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A Comparison of Event Study Methods for Foreign Firms Listed on the U.S. Stock Exchanges

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ABSTRACT: The rapid integration of international capital markets is apparent from the increasing number of foreign firms listed on the U.S. stock exchanges. A number of event studies have used stock returns of foreign firms listed on U.S. exchanges to examine the stock price reactions to various announcements. However, some researchers have raised concerns over the choice of event study models in the study of foreign firms. By employing actual stock return data in various simulation scenarios, this study compares the powers of alternative event study methods for foreign firms. The results show that all models and equity indexes perform equally well when there is no clustering of event dates, though there are high Type I and Type II errors when event dates cluster together.

Keywords: American depositary receipts; foreign firms; event study.

I. INTRODUCTION

The rapid globalization of international capital markets in recent years is reflected in the sharp increase of foreign firms that list their common stocks directly or through American Depositary Receipts (ADRs) on the U.S. stock exchanges (referred to as "foreign firms" hereafter). The trading volume of foreign stocks reached $687 billion in 1998 on the New York Stock Exchange.[1] At the National Association of Security Dealers and Quotation System (NASDAQ), the trading volume of American Depositary Receipts totaled $273 billion in 2000.[2] The globalization of international financial markets in recent years has led many researchers to examine the international differences in corporate policy and value-relevance of accounting earnings. For example, Porta et al.

[1] New York Stock Exchange 1999 Fact Book.
[2] See http://www.nasdaq.com.

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(2000) and Rajan and Zingales (1995) examine the differences in dividend policy and capital structure among firms in different countries. Other studies, such as Alford et al. (1994), Ali and Hwang (2000), and Ball et al. (2000) examine the international differences in the value-relevance of accounting earnings.

Another major area of research is the difference between the value-relevance of U.S.-GAAP and foreign-GAAP information released by foreign firms to U.S. investors (see Frost and Lang [1996] and Saudagaran and Meek [1997] for summaries of related literature). Currently, the Securities and Exchange Commission requires foreign firms to report certain accounting information prepared using U.S.-GAAP in their 10-K or 20-F reports. While some prior studies use association tests of returns and earnings over long event-windows to examine the value-relevance of U.S.-GAAP and foreign-GAAP information, other studies use short event-windows to examine the effects of announcements of U.S.-GAAP and foreign-GAAP information on daily returns of foreign firms. However, Frost and Lang (1996) suggest that association tests using long event-windows do not provide direct evidence that reported U.S.-GAAP and/or foreign-GAAP information is used by investors. It is possible that the information is not timely and the observed association between returns and earnings is caused by other confounding factors. On the other hand, findings from short event-windows might provide more convincing evidence that U.S.-GAAP and/or foreign-GAAP information announcements caused stock price changes. In addition, Fama (1998) suggests that a major advantage of short window studies over long window studies is that measures of short-term expected returns have less bias than measures of long-term expected returns. Thus, findings from short event-windows studies are more reliable than findings from long event-windows studies because measures of long-term expected returns are sensitive to methods used. In addition to accounting studies, event studies using stock returns of foreign firms also appear in the finance literature (Muscarella and Vetsuypens 1996; Sun and Tong 2000).

Authors of some of the prior event studies (e.g., Meek 1983; Amir et al. 1993) have expressed concerns over the appropriate choice of equity index and model specification in studies involving foreign firms. As a result, different event studies have used different model specifications and stock indexes, including less readily available foreign equity indexes. For example, some prior studies employ the commonly used one-index market model, while others use a two-index market model that includes a global or foreign equity index besides an U.S. equity index. Yet other studies (e.g., Meek 1985; Amir et al. 1993) suggest that a mean-adjusted model or a market-adjusted model rather than market model should be used. In addition, sensitivity tests using alternative combinations of model specifications and indexes are conducted in various studies (e.g., Meek 1983; Frost and Pownall 1994). In view of the controversy over the appropriateness of event study methods for foreign firms, we employ a simulation process to evaluate the power of these alternative model specifications and stock indexes.

Given the increasing presence of foreign firms on the U.S. exchanges, more event studies of foreign firms are expected. For example, scholars have started using event studies to examine the value-relevance of U.S.-GAAP and foreign-GAAP information to U.S. investors (e.g., Frost and Pownall 1996). The objective of this study is to present other researchers with important information regarding event study methods for these firms. Since prior studies have used different indexes and models, assessing the power of these indexes and models could provide additional insight into the validity of their conclusions. Such assessment also enables researchers to select more powerful methods in future studies and reduces the need to conduct sensitivity tests using alternative model specifications and equity indexes. Moreover, if the more readily available (and less costly) CRSP indexes perform as satisfactorily as the global or foreign stock indexes, then it may not be necessary for future studies to use the latter.

Our study addresses these issues by comparing the power of alternative event study methods for foreign firms. Power refers to a statistical method's ability to lead to the correct conclusion. For a

given level of Type I error and a given magnitude of abnormal returns, the power of a test is the probability that the null hypothesis of no abnormal returns will be rejected. A method with high power is preferred to one with low power. In particular, we use simulation techniques to evaluate the power of the market, two-index market, market-adjusted, and mean-adjusted models for foreign firms. The CRSP Equal- and Value-Weighted Indexes as well as the Morgan Stanley Capital International (MSCI) indexes are examined to determine the better equity index to use for the market and market-adjusted models. Since event study models are statistical models not based on valuation theory (Copeland and Weston 1983; Fama 1976), it is an empirical issue as to which combination of equity index and model specification has more power.

The rest of this paper is organized as follows. Section II summarizes related prior studies. Section III presents the simulation methods. Sections IV and V discuss the empirical findings. Section VI provides some concluding remarks.

