei Volume*	*S&P Shock*	*S&P Volume*
LogLikelihood	-2.896	-2.830	-1.356	-2.198	0.572	2.761	-1.174	4.219	-2.073
LR Test		0.131	3.079	1.394	6.935	11.312	3.443	14.229	1.645
p-value		0.718	0.079	0.238	0.008	0.001	0.064	0.000	0.200

Table VII. Multivariate GARCH Model Estimates for Overnight Returns of the Japanese ADR and U.S. Stock Portfolios.

A bivariate GARCH system for the joint overnight returns generating process of the Japanese ADR portfolio and U.S. Industry-Matched portfolio is:

$$R_{it} = E[R_{it} \mid Z_{t-1}] + \varepsilon_{it} \qquad E[R_{it} \mid Z_{t-1}] = \delta_{i0} + \Sigma_k \delta_{ik} z_{t-1} \qquad \varepsilon_t \mid Z_{t-1} \sim N(0, H_t)$$

$$h_{ii,t} = c_i + a_i h_{ii,t-1} + b_i \varepsilon_{i,t-1}^2 + \Sigma_k d_{ik} z_{k,t-1} \qquad h_{ij,t} = [\rho_{ij,0} + \Sigma_k \rho_{ij,k} z_{k,t-1}] (h_{ii,t} h_{jj,t})^{1/2}$$

where R_{it} are the returns for the Japanese and U.S. portfolios, Z_{t-1} is the vector of information variables for the conditional mean returns, conditional variance ($h_{ii,t}$) processes, and conditional correlation processes. Information variables include a Monday dummy (MON_t), news announcement dummy (NWS_t), daily closing returns on the CME Yen/Dollar currency futures (RFX_t), on the CME Treasury bill futures (RTB_t) and on the CRSP value-weighted portfolio (RVW_t), preceding overnight returns on the Nikkei ($NKCO_t$) and daytime returns on the S&P 500 index ($SPOC_{t-1}$) and demeaned trading volume on Nikkei stocks ($NKVOL_t$) and S&P 500 stocks ($SPVOL_t$). Standard errors are computed with Quasi-MLE from Bollerslev-Wooldridge (1993). Significance at the 10% level is denoted by * and at the 5% level by **. Columns correspond to different specifications for the conditional correlation process. Likelihood ratio statistics test the null hypothesis that the conditional correlation process is constant (χ^2 with k degrees of freedom).

Panel A. Conditional Mean Returns Equations

Coefficient	*No Shock*	*News Shock*	*FX Shock*	*T-bill Shock*	*VW Shock*	*Nikkei Shock*	*Nikkei Volume*	*S&P Shock*	*S&P Volume*
				Japanese ADR Portfolio					
δ_{10} (Constant)	-0.077	-0.076	-0.078	-0.083	-0.075	-0.080	-0.078	-0.081	-0.079
δ_{11} (RFX_{t-1})	0.059	0.058	0.061	0.059	0.064	0.064	0.060	0.060	0.059
δ_{12} (RTB_{t-1})	-0.035	-0.035	-0.036	-0.033	-0.032	-0.035	-0.035	-0.036	-0.035
δ_{13} (RVW_{t-1})	-0.307**	-0.314**	-0.306**	-0.301**	-0.296**	-0.305**	-0.308**	-0.287	-0.307**
δ_{14} (NWS_t)	0.070	0.069	0.072	0.077	0.064	0.085	0.070	0.076	0.071
δ_{15} ($NKCO_t$)	0.468**	0.468**	0.467**	0.468**	0.473**	0.463**	0.468**	0.474**	0.469**
δ_{16} ($SPOC_{t-1}$)	0.308**	0.314**	0.308**	0.301**	0.294**	0.312**	0.309**	0.276**	0.310**
δ_{17} (MON_t)	-0.260**	-0.262**	-0.259**	-0.252**	-0.273**	-0.249**	-0.259**	-0.265**	-0.259**
				U.S. Industry-Matched Portfolio					
δ_{20} (Constant)	0.008	0.008	0.007	0.009	0.007	0.008	0.007	0.008	0.007
δ_{21} (RFX_{t-1})	0.005	0.005	0.004	0.006	0.005	0.004	0.005	0.006	0.005
δ_{22} (RTB_{t-1})	-0.014	-0.014	-0.014	-0.016	-0.015	-0.012	-0.014	-0.014	-0.014
δ_{23} (RVW_{t-1})	0.003	0.004	0.003	0.001	0.007	0.010	0.004	0.004	0.005
δ_{24} (NWS_t)	0.019	0.018	0.019	0.017	0.018	0.018	0.019	0.017	0.019
δ_{25} ($NKCO_t$)	0.054**	0.053	0.054**	0.054**	0.051**	0.054**	0.054**	0.055**	0.054**
δ_{26} ($SPOC_{t-1}$)	0.124**	0.125**	0.124**	0.127**	0.123**	0.121**	0.124**	0.124**	0.123**
δ_{27} (MON_t)	-0.048	-0.048	-0.047	-0.048	-0.043	-0.045	-0.047	-0.046	-0.047

Table VII - Continued.

