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I. INTRODUCTION

Recent studies by Bekaert and Harvey (BH, 1997 and 2000) and Aggarwal, Inclan, and Leal (AIL, 1999) examine the volatility of equity indexes in emerging markets. BH find that capital market liberalizations increase the susceptibilities of emerging markets to world factors but that — after controlling for cross-country differences in relevant variables — emerging market volatilities decline after liberalizations occur. BH suggest that emerging market volatilities change gradually because liberalization itself is gradual.

Unlike BH, AIL identify *sudden* shifts in volatility and then look for local or global events that can explain these shifts. Except the stock market crash in October 1987, all shifts in the AIL analysis stem from local events. This finding is consistent with Bailey and Chung's (1995) evidence concerning volatility shifts in the Mexican equity market and with the relatively low (but increasing) fractions of emerging market variances explained by world factors in the BH (1997) analysis.

We extend BH and AIL in several ways. Like AIL, we examine shifts in volatility around specific events. Like BH, we use events that should increase market integration *a priori*. Unlike either study, we examine shifts for *individual firms*. Thus, we use firm-specific data with volatilities measured over daily intervals to discern the impact on volatility of one event in the integration and liberalization process. As BH argue, understanding volatility is important for determining the cost of capital and for examining direct investment decisions. To the extent such decisions are not driven solely by market-wide factors, our analysis of firm-specific influences should enhance decision makers' understanding of volatility.

The event we study is the issue of Global Depositary Receipts (GDRs) by Indian firms from 1992 through 1998. India's economic liberalization process includes a wide gamut of domestic economic activities. However, its GDR program is widely considered to have provided the most direct link between Indian firms and world capital markets. The non-convertibility of the Indian rupee, the restrictions on foreign investments in Indian securities, and the prior inability of Indian firms to issue securities in an overseas public offering make the GDR program a critical element of India's liberalization process. Under this program (explained in greater detail in Section II), Indian firms were permitted for the first time to raise public funding abroad. All Indian GDRs issued to date have been issued in Europe and/or the U.S. The home-market impact of these issues on the volatility of the underlying shares in Bombay and the potential volatility spillover from markets into which these GDRs were issued form the focus of our study.

Besides extending BH and AIL, we also extend Foerster and Karolyi (1999) and Miller (1999) who examine home-market price effects when foreign firms first issue American Depositary Receipts (ADRs). Both studies interpret their evidence to support Merton's (1987) investor recognition hypothesis that implies that ADR issues help integrate world markets. We extend these studies by examining volatility shifts that occur when Indian firms issue GDRs under the SEC's Rule 144A and/or Regulation S. GDRs differ from ADRs in that they trade in the U.S. and *other* countries simultaneously. Rule 144A and Regulation S issues differ from publicly traded issues in that they trade only among Qualified Institutional Buyers on the NASD PORTAL system and/or on Designated Offshore Securities Markets.

Though firms in almost 60 foreign countries have used Rule 144A and/or Regulation S to issue equity since 1991, Indian firms have dominated the market. They account for approximately 14% of the Rule 144A offerings and for approximately 19% of the Regulation S offerings through 1997.[1] Though such issues are less liquid and require less disclosure than publicly traded ADRs, Pinegar and Ravichandran (1999) show that the effects on Indian firms of issuing Rule 144A and Regulation S GDRs are similar to the effects on non-Indian firms of issuing publicly traded ADRs. Thus, to the extent ADRs help integrate markets, GDRs should help also.

Besides Merton's (1987) hypothesis, other factors predict changes in firm-specific volatilities following GDR issues. Healy and Palepu (1989) argue, for example, that U.S. investors perceive that business risk will increase when U.S. firms issue seasoned equity. Such expectations may contribute to the announcement period decline in stock prices observed in studies of seasoned equity offerings [e.g., Asquith and Mullins (1986) and Masulis and Korwar (1986)]. Increased business risk may also be part of the "window of opportunity" hypothesis of Loughran and Ritter (1995). If Indian managers issue GDRs with the foreknowledge that business risk will increase, stock price volatilities should increase after the offer. However, Pinegar and Ravichandran (1999) argue that GDR announcements convey "good news" to the Indian market. If that news relates to future changes in risk, we expect post-issue stock price volatilities to decline.[2] Even if business risk remains the same, volatilities could decline because the equity infusions from GDR issues reduce financial leverage [See Black (1976) and Christie (1982)].