II. PRIOR STUDIES

Brown and Warner (1980, 1985) examine the power of the market, market-adjusted, and mean-adjusted models, which are commonly used in event studies. They simulate the use of these models by applying them to a large number of constructed samples. Each sample consists of randomly selected securities, each of which is assigned a randomly generated hypothetical event day. Since these samples should, on average, exhibit no abnormal returns, applying each model to the samples enables them to assess the model's Type I error, that is, the likelihood of the model to reject the null hypothesis of no abnormal return when it is true. Then, they introduce abnormal stock performance into the samples by adding a constant to the actual returns on the event day of each security. Each event study model is again applied to the samples to estimate its Type II error, which is the model's frequency of failing to reject the null hypothesis of no abnormal returns when it is false. The simulation results show that all three models perform equally well in event studies, except that the market and market-adjusted models perform better than the mean-adjusted model when there is a clustering of event dates.

However, the simulation results of Brown and Warner (1980, 1985) may not be generalized to event studies related to foreign firms. For example, Brown and Warner (1980, 1985) suggest that the power of the market and market-adjusted models will be adversely affected if the market index in the model is not well specified. For foreign firms, the use of an U.S. equity index, such as the CRSP Equal-Weighted Index, may not be appropriate since these firms are traded in both the U.S. and overseas markets. Stock prices of these dual-listed firms could be affected by trading activities in both of their local stock markets and the U.S. stock market. The U.S. equity index may not fully capture the stock price movements of foreign stock exchanges. As a result, Meek (1983) and Amir et al. (1993) have expressed concerns about the use of CRSP indexes and the market model in event studies on foreign firms. Besides, while Brown and Warner (1980, 1985) have examined the power of one-index market and market-adjusted models, the power of the two-index market model, which takes into account a foreign equity index in addition to a U.S. equity index, has not been examined in prior research. These uncertainties have led to different model specifications and equity indexes being used in prior studies.

Prior studies on foreign firms have utilized various event study models. Some of them have used the market model with U.S. equity indexes. For example, Meek (1983) examines the U.S. stock price reactions to annual earnings announcements and filings of 20-K reports of foreign firms. He uses the CRSP Equal-Weighted Index in a market model to measure the stock price reactions. He finds significant stock price reactions around annual earnings announcements, but not around the 20-K report filings. He argues that the U.S. equity index could be an appropriate index in the market model since the indexes of world markets are significantly correlated. Frost and Pownall (1994) compare

the stock price reactions on the U.S. and U.K. stock exchanges to earnings announcements of dual-listed firms. A market model using the CRSP Equal-Weighted Index is used to measure the stock price reactions on the U.S. exchanges. A market model using the Financial Times Stock Exchange (FTSE) Index is used to measure the stock price reactions on the U.K. exchanges. Frost and Pownall (1996) employ a two-index market model using the CRSP Equal-Weighted and FTSE Indexes to measure the stock price reactions on the U.S. and U.K. exchanges to the earnings announcements of SmithKline Beecham plc. Both studies (Frost and Pownall 1994, 1996) find that the stock price reactions on the U.S. and U.K exchanges to earnings announcement of dual-listed firms are significantly different. Bandyopadhyay et al. (1994) examine the information content of U.S.-GAAP reconciliation disclosures by Canadian firms listed on U.S. exchanges. They use a market model with CRSP Equal-Weighted Index in their short return-window analysis. They find no incremental information content for the filings of 10-K or annual report by U.S.-listed Canadian firms.

Other studies have used the market-adjusted and mean-adjusted models in the analysis of foreign firms. Amir et al. (1993) examine the value-relevance of U.S.-GAAP reconciliation information. A market-adjusted model using the MSCI World Index is employed to measure the stock price reactions to the reconciliation disclosure. They find no significant stock price reactions to the disclosure of U.S.-GAAP reconciliation information in the short window return analysis. Rees (1995) uses the CRSP Equal-Weighted Index in a market-adjusted model to examine the stock price reactions to the filings of 20-F reports by foreign firms. Rees finds that stock price reactions are correlated with the U.S.-GAAP reconciliation information. On the other hand, Meek (1985) uses the mean-adjusted model to examine the stock price reactions on the U.S. stock exchanges to the interim earnings announcements of foreign firms. Consistent with his earlier study (Meek 1983) of annual earnings announcement, he finds significant stock price reactions to the interim earnings announcements of foreign firms.[3]

Muscarella and Vetsuypens (1996) examine the stock price reactions of the U.S. investors to the sole stock splits of American Depositary Receipts (ADRs) and the change in raw returns of the ADRs around the event day without adjustment for expected returns. Sun and Tong (2000) examine the effects of U.S. trade deficit announcements on stock returns of Japanese automakers' ADRs. They use both the U.S. stock market index and Japanese stock market index to control for the expected stock returns. They find that the trade deficit announcements have significant effects on the returns of the Japanese automakers' ADRs.

III. RESEARCH METHODOLOGY

The simulation process is similar to the procedures used in Brown and Warner (1980, 1985) and Kothari and Warner (1997). Foreign firms that are listed on the New York Stock Exchange, American Stock Exchange, or the NASDAQ were identified from the CRSP tapes. All foreign firms traded in the form of common shares as well as ADRs are included in the sample. A total of 503 foreign securities are identified from the CRSP tapes.[4] The sample distribution by countries is reported in Table 1. Canada and United Kingdom have the largest number of U.S. stock listings, followed by Mexico, Australia, and Japan.

This study examines a number of scenarios to investigate the effects of sample size, magnitude of abnormal return, event date clustering, and market index choice on the market, two-index market, market-adjusted, and mean-adjusted models. The research design is similar to Brown and Warner (1980, 1985), with the exception of the two-index market model and foreign equity index we used in this simulation. This allows for comparison between the findings of this study and that of the two

[3] Jayaraman et al. (1993) and Miller (1999), who examine the effect of American Depositary Receipt listings on underlying foreign shares, use a two-index market model in their sensitivity analyses.