Panel B. Conditional Variance and Correlation Equations

Coefficient	*No Shock*	*News Shock*	*FX Shock*	*T-bill Shock*	*VW Shock*	*Nikkei Shock*	*Nikkei Volume*	*S&P Shock*	*S&P Volume*
				Japanese ADR Portfolio					
c_1 (Constant)	0.112	0.110	0.105	0.105	0.103	0.039	0.112	0.094	0.109
a_1 ($h_{11,t-1}$)	0.294**	0.295**	0.292**	0.298**	0.286**	0.372**	0.293**	0.309**	0.289**
b_1 (ε_{t-1}^2)	0.099**	0.097**	0.102**	0.103**	0.092**	0.092**	0.100**	0.100**	0.098**
d_{11} ($\lvert NKCO_t \rvert$)	0.622**	0.625**	0.628**	0.626**	0.623**	0.634**	0.623**	0.597**	0.627**
d_{12} ($\lvert SPOC_{t-1} \rvert$)	0.582**	0.582**	0.587**	0.582**	0.618**	0.506**	0.584**	0.588**	0.596**
d_{13} (MON_t)	0.420**	0.423**	0.427**	0.397**	0.419**	0.420**	0.422**	0.406**	0.426**
				U.S. Industry-Matched Portfolio					
c_2 (Constant)	0.003	0.003	0.003	0.002	0.002	0.000	0.003	0.002	0.003
a_2 ($h_{11,t-1}$)	0.649**	0.643**	0.645**	0.654**	0.633**	0.646**	0.648**	0.637**	0.643**
b_2 (ε_{t-1}^2)	0.006**	0.006**	0.006**	0.006**	0.006**	0.007**	0.006**	0.006**	0.006**
d_{21} ($\lvert NKCO_t \rvert$)	0.053**	0.054**	0.053**	0.053**	0.053**	0.060**	0.053**	0.053**	0.054**
d_{22} ($\lvert SPOC_{t-1} \rvert$)	0.037**	0.037**	0.038**	0.038**	0.041**	0.035**	0.037**	0.041**	0.038**
d_{23} (MON_t)	-0.029**	-0.028**	-0.028**	-0.030**	-0.027**	-0.028**	-0.029**	-0.029**	-0.029**
				Conditional Correlation					
ρ_0 (Constant)	0.276**	0.235**	0.244**	0.327**	0.197**	0.086	0.277**	0.214**	0.278**
ρ_1 (MON_t)	0.123**	0.152**	0.124**	0.155**	0.101*	0.111**	0.123**	0.101*	0.110*
ρ_2 (NWS_t)		0.055							
ρ_3 (RFX_t)			0.063						
ρ_4 (RTB_t)				-0.070*					
ρ_5 (RVW_t)					0.123**				
ρ_6 ($\lvert NKCO_t \rvert$)						0.293**			
ρ_7 ($NKVOL_t$)							0.007		
ρ_8 ($\lvert SPOC_{t-1} \rvert$)								0.107**	
ρ_9 ($SPVOL_{t-1}$)									-0.082

Panel C. Likelihood Ratio Tests

Coefficient	*No Shock*	*News Shock*	*FX Shock*	*T-bill Shock*	*VW Shock*	*Nikkei Shock*	*Nikkei Volume*	*S&P Shock*	*S&P Volume*
LogLikelihood	-76.908	-76.538	-76.442	-75.383	-74.584	-65.243	-76.905	-70.846	-76.689
LR Test		0.740	0.933	3.050	4.648	23.329	0.006	12.124	0.439
p-value		0.390	0.334	0.081	0.031	0.000	0.936	0.000	0.508

Table VIII. Comparison of Multivariate GARCH Model Estimates for Japanese and U.S. Markets using ADR Portfolio and Nikkei Futures Contract.