Of course, macro factors also influence volatilities. Hamao, Masulis, and Ng (1990) and King and Wadhwani (1990) document volatility spillovers across international equity markets, and BH show that emerging market volatilities become more susceptible to world market influences after markets are liberalized. If GDRs increase Indian firms' world market exposure, world market spillovers may make Indian firms' stocks more volatile after the issue than they were before. However, BH and AIL show that local, not global, factors cause most of the change in emerging market volatilities. Thus, macro-induced changes in volatility may be limited to home-market influences.

To determine whether potential volatility shifts result from firm-specific or global or local macroeconomic forces, we estimate time-varying volatility for each of the firms in our sample, and for market indexes in India, Europe, and the U.S. Estimates are calculated for 200 trading days before and after the GDR issue by each firm.[3] Post-issue volatilities are lower than pre-issue volatilities for over two-thirds of our sample. Reductions occur with even greater frequency in the Indian index. However, neither the European nor the U.S. index experiences similar declines, and only scanty evidence exists of volatility spillovers from Europe and the U.S. to India either before or after GDRs were issued. Evidence of changes in firms' betas measured with respect to appropriate foreign market indexes is equally weak. Thus, the decline in volatility for Indian stocks in Bombay does not appear to be caused by changes in volatility in foreign markets where the GDRs trade. These findings are consistent with the findings in BH and with AIL that emerging market volatility is caused primarily by home-market influences. However, our analysis shows that systematic and firm-specific local events contribute to the reductions in volatility we document.

Though we focus only on GDRs, the importance of the Rule 144A and Regulation S markets adds significance to our findings. In 1999 alone, foreign firms raised more than $21 billion through ADRs and GDRs. Of the 10 largest issues, three were 144A GDRs in which one Taiwanese and two Korean firms raised a total of $1.92 billion. Approximately 40% of the DRs issued in 1999 were Rule 144A and/or Regulation S issues.[4] Since private and offshore issues can be large and relatively frequent sources of funding for foreign firms and can help integrate financial markets, understanding the impact on individual firms of GDR issues is important.

The rest of the paper proceeds as follows. Section II discusses the SEC's Rule 144A and Regulation S and describes important steps in the liberalization of the Indian market. Section III describes our data and statistical methods. Section IV describes our empirical results, and Section V concludes.

II. Description of Rule 144A/Regulation S, Data, and Statistical Methods

A. Rule 144A and Regulation S

In April 1990, the SEC adopted Rule 144A which governs the resale of privately placed securities by Qualified Institutional Buyers (QIBs).[5] Because Rule 144A attempts to provide an efficient and liquid market for institutional investors, *no waiting period* exists for trading these securities if buyers and sellers are both QIBs. Trades of 144A offerings are executed under the PORTAL (*Private Offerings Resales and Trading through Automated Linkages)* system, established in 1990 by the NASD. The system is a computerized, screen-based, quotation, trading, settlement and clearing system. Only "non-fungible" securities (i.e., securities that are not part of the same class as securities simultaneously listed on a U.S. exchange or OTC) can trade on the PORTAL system. PORTAL trades are cleared through the Depository Trust Corporation. GDRs issued under Rule 144A by Indian firms are not “listed” on U.S. exchanges. However, PORTAL trading and other telecommunications options provide some liquidity for U.S. QIBs.