[4] 504 issues are initially identified from the CRSP tapes, but one firm is found to be incorporated in the U.S.

TABLE 1
Sample Distribution by Countries

Countries	Number of Observations
Argentina	9
Australia	27
Bahamas	2
Bermuda	17
Brazil	1
Canada	115
Cayman Islands	3
Chile	16
China	4
Colombia	1
Denmark	3
Finland	2
France	9
Germany	2
Greece	2
Hong Kong	9
Indonesia	2
Ireland	11
Israel	13
Italy	8
Japan	27
Liberia	1
Luxemburg	2
Mexico	34
The Netherlands	18
New Zealand	4
Norway	7
Panama	4
Peru	1
Portugal	2
Philippines	5
Puerto Rico	3
Singapore	3
South Africa	24
South Korea	2
Spain	7
Sweden	9
Switzerland	1
United Kingdom	92
Venezuela	1
Total	503

Brown and Warner studies. In each scenario, foreign firms are randomly drawn from the CRSP tapes with replacement and assigned to 250 random samples. Sample sizes of 50 and 100 firms are used. Abnormal returns of 0 percent, 0.5 percent, 1 percent, and 2 percent are introduced into the data. The CRSP Equal-Weighted Index, Value-Weighted Index, MSCI World Index, and MSCI Country Indexes are used to determine the better market index. The experimental design of sample size, event day distribution, and significance level of abnormal returns are important to event studies in general. As discussed in the previous sections, some researchers believe that a foreign or global index and a two-index market model should be used in event studies of foreign firms. Thus, the choice of equity index and the choice of one- or two-index market model are of specific importance for event studies using samples of foreign firms.

For U.S. investors returns on their investment on foreign firms are in terms of U.S. dollars and they have to assume the exchange rate risk. Since the main objective of event studies is to examine the effects of announcements on U.S. stock prices, the MSCI World Index and MSCI Country Indexes are stated in U.S. dollars. This is consistent with the approach in prior studies and also consistent with the fact that return data in CRSP tapes are stated in U.S. dollars. Thirty MSCI country equity indexes are available from the MSCI database. Return data is not available for all countries in the sample and the return data for some emerging market countries only begins at the start of 1989.[5]

An event date is randomly assigned to each randomly selected foreign firm in the period from the beginning of 1986 to the end of 1995. Then the simulation is repeated using one calendar date as the event date for all securities in a random sample to examine the effect of event date clustering. Test statistics are first calculated assuming cross-sectional independence of abnormal stock returns. However, abnormal stock returns could be correlated if sample firms share common features such as similar business environments. For a sample of foreign firms, their common features, such as being mainly large multinational firms, could induce cross-sectional dependence of abnormal stock returns. Therefore, we repeat the analysis with an assumption of cross-sectional dependence of abnormal stock returns. A total of 384 scenarios are analyzed.

For each random sample, the following procedures are applied to calculate the test statistic. Day 0 is defined as the event day. The estimation period is composed of day –244 through day –6 for a maximum of 239 daily return observations. For a security to be included in a sample, it must have at least 100 daily stock returns in the estimation period and no missing return data in the 11 days around the event day. The induced abnormal return is added to the actual stock return on the event day. The abnormal return (AR) for security i at day t is calculated using the following procedures.

Under the market model, the abnormal return is calculated as:

$$AR_{it} = R_{it} - \beta_0 - \beta_1 R_{mt} \quad (1)$$

where R_{it} is the daily return of security i at day t. R_{mt} is return on the CRSP Equal-Weighted Index, CRSP Value-Weighted Index, MSCI World Index, or MSCI Country Index.[6] β_0 and β_1 are ordinary least squares estimates.

Under the two-index market model, the abnormal return is computed as:

$$AR_{it} = R_{it} - \beta_0 - \beta_1 R_{at} - \beta_2 R_{bt} \quad (2)$$

where R_{at} is return on the CRSP Equal-Weighted Index, CRSP Value-Weighted Index, or MSCI World Index. R_{bt} is return on the MSCI Country Index. β_0, β_1, and β_2 are ordinary least squares estimates.

Under the market-adjusted model, the abnormal return is:

$$AR_{it} = R_{it} - R_{mt}. \quad (3)$$

[5] 463 of the 503 issues have MSCI country index data.

[6] We thank an anonymous reviewer for suggesting the use of MSCI country indexes in a one-factor model.

Under the mean-adjusted model, the abnormal return is given by:

$$AR_{it} = R_{it} - MR_i \tag{4}$$

where MR_i is the average daily stock return of security i during the estimation period.

Patro (2000) provides interesting evidence to suggest that the two-index model with a world market index and a home country index is better than the one-index model using just a world market index or a home country index in explaining the variations of ADRs' stock returns. Patro (2000) also finds that adding other factors such as exchange rate, interest rate, and oil price to the two-index model would not significantly increase the power of the two-index model. Patro's (2000) findings support the use of the two-index market model in this simulation.

The null hypothesis is that the average abnormal return of a random sample on day 0 is not significantly different from zero. The test statistic for this null hypothesis is first calculated assuming cross-sectional dependence of stock returns:

$$MAR_t / Std(MAR_t) \tag{5}$$

where:

$$MAR_t = 1/N_t \sum_{i=1}^{N_t} AR_{it} \tag{6}$$

$$Std(MAR_t) = \sqrt{\left(\left(\sum_{t=-244}^{t=-6} (MAR_t - MAR)^2\right)\right)/238} \tag{7}$$

$$MAR = 1/239 \sum_{t=-244}^{t=-6} MAR_t. \tag{8}$$

Then the test statistic assuming cross-sectional independence is computed as:

$$\left(\sum_{i=1}^{N_t} SAR_{it}\right) (N_t)^{-0.5} \tag{9}$$

where:

$$SAR_{it} = AR_{it} / Std(AR_{it}) \tag{10}$$

$$Std(AR_{it}) = \sqrt{\left(\left(\sum_{t=-244}^{t=-6} (AR_{it} - AAR_i)^2\right)\right)/\ 238} \tag{11}$$

$$AAR_i = 1/239 \sum_{t=-244}^{t=-6} AR_{it}. \tag{12}$$

N_t is the sample size and both test statistics are assumed to be unit normally distributed.