A bivariate GARCH system is specified for the joint returns generating process for two sets of assets: (1) the ADR Japanese portfolio and its U.S. Industry-Matched portfolio, and (2) the CME Nikkei futures contract with the S&P 500 stock index. See Tables VI and VII for specifications. Information variables include a Monday dummy (MON_t), news announcement dummy (NWS_t), daily closing returns on the CME Yen/Dollar currency futures (RFX_t), on the CME Treasury bill futures (RTB_t) and on the CRSP value-weighted portfolio (RVW_t), preceding overnight returns on the Nikkei ($NKCO_t$) and daytime returns on the S&P 500 index ($SPOC_{t-1}$) and demeaned trading volume on Nikkei stocks ($NKVOL_t$) and S&P 500 stocks ($SPVOL_t$). Standard errors are computed with Quasi-MLE from Bollerslev-Wooldridge (1993). Significance at the 10% level is denoted by * and at the 5% level by **. Columns correspond to different specifications for the conditional correlation process. Likelihood ratio statistics test the null hypothesis that the conditional correlation process is constant (χ^2 with k degrees of freedom).

Panel A. Conditional Mean Returns Equations

	Daytime Returns					*Overnight Returns*			
	Japanese ADR & U.S. Portfolios		*Nikkei Futures & S&P 500 Index*			*Japanese ADR & U.S. Portfolios*		*Nikkei Futures & S&P 500 Index*	
Coefficient	*Constant*	*Time-Varying*	*Constant*	*Time-Varying*	*Coefficient*	*Constant*	*Time-Varying*	*Constant*	*Time-Varying*
				Japanese Portfolio					
δ_{10} (Constant)	-0.011	-0.004	-0.074*	-0.087**	δ_{10} (Constant)	-0.077	-0.083	-0.160	-0.171
δ_{11} (RFX_{t-1})	0.034	0.043**	0.020	0.024	δ_{11} (RFX_{t-1})	0.059	0.065	0.067	0.046
δ_{12} (RTB_{t-1})	0.012	0.008	-0.018	-0.025	δ_{12} (RTB_{t-1})	-0.035	-0.034	-0.059	-0.064
δ_{13} (RVW_{t-1})	-0.043**	-0.031*	-0.014	-0.007	δ_{13} (RVW_{t-1})	-0.307**	-0.306**	-0.149	-0.139
δ_{14} (NWS_t)	0.024	0.026	0.111**	0.117**	δ_{14} (NWS_t)	0.070	0.093	0.183	0.136
δ_{15} ($NKOC_t$)	0.010	0.008	-0.023	-0.015	δ_{15} ($NKCO_t$)	0.468**	0.458**	0.516**	0.599**
δ_{16} ($SPCO_t$)	0.176**	0.179**	0.140**	0.156**	δ_{16} ($SPOC_{t-1}$)	0.308**	0.300**	-0.012	-0.101
δ_{17} (MON_t)	0.005	-0.002	0.132**	0.133**	δ_{17} (MON_t)	-0.260**	-0.241**	-0.426**	-0.468**
				U.S. Portfolio					
δ_{20} (Constant)	-0.056	-0.056	-0.029	-0.041	δ_{20} (Constant)	0.008	0.009	0.072*	0.081*
δ_{21} (RFX_{t-1})	-0.016	-0.019	0.035	0.041	δ_{21} (RFX_{t-1})	0.005	0.007	-0.006	0.009
δ_{22} (RTB_{t-1})	0.029	0.031	-0.026	-0.034	δ_{22} (RTB_{t-1})	-0.014	-0.013	-0.024	-0.024
δ_{23} (RVW_{t-1})	0.066*	0.074**	0.025	0.052	δ_{23} (RVW_{t-1})	0.003	0.006	-0.035	-0.043
δ_{24} (NWS_t)	0.111*	0.107*	0.040	0.052	δ_{24} (NWS_t)	0.019	0.014	-0.047	-0.053
δ_{25} ($NKOC_t$)	0.010	-0.002	0.032	0.021	δ_{25} ($NKCO_t$)	0.054**	0.055**	0.075**	0.084**
δ_{26} ($SPCO_t$)	0.094	0.145*	-0.088	-0.126	δ_{26} ($SPOC_{t-1}$)	0.124**	0.123**	0.038	0.026
δ_{27} (MON_t)	0.144**	0.139**	0.238**	0.218**	δ_{27} (MON_t)	-0.048	-0.046	-0.126**	-0.136**

Table VIII - Continued.