The SEC also adopted Regulation S in April 1990. Regulation S governs the registration of offshore placements by both U.S. and foreign issuers. It also provides guidelines for subsequent secondary market resales within the U.S. of securities originally issued as offshore placements by both foreign and U.S. issuers. Aggarwal, Gray, and Singer (1999) and Choi (2000) discuss the use of offshore markets for raising capital. Unlike Rule 144A, Regulation S prohibits pre-selling securities in the U.S. To avoid subjection to U.S. securities laws, Regulation S offerings must be sold and come to rest outside the U.S. with no efforts to sell initially inside the U.S. However, Regulation S placements may trade on many exchanges internationally where securities trade that are *not* technically listed. The SEC recognizes 16 such exchanges as “Designated Offshore Securities Markets” or “DOSM.”[6] Trades on DOSM are settled through European Clearing Agencies CEDEL or EUROCLEAR rather than through exchange facilities *per se*. If a U.S. broker, acting for a U.S. customer, places an order on the DOSM for securities issued under Regulation S, the SEC treats the transaction as “offshore.” The U.S. purchaser (if not a dealer or distributor) can then resell such securities without restriction in the U.S. The direct access of Regulation S offerings to DOSM and their indirect access to U.S. markets enhances the liquidity of offshore placements.

B. Liberalizing the Indian Market

Though BH (2000, Table I) list November 1992 as the official liberalization date of the Indian market, the process may have begun earlier. Henry (2000, Table II), for example, uses June 1986 because that was when the India country fund was first introduced. However, as BH stress, liberalization is a *gradual* process. The purpose of this section is to discuss a few of the steps in that process for India.

In July 1991, the Indian government announced the New Industrial Policy to liberalize its economy. In 1992, the Indian Parliament created the Securities and Exchange Board of India with statutory authority to oversee India’s capital markets. The Securities and Exchange Board has initiated and implemented extensive reforms in all 23 Indian stock exchanges including the introduction of electronic trading and order matching systems.

The Bombay Stock Exchange, the biggest and most important stock exchange in India, operates from 9:30 a.m. to 4:00 p.m. weekdays. Clearing and settlement operations are managed by National Securities Clearing Corporation. Berkman and Eleswarapu (1998) discuss operations of the Bombay Stock Exchange at an earlier stage in their evolution and report that (except for carryover provisions) settlement took place every 14 days. Currently, the exchange facilitates multiple settlement mechanisms including account period (Wednesday through Tuesday) and rolling period (five business days) settlements.[7]

Indian stock exchanges currently have no market makers bound to give two-way quotes or to act as dealers for any particular stock. Therefore, bid-ask spreads as known in the U.S. do not exist on the Bombay Stock Exchange. However, in March of 1998, the Securities and Exchange Board established a committee to study market making and to draft procedures for its implementation. The committee released its report in October 1999 and the Securities and Exchange Board finalized guidelines for market making in January 2000.[8]

As part of its Economic Liberalization Policy, the Indian government announced in 1992 that Foreign Institutional Investors could invest directly in Indian securities under specific guidelines, issued by the Reserve Bank of India and the Securities and Exchange Board. Other sources of foreign investments include Non-Resident Indians, Overseas Corporate Bodies, and GDRs. To date, severe restrictions are placed on each source. We discuss restrictions specific to Foreign Institutional Investors and GDRs.

Foreign Institutional Investors must register with the Securities and Exchange Board in accordance with guidelines issued by the Ministry of Finance before they trade securities of companies listed on Indian stock exchanges. Since the Indian rupee is not freely convertible, Foreign Institutional Investors also fall under the purview of India’s Foreign Exchange Regulation Act issued by the Reserve Bank. Besides their application to the Securities and Exchange Board for initial registration, therefore, Foreign Institutional Investors must apply with the Reserve Bank for permission. They must also register with the SEC or the comparable regulatory body in their respective countries of domicile or incorporation. Though ownership restrictions vary across industries, combined investments of all Foreign Institutional Investors in primary and secondary markets in India may, in general, not exceed 24% of capital in any company. Holdings of a single Foreign Institutional Investor in any company may not exceed 5% of capital.

BH (2000, Table I) indicate that as of December 1995, the U.S. percentage ownership of Indian firms was only 1.14%, third lowest of the emerging market countries for which data are available in the BH analysis. At the end of 1998, only 200 Foreign Institutional Investors were registered with the Securities and Exchange Board of India. Bloomenthal (1998) reports, however, that there are 4,000 QIBs. How many Foreign Institutional Investors were registered with the Securities and Exchange Board and were also among the 4,000 QIBs is unknown. However, even if all Foreign Institutional Investors were QIBs, the overwhelming majority (3,800 of 4,000) of QIBs eligible to purchase Indian GDRs are not eligible to buy Indian shares on the home market.[9] Thus, large increases in direct foreign holdings of Indian shares through GDR issues seem unlikely.