A one-tailed test with a 5 percent significance level is used to determine if there is a positive abnormal return on day 0. Under each scenario, this statistical test is applied to each of the 250 random samples and the frequency of rejecting the null hypothesis is computed. When 0 percent abnormal return has been introduced into the samples, the null hypothesis of no abnormal returns is true. Rejections of the null hypothesis represent Type I errors. In cases where positive abnormal returns (0.5 percent, 1 percent, 2 percent) have been introduced, failures to reject the null hypothesis represent Type II errors.

IV. EMPIRICAL FINDINGS

Table 2 reports the findings when there is no clustering of event dates. It shows the frequencies with which the null hypothesis is rejected. In general, the results are consistent with those reported in Brown and Warner (1980, 1985). When positive abnormal returns are present, the rejection rate ranges between 31 percent and 100 percent. It is higher as the magnitude of abnormal return is higher. When the level of abnormal returns is 0.5 percent, the best performing model detects it only 84 out of 100 times. However, as the level of abnormal return is increased from 0.5 percent to 2 percent, all methods are highly effective in detecting the abnormal returns, with rejection rates between 98 percent and 100 percent. The rejection rate also increases with sample size. For example, in the 0.5 percent abnormal return cases, when sample size is changed from 50 to 100 firms, the rejection rate exhibits increases between 6 percent and 25 percent. The models work better when cross-sectional abnormal stock returns are assumed to be independent. The results are robust with respect to the choice of abnormal return models and equity indexes. There is no nonsynchronous trading problem in the estimation periods. For example, in the analysis of market model for the case

TABLE 2
Percent Rejection Frequency for the 250 Random Samples
When There Is No Clustering of Event Dates
(p-value = 5%, one-tailed test)

H_0: Abnormal return at day 0 is equal to zero.
H_A: Abnormal return at day 0 is greater than zero.

	Sample Size = 50				Sample Size = 100			
Abnormal Returns (%)	**0**	**0.5**	**1**	**2**	**0**	**0.5**	**1**	**2**
Panel A: Cross-Sectional Dependence Is Assumed								
Mean-adjusted model	6	34	68	98	5	40	86	100
Market model:								
Equal-weighted Index	7	34	70	98	6	41	88	100
Value-weighted Index	6	34	69	98	6	41	88	100
MSCI World Index	6	33	69	99	5	40	88	100
MSCI country indexes	6	32	76	98	5	45	91	100
Market-adjusted model:								
Equal-weighted Index	6	31	68	98	5	38	87	100
Value-weighted Index	8	32	72	98	6	44	88	100
MSCI World Index	8	36	72	99	7	44	90	100
MSCI country indexes	8	34	74	99	5	46	90	100
Panel B: Cross-Sectional Independence Is Assumed								
Mean-adjusted model	8	51	97	100	7	75	100	100
Market model:								
Equal-weighted Index	8	56	98	100	6	78	100	100
Value-weighted Index	8	54	98	100	6	79	100	100
MSCI World Index	7	57	99	100	7	78	100	100
MSCI country indexes	7	60	98	100	4	84	100	100
Market-adjusted model:								
Equal-weighted Index	6	51	96	100	5	69	100	100
Value-weighted Index	8	53	98	100	6	76	100	100
MSCI World Index	9	58	98	100	8	79	100	100
MSCI country indexes	9	61	98	100	5	82	100	100

of zero abnormal return in Panel A of Table 2, the average number of daily return observations in the estimation period is 234 out of the maximum 239 daily return observations.

When no abnormal return is introduced to the samples, rejection rates range from 4 percent to 9 percent. Since this study uses a 5 percent p-value for a one-tailed test, the rejection rate should be 5 percent. A rejection rate between 2 to 8 percent would not be considered significantly different from 5 percent assuming a Bernoulli process (Brown and Warner 1980, 216). Therefore, all rejection rates under the zero abnormal return cases are within the acceptable range, except when the MSCI World Index and MSCI Country Indexes are used in the market-adjusted model with a sample size of 50 and cross-sectional independence of abnormal returns is assumed. Although most of the rejection rates are within the acceptable range, they are on the high end of the range and much higher than those reported by Brown and Warner (1980, 1985).

Table 3 reports the results when there is clustering of event dates. As expected, the mean-adjusted model does not perform well. When cross-sectional abnormal stock returns are assumed to

TABLE 3
Percent Rejection Frequency for the 250 Random Samples
When There Is Clustering of Event Dates
(p-value = 5%, one-tailed test)

H_0: Abnormal return at day 0 is equal to zero.
H_A: Abnormal return at day 0 is greater than zero.