Panel B. Conditional Variance and Correlation Equations

	Daytime Returns					*Overnight Returns*			
	Japanese ADR & U.S. Portfolios		*Nikkei Futures & S&P 500 Index*			*Japanese ADR & U.S. Portfolios*		*Nikkei Futures & S&P 500 Index*	
Coefficient	*Constant*	*Time-Varying*	*Constant*	*Time-Varying*	*Coefficient*	*Constant*	*Time-Varying*	*Constant*	*Time-Varying*
				Japanese Portfolio					
c_1 (Constant)	0.039**	0.038**	0.000	0.015	c_1 (Constant)	0.112	0.063	-0.240**	-0.236**
a_1 ($h_{11,t-1}$)	0.779**	0.767**	0.673**	0.579**	a_1 ($h_{11,t-1}$)	0.294**	0.330**	0.917**	0.934**
b_1 (ε_{t-1}^2)	0.005	0.019**	0.150**	0.179**	b_1 (ε_{t-1}^2)	0.099**	0.101**	-0.004	-0.019**
d_{11} ($\|NKOC_t\|$)	0.088**	0.073**	0.089**	0.100**	d_{11} ($\|NKCO_t\|$)	0.622**	0.640**	0.597**	0.622**
d_{12} ($\|SPCO_t\|$)	-0.045**	-0.048**	0.103**	0.111**	d_{12} ($\|SPOC_{t-1}\|$)	0.582**	0.541**	-0.074*	-0.079*
d_{13} (MON_t)	-0.109**	-0.091**	-0.173**	-0.189**	d_{13} (MON_t)	0.420**	0.355**	0.428*	0.331*
				U.S. Portfolio					
c_2 (Constant)	0.215**	0.227**	0.263**	0.357**	c_2 (Constant)	0.003	0.000	-0.030**	-0.025**
a_2 ($h_{11,t-1}$)	0.582**	0.469**	0.180**	0.031	a_2 ($h_{11,t-1}$)	0.649**	0.651**	0.730**	0.739**
b_2 (ε_{t-1}^2)	-0.024**	-0.023**	0.034**	0.022**	b_2 (ε_{t-1}^2)	0.006**	0.007**	-0.002**	-0.002**
d_{21} ($\|NKOC_t\|$)	0.028	0.046	0.095*	0.142**	d_{21} ($\|NKCO_t\|$)	0.053**	0.060**	0.062**	0.054**
d_{22} ($\|SPCO_t\|$)	0.254**	0.314**	0.306**	0.314**	d_{22} ($\|SPOC_{t-1}\|$)	0.037**	0.034**	0.064**	0.053**
d_{23} (MON_t)	-0.112*	-0.042	0.038	-0.083*	d_{23} (MON_t)	-0.029**	-0.028**	0.019	0.027
				Conditional Correlation					
ρ_0 (Constant)	0.276**	0.213**	0.732**	0.886**	ρ_0 (Constant)	0.276**	0.022	0.433**	0.450**
ρ_1 (MON_t)	0.165**	0.215**	0.018	-0.089	ρ_1 (MON_t)	0.123**	0.155**	0.152*	0.175*
ρ_2 (NWS_t)		-0.017		0.088*	ρ_2 (NWS_t)		0.058		-0.023
ρ_3 (RTB_t)		-0.050		0.024	ρ_3 (RTB_t)		-0.040		0.008
ρ_4 (RFX_t)		0.101		-0.055	ρ_4 (RFX_t)		-0.008		-0.183**
ρ_6 ($\|NKOC_t\|$)		-0.056		0.211**	ρ_6 ($\|NKCO_t\|$)		0.281**		-0.031*
ρ_8 ($\|SPCO_t\|$)		0.283**		-0.072	ρ_8 ($\|SPOC_{t-1}\|$)		0.092**		0.609**

Panel C. Likelihood Ratio Tests

	Daytime Returns					*Overnight Returns*			
	Japanese ADR & U.S. Portfolios		*Nikkei Futures & S&P 500 Index*			*Japanese ADR & U.S. Portfolios*		*Nikkei Futures & S&P 500 Index*	
Coefficient	*Constant*	*Time-Varying*	*Constant*	*Time-Varying*	*Coefficient*	*Constant*	*Time-Varying*	*Constant*	*Time-Varying*
LogLikelihood	-2.890	13.336	-33.415	-16.619	LogLikelihood	-76.908	-60.930	-145.110	-126.330
LR Test		32.452		33.592	LR Test		31.956		37.560
p-value		0.000		0.000	p-value		0.000		0.000

Figure 1. Timing Conventions for Intraday and Overnight Returns for Japanese and U.S. portfolios. Returns are measured as log changes in the bid-ask midpoint quotes from May 31, 1988 to May 29, 1992. Overnight returns are computed from the previous day's last quote or transaction to today's first available quote or transaction up to 10:30am (New York time); otherwise the observation is missing. The overnight and daytime returns on these portfolios align with New York trading hours. Daily open and close stock index quotes for the Nikkei Stock Average are from the Nihon Keizai Shimbun and for the Nikkei futures contract and S&P 500 stock index directly from the Chicago Mercantile Exchange. Overnight timing conventions for a 24-hour period (Day "t") set the trading day in Tokyo to precede that of New York: Tokyo's open-close return ($NKOC_t$), which is contemporaneous with New York's overnight return ($SPCO_t$), and both precede Tokyo's overnight return ($NKCO_{t+1}$), contemporaneous with New York's open-close return ($SPOC_t$).