	Sample Size = 50				Sample Size = 100			
Abnormal Returns (%)	**0**	**0.5**	**1**	**2**	**0**	**0.5**	**1**	**2**
Panel A: Cross-Sectional Dependence Is Assumed								
Mean-adjusted model	7	16	34	80	7	16	36	80
Market model:								
Equal-weighted Index	10	21	53	92	6	21	52	93
Value-weighted Index	10	20	49	88	6	21	47	89
MSCI World Index	11	24	50	94	7	20	52	95
MSCI country indexes	7	19	46	92	6	24	61	96
Market-adjusted model:								
Equal-weighted Index	9	21	50	92	6	20	51	94
Value-weighted Index	10	20	46	85	6	19	40	86
MSCI World Index	10	24	45	92	6	18	46	94
MSCI country indexes	7	20	51	92	8	25	61	94
Panel B: Cross-Sectional Independence Is Assumed								
Mean-adjusted model	24	52	84	98	27	61	87	98
Market model:								
Equal-weighted Index	20	54	89	100	19	66	90	100
Value-weighted Index	23	56	88	100	22	62	93	99
MSCI World Index	18	60	92	99	20	69	94	100
MSCI country indexes	18	52	92	99	17	68	94	100
Market-adjusted model:								
Equal-weighted Index	18	51	88	100	19	60	90	100
Value-weighted Index	28	59	85	100	26	63	90	100
MSCI World Index	20	61	90	99	24	66	94	100
MSCI Country indexes	17	55	92	99	21	68	95	100

be dependent, the rejection rates are lower than those reported in Table 2 when abnormal returns are nonzero. When cross-sectional stock returns are assumed to be independent, the rejection rate is excessively high when abnormal returns are zero. In other words, both Type I and Type II errors increase when there is clustering of event dates. These results are consistent with that of Brown and Warner (1980, 1985). However, the market and market-adjusted models also perform poorly when there is clustering of event dates and these results are different from that of Brown and Warner (1980, 1985). Increased sample size and the use of MSCI World Index or the MSCI Country Indexes do not solve the problem.

Tables 4 and 5 report the results from using the two-index market models. In the two-index market models, a MSCI country equity index is used in addition to CRSP or the MSCI World Index. The results in Tables 4 and 5 are similar to the results reported in Tables 2 and 3. The two-index market models work well when there is no clustering of event dates. All models have Type I error within the acceptable range. Their Type II errors decrease with sample size and magnitude of the abnormal returns. However, their Type II errors are not much less than those from the one-index models. Therefore, there is little evidence that choosing a two-index model over a one-index model will increase the power of the event study test. Similar to their one-index counterparts, the two-index models exhibit much higher Type I and Type II errors when event dates cluster. One possible reason for the failure of the market, market-adjusted, two-index market models could be the relatively stronger common characteristics among foreign firms in a random sample compared to the common characteristics among U.S. firms in a random sample. For example, when Brown and Warner (1980, 1985) drew random samples of 50 and 100 firms from thousands of firms in the CRSP tapes, the population of foreign firms in this simulation is only in the hundreds.

Since there are a growing number of foreign firms listed on U.S. exchanges in recent years, we conduct a sensitivity analysis to examine the effects of increasing number of foreign firms on the power of event studies. A total of 978 foreign firms with sufficient return data are identified from the most recent CRSP tapes and an event date is randomly assigned to each randomly selected foreign firm in the period from the beginning of 1986 to the end of 2001. The findings are reported in Table 6.[7] Overall, the findings are consistent with those reported in Tables 2 to 5. Using a sample size of 100 with the mean-adjusted model, market-adjusted model, and market model, the results show that all three model specifications and the two CRSP indexes as well as MSCI World Index yield similar power for event studies. Also, the increased number of foreign firms does not resolve the high Type I and Type II error problems associated with clustering of event dates. Even with the increasing number of foreign firms on U.S. exchanges, the number of foreign firms is still limited compared to the number of U.S. firms on U.S. exchanges and these foreign firms may share common characteristics such as being relatively large multinational firms. From a statistical sampling point of view, the randomness within a random sample of foreign firms could be less than a random sample of U.S. firms. Thus, it would be much more difficult for market indexes to control for common stock price movements when there is clustering of event dates.

V. ADDITIONAL ANALYSES

Two additional tests on the power of the event study methodologies are conducted. The first one is the effect of inflation rate differences among countries. In an event study, the expected return for each firm is calculated using the stock returns of the estimation period. The abnormal returns in the

[7] We did not use individual MSCI country indexes for the new sample period because (1) free daily MSCI country indexes are available only for the most recent five years (mid-1997 to mid-2002) and earlier MSCI country indexes are not daily data; (2) archival MSCI daily country indexes are too expensive to procure and only a few are available from secondary sources such as the *Wall Street Journal;* and (3) running simulations with only the most recent five years of MSCI data is almost impractical. Nevertheless, Table 6 shows that other indexes yielded similar findings in both the original sample period and the extended sample period.

TABLE 4
Percent Rejection Frequency for the 250 Random Samples When There Is No Clustering of Event Dates and a Two-Index Market Model Is Used
(p-value = 5%, one-tailed test)

H_0: Abnormal return at day 0 is equal to zero.
H_A: Abnormal return at day 0 is greater than zero.

	Sample Size = 50				Sample Size = 100			
Abnormal Returns (%)	**0**	**0.5**	**1**	**2**	**0**	**0.5**	**1**	**2**
Panel A: Cross-Sectional Dependence Is Assumed								
Two-Index Market Model using MSCI country index and:								
Equal-weighted Index	5	28	70	98	3	37	90	100
Value-weighted Index	5	27	71	99	5	41	90	100
MSCI World Index	7	30	73	99	4	42	92	100
Panel B: Cross-sectional Independence Is Assumed								
Two-Index Market Model using MSCI country index and:								
Equal-weighted Index	5	57	94	100	3	72	100	100
Value-weighted Index	6	57	96	100	6	74	99	100
MSCI World Index	7	57	95	100	4	78	100	100

TABLE 5
Percent Rejection Frequency for the 250 Random Samples When There Is Clustering of Event Dates and a Two-Index Market Model Is Used
(p-value = 5%, one-tailed test)

H_0: Abnormal return at day 0 is equal to zero.
H_A: Abnormal return at day 0 is greater than zero.

	Sample Size = 50				Sample Size = 100			
Abnormal Returns (%)	**0**	**0.5**	**1**	**2**	**0**	**0.5**	**1**	**2**
Panel A: Cross-Sectional Dependence Is Assumed								
Two-Index Market Model using MSCI country index and:								
Equal-weighted Index	8	18	46	90	5	19	53	96
Value-weighted Index	6	18	44	82	6	20	44	87
MSCI World Index	8	22	48	88	5	22	56	95
Panel B: Cross-Sectional Independence Is Assumed								
Two-Index Market Model using MSCI country index and:								
Equal-weighted Index	19	50	85	100	20	61	88	100
Value-weighted Index	24	56	82	100	26	61	90	100
MSCI World Index	18	56	88	98	20	66	94	100

event dates are computed by subtracting the expected returns from the actual returns. As Masulis (1980) points out, an underlying assumption of event studies is that the return-generating process is stationary throughout the model estimation and event periods. Although event study models are not based on valuation theory, the mean-adjusted model, the market-adjusted model, and the market model can be considered as consistent with the Capital Asset Pricing Model (CAPM) (Brown and Warner 1980). The two-index market model is also consistent with a multifactor asset pricing model

TABLE 6
Percent Rejection Frequency for the 250 Random Samples with Sampling Period from 1985–2001
(p-value = 5%, one-tailed test)

H_0: Abnormal return at day 0 is equal to zero.
H_A: Abnormal return at day 0 is greater than zero.

	No Clustering of Event Dates				Clustering of Event Dates			
Abnormal Returns (%)	**0**	**0.5**	**1**	**2**	**0**	**0.5**	**1**	**2**
Panel A: Cross-Sectional Dependence Is Assumed								
Mean-adjusted model	5	38	82	100	6	16	40	82
Market model:								
Equal-weighted Index	5	40	84	100	6	23	55	97
Value-weighted Index	5	39	83	100	4	20	56	94
MSCI World Index	6	42	84	100	6	20	54	95
Market-adjusted model:								
Equal-weighted Index	5	38	81	100	5	21	49	96
Value-weighted Index	6	40	83	100	4	15	43	87
MSCI World Index	6	42	86	100	7	20	50	92
Panel B: Cross-Sectional Independence Is Assumed								
Mean-adjusted model	7	70	100	100	29	60	86	99
Market model:								
Equal-weighted Index	6	74	100	100	22	62	94	100
Value-weighted Index	6	72	100	100	22	65	95	100
MSCI World Index	7	73	100	100	20	67	94	100
Market-adjusted model:								
Equal-weighted Index	5	66	99	100	18	59	92	100
Value-weighted Index	8	69	100	100	26	62	90	100
MSCI World Index	8	73	100	100	23	65	93	100

(Patro 2000). For example, β_1 in Equation (1) is often considered as an estimate of the systematic risk in CAPM. Many prior studies such as Blume (1971) and Sunder (1980) show that systematic risk is nonstationary. Robichek and Cohn (1974) provide evidence that the change in beta is associated with inflation rate. Robichek and Cohn (1974) argue that stock price is the sum of discounted future cash flows and macroeconomic conditions such as inflation would affect future cash flows. Thus, inflation would affect stock price and the resulting change in stock price would in turn be reflected in change in systematic risk. DeJong and Collins (1985) and Collins et al. (1987) also present evidence to suggest that nonstationarity of beta is associated with unexpected changes in risk-free rate and inflation rate. In the case of foreign firms, these firms have various country origins and operate in different macroeconomic environments. Based on the findings of prior studies on the relationship between beta nonstationarity and inflation, it is possible that the power of the event study model is lower for firms from countries with relatively higher inflation rates since these firms are more likely to have nonstationary return generating processes.

To examine the effect of inflation on the power of the event study methodologies, the sample firms are classified into two subsamples based on their average annual inflation rates in the 1986–1995 period. The inflation rate data are collected from the Global Market Information Database. Sample countries are ranked based on the ascending order of their average annual inflation rates. In order to have two subsamples of similar size, countries are classified one by one into the low-inflation

subsample until the cumulative total number of firms in the low-inflation subsample is over half of the overall sample firms. The remaining countries are classified into the high-inflation subsample. Countries in the low-inflation subsample include Canada, Denmark, Finland, France, Ireland, Japan, The Netherlands, Norway, Singapore, Switzerland, and United Kingdom. All countries in the low-inflation subsample have average annual inflation rate of less than 5 percent with a median annual inflation rate of 2.91 percent. Every country in the high-inflation subsample all has an average inflation rate of more than 5 percent and their median annual inflation rate is 13.32 percent.

In these two additional analyses, a sample size of 50 and the market model with the MSCI country indexes are used. This is because the preceding analysis shows that the results are not sensitive to the choice of event study model, index, or sample size. The market model using the MSCI country indexes has Type I errors within the acceptable range in all cases as reported in Table 2 and the model's rejection rates are comparable to other models. A sample size of 50 is used to maintain a reasonable degree of randomness in the analysis since the subsamples have fewer observations than the overall sample.

Table 7 reports the results of the analysis of the two inflation subsamples. When there is no clustering of event dates, both subsamples have Type I errors within the acceptable range regardless of whether cross-sectional independence or dependence is assumed for the abnormal returns. Also, the rejection rate increases with the level of abnormal return. However, the low-inflation subsample has significantly higher rejection rates when the level of abnormal return is low. This is consistent with the expectation that the event study model would be more powerful when the sample firms are from low-inflation countries. When there is clustering of event dates, the results for both subsamples are affected in similar ways as the overall sample.

Another issue specific to foreign firms is the different degrees of trading hour overlapping between foreign stock exchanges and the U.S. stock exchanges. While the stock returns of the U.S. listed foreign firms are computed using their closing stock prices in the U.S. stock exchanges, the foreign firms' stock prices could be affected by the foreign firms' underlying foreign stock prices as well as the trading activities on the U.S. exchanges. Foreign stock exchanges have various degrees of trading hour overlapping with the U.S. stock exchanges. For example, the stock exchanges in Asia and Middle East are closed when trading begins in the U.S. exchanges and there is no overlapping of

TABLE 7
Percent Rejection Frequency for the 250 Random Samples in Two Inflation Country Groups
(p-value = 5%, one-tailed test)
Sample size = 50

H_0: Abnormal return at day 0 is equal to zero.
H_A: Abnormal return at day 0 is greater than zero.

	No Clustering of Event Dates				Clustering of Event Dates			
Abnormal Returns (%)	**0**	**0.5**	**1**	**2**	**0**	**0.5**	**1**	**2**
Panel A: Cross-Sectional Dependence Is Assumed								
Market model with MSCI country indexes:								
High inflation	7	28	63	97	8	17	35	72
Low inflation	5	36	75	100	6	21	47	93
Panel B: Cross-Sectional Independence Is Assumed								
Market model with MSCI country indexes:								
High inflation	8	51	95	100	23	51	79	98
Low inflation	7	60	100	100	16	51	91	100

trading hours. European and African stock exchanges are still open when trading begins in the U.S. exchanges and there are some overlapping trading hours. Other stock exchanges in the Americas would have substantial overlapping trading hours compared to that of the U.S. stock exchanges.

Chan et al. (1996) compare the intra-day patterns of U.S. return volatility of U.S. firms with the U.S. return volatility of European and Japanese firms that are dual-listed on U.S. exchanges and their respective domestic exchange. They find that trading patterns of the Japanese and European shares are similar to that of the U.S. shares, except that the foreign shares have higher return volatility in the morning hours when the U.S. exchanges open. They suggest that the higher return volatility of European and Japanese shares represents the accumulation of public information when the U.S. markets are closed and overseas market are open. The trading patterns of the Japanese and European shares are similar to that of the U.S. shares after the morning hours. Kato et al. (1991) and Wahab et al. (1992) also find that there is no significant difference between the closing stock price of American Depositary Receipts and that of their underlying shares. Thus, findings from prior studies seem to suggest that the degree of overlapping trading hours has no effect on the trading of the foreign firm stocks on U.S. exchanges. Since there is no direct evidence concerning the effect of overlapping trading hours on the power of event study model for foreign firms in the literature, this study provides such an exploratory analysis. In this analysis, three subsamples of firms are examined. The first subsample consists of firms with country origins from Asia and Middle East. The second subsample includes firms with country origins from Europe and Africa. The third subsample is made up of firms with country origins from the Americas.

Table 8 reports the results of this analysis. When there is no clustering of event dates, all three regions have Type I errors within the acceptable range. As in the other analysis, the rejection rate increases with the level of abnormal return and is higher when abnormal stock returns are assumed to be independent cross-sectionally. The rejection rates for the Asia and Middle East region are similar to that of the Americas region. The Europe and Africa region has higher rejection rates than the other two regions. The result suggests that the differences in rejection rates are not caused by the degree of overlapping trading hours since the Europe and Africa region has the medium amount of overlapping

TABLE 8
Percent Rejection Frequency for the 250 Random Samples in Three Geographical Regions
(p-value = 5%, one-tailed test)
Sample size = 50

H_0: Abnormal return at day 0 is equal to zero.
H_A: Abnormal return at day 0 is greater than zero.

	No Clustering of Event Dates				Clustering of Event Dates			
Abnormal Returns (%)	**0**	**0.5**	**1**	**2**	**0**	**0.5**	**1**	**2**
Panel A: Cross-Sectional Dependence Is Assumed								
Market model with MSCI country indexes:								
Asia and Middle East	5	26	68	98	10	16	33	73
Europe and Africa	4	34	83	100	6	16	37	88
Americas	7	29	65	98	6	17	38	85
Panel B: Cross-Sectional Independence Is Assumed								
Market model with MSCI country indexes:								
Asia and Middle East	6	52	96	100	26	54	80	98
Europe and Africa	4	65	98	100	16	56	86	99
Americas	6	57	96	100	16	56	85	99

trading hours compared to the other two regions. The result is probably due to the fact that the Europe and Africa region consists of many firms from developed countries such as The Netherlands and United Kingdom. When there is clustering of event dates, the Type I and Type II errors of the three regions are affected in the same way as the overall sample.

VI. CONCLUDING REMARKS

This study compares the event study methods of foreign stock listed on U.S. exchanges as common stocks and ADRs. With the increasing number of foreign companies listed on U.S. stock exchanges, the number of event studies on these foreign companies is expected to increase in the future. However, there are some uncertainties in the prior literature concerning the choice of the more appropriate of the methods. The objective of this study is to provide important information on the power of the standard event study methods for investigating foreign firms. The results show that the market, market-adjusted, two-index market, and mean-adjusted models have similar power when there is no clustering of event dates. Also, the more readily available CRSP Equal- and Value-Weighted Indexes are as effective as the MSCI World Index and MSCI Country Indexes. The results also show that the standard market, market-adjusted, and mean-adjusted models perform equally as well as the two-index market model. Further analysis shows that the general results are consistent across different groupings of firms according to their country inflation rates or similarity of trading hours compared to that of the U.S. trading hours.

The results suggest that prior research findings are not subject to potential method selection problems even though those studies use different model specifications and market indexes. However, all four models exhibit high Type I and Type II errors when there is clustering of event dates. Therefore, a researcher should be aware of the potential limitations of standard event study methods when the sample of foreign firms exhibits a clustering of event dates. The results should be interpreted with caution. In some cases, alternative research designs might be available to alleviate the problem. For example, in an event study on a regulatory change affecting foreign firms, there may be multiple announcements regarding the status of the proposed regulation. In this case, the researchers could examine the stock price effects on these multiple dates to determine if the findings are consistent with the hypothesized effects. Furthermore, clustering of event dates tends to increase the number of Type II errors if abnormal returns are assumed to be cross-sectionally dependent and increase the number of Type I errors if abnormal returns are assumed to be cross-sectionally independent. Thus, researchers could analyze the abnormal returns using both of these two assumptions as sensitivity tests in order to increase the reliability of the conclusions. Future studies are needed to explore other event study procedures to overcome the problem of event date clustering in studies involving U.S. listed foreign firms.

REFERENCES

Alford, A., J. Jones, R. Leftwich, and M. Zeijewski. 1994. The relative informativeness of accounting disclosures in different countries. *Journal of Accounting Research* 31: 183–223.

Ali, A., and L. S. Hwang. 2000. Country-specific factors related to financial reporting and the value relevance of accounting data. *Journal of Accounting Research* 38: 1–21.

Amir, E., S. Harris, and E. Venuti. 1993. A comparison of the value-relevance of U.S. versus non-U.S. GAAP accounting measures using Form 20-F reconciliations. *Journal of Accounting Research* 31: 230–264.

Ball, R., S. P. Kothari, and A. Robin. 2000. The effect of international institutional factors on properties of accounting earnings. *Journal of Accounting and Economics* 29: 1–51.

Bandyopadhyay, S. P., J. D. Hanna, and G. Richardson. 1994. Capital market effects of U.S.-Canada GAAP differences. *Journal of Accounting Research* 32: 262–277.

Blume, M. 1971. On the assessment of risk. *Journal of Finance* 26: 1–10.

Brown, S. J., and J. B. Warner. 1980. Measuring security price performance. *Journal of Financial Economics* 8: 205–258.

———, and J. B. Warner. 1985. Using daily stock returns: The case of event studies. *Journal of Financial Economics* 14: 3–31.

Chan, K., W. Fong, B. Kho, and R. Stulz. 1996. Information, trading and stock returns: Lessons from dually-listed securities. *Journal of Banking and Finance* 20: 1161–1187.

Collins, D., J. Ledolter, and J. Rayburn. 1987. Some further evidence on the stochastic properties of systematic risk. *Journal of Business* 60: 425–448.

Copeland, T., and J. Weston. 1983. *Financial Theory and Corporate Policy*. Reading, MA: Addison-Wesley Publishing Company, Inc.

DeJong, D., and D. Collins. 1985. Explanations for the instability of equity beta: Risk-free rate changes and leverage effects. *Journal of Financial and Quantitative Analysis* 20: 73–94.

Fama, E. 1976. *Foundations of Finance*. New York, NY: Basic Books, Inc.

———. 1998. Market efficiency, long-term returns, and behavioral finance. *Journal of Financial Economics* 49: 282–306.

Frost, C. A., and G. Pownall. 1994. A comparison of the stock price response to earnings disclosures in the United States and the United Kingdom. *Contemporary Accounting Research* 11: 59–83.

———, and M. H. Lang. 1996. Foreign companies and U.S. securities markets: Financial reporting policy issues and suggestions for research. *Accounting Horizons* 10: 95–109.

———, and G. Pownall. 1996. Interdependencies in the global markets for capital and information: The case of Smithkine Beecham plc. *Accounting Horizons* 10: 38–57.

Jayaraman, N., K. Shastri, and K. Tandon. 1993. The impact of international cross listings on risk and return: The evidence from American depositary receipts. *Journal of Banking and Finance* 17: 91–103.

Kato, K., S. Linn, and J. Schallheim. 1991. Are there arbitrage opportunities in the market for American depository receipts? *Journal of International Financial Markets, Institutions and Money* 1: 73–89.

Kothari, S. P., and J. B. Warner. 1997. Measuring long-horizon security price performance. *Journal of Financial Economics* 43: 301–339.

Masulis, R. 1980. The effects of capital structure change on security prices: A study of exchange offers. *Journal of Financial Economics* 8: 139–178.

Meek, G. K. 1983. U.S. securities market responses to alternate earnings disclosures of non-U.S. multinational corporations. *The Accounting Review* 58: 394–402.

———. 1985. Interim earnings announcements in the United States by non-U.S. multinational corporations-responses by the U.S. securities market. *International Journal of Accounting* 20: 1–18.

Miller, D. P. 1999. The market reaction to international cross-listings: Evidence from depositary receipts. *Journal of Financial Economics* 51: 103–123.

Muscarella, C., and M. Vetsuypens. 1996. Stock splits: Signaling or liquidity? The case of ADR "solo-splits." *Journal of Financial Economics* 42: 3–26.

Patro, D. K. 2000. Return behavior and pricing of American depositary receipts. *Journal of International Financial Markets, Institutions and Money* 9: 43–67.

Porta, R., F. Silanes, A. Shleifer, and R. Vishny. 2000. Agency problems and dividend policies around the world. *The Journal of Finance* 55: 1–33.

Rajan, R., and L. Zingales. 1995. What do we know about capital structure? Some international data. *The Journal of Finance* 50: 1421–1460.

Rees, L. L. 1995. The information contained in reconciliations to earnings based on U.S. accounting principles by non-U.S. companies. *Accounting and Business Research* 25: 301–310.

Robichek, A., and R. Cohn. 1974. The economic determinants of systematic risk. *Journal of Finance* 29: 439–447.

Saudagaran, S., and G. K. Meek. 1997. A review of research on the relationship between international capital markets and financial reporting by multinational firms. *Journal of Accounting Literature* 16: 127–159.

Sun, Q., and W. H. S. Tong. 2000. The effect of U.S. trade deficit announcements on the stock prices of U.S. and Japanese automakers. *Journal of Financial Research* 23: 15–43.

Sunder, S. 1980. Stationarity of market risk: Random coefficients tests for individual stocks. *Journal of Finance* 35: 883–896.

Wahab, M., M. Lashgari, and R. Cohn. 1992. Arbitrage opportunities in the American depositary receipt market revisited. *Journal of International Financial Markets, Institutions and Money* 2: 97–130.