Before 1992, Indian law prohibited Indian companies from issuing securities publicly outside of India. As part of the New Industrial Policy, the New Economic Liberalization Policy formalized on April 1, 1992 permitted Indian firms to raise capital outside India through GDRs. Since the Indian rupee is not freely convertible in world markets, Indian firms that raise funds denominated in foreign currencies must obtain permission from the Ministry of Finance. GDRs may be denominated in any freely convertible foreign currency and may be listed on any international stock exchange outside India. These GDRs may be purchased, possessed and transferred among persons who are "nonresident" as defined under Section 2(q) of subsection 46 of India's Foreign Exchange Regulation Act. Indian citizens are prohibited from investing in these GDRs. The ordinary shares underlying the GDRs are denominated only in rupees and trade only in India. The issuing firms are required to abide by all other relevant Indian laws.

If GDR holders ask the overseas depositary to redeem the GDRs for the underlying shares, their requests must be transmitted to the custodian bank in India and then to the issuing company. For much of our sample period, GDR holders who wanted to redeem could do so only for direct sale of the released shares on the Bombay Stock Exchange. They could not redeem the GDR and hold the underlying shares. To the extent arbitrage depends on quickness, the time required to notify the domestic custodian bank and the issuing company would limit arbitrage activities.

Though provisions in Rule 144A and Regulation S are intended to enhance liquidity of private and offshore security placements, the limitations on Foreign Institutional Investors' ability to own and trade Indian firms' shares and the prohibitions on Indian citizens against owning and trading GDRs may impede the flow of information between the markets in which the GDRs trade (Europe and the U.S.) and the Indian market where the underlying shares trade. Thus, volatility spillovers between markets may also be limited. Nevertheless, we test for such spillovers below.

III. DATA AND STATISTICAL METHODS

Table 1 lists the calendar time distribution of sample GDR issues from 1992 through the middle of 1998. *Economic Times*, an Indian business daily similar to the *Wall Street Journal*, gives the month and year of each issue for both debt and equity GDRs. Our sample contains 60 of the 66 equity-backed Indian GDRs issued over the sample period.[10] Thirty-seven of these occurred in 1994. This clustering extends across SEC provisions, though single-provision offers occur relatively more frequently in the early and middle parts of the sample, while tandem offers occur more frequently in the middle and later parts.[11]

A potential explanation for the clustering in Table 1 is Loughran and Ritter's (1995) "window of opportunity" hypothesis. To illustrate, Figure 1 compares price movements of the Bombay "Sensex" Index (BSE) to movements in a European and a World index. Daily data for the BSE and for individual Indian stock prices used in our analysis come from the PROWESS data base maintained by the Center for Monitoring Indian Economy (CMIE) in Bombay. Data for the European and World indexes and for exchange rates to convert Indian Rupees to U.S. dollars come from *Bloomberg*.

The figure, which uses December 31, 1991 as the base date, shows that BSE prices doubled in early 1992 while the European and World indexes remained fairly flat. Though the BSE declined and remained close to European and World index levels from mid-1993 to the end of the year, it rose again quickly and remained high throughout 1994 and into 1995. The clustering in Table 1 coincides with the strong Indian market performance vis-a-vis European and other world markets. This pattern supports Loughran and Ritter's (1995) evidence and may suggest that Indian managers take advantage of attractive conditions to issue equity. If those conditions include knowledge that business risk will increase after GDRs are issued, stock prices should be more volatile after the issue than they were before. Of course, the need for Indian firms to get approval from the Ministry of Finance to issue GDRs may limit this explanation.

BH (2000) argue, for example, that governments may only let firms issue ADRs when it is most advantageous to the government, even if stock prices are low. However, Figure 1 clearly indicates that most Indian firms that issued GDRs did so when their home market was performing well relative to other world markets.

Table 2 categorizes the sample by the exchange (DOSM) on which the GDR trades. Data for this table come from *Bloomberg*. Indian GDRs trade on a combination of three exchanges — the London International Exchange, Luxembourg, and Frankfurt. [In London and Luxembourg, GDRs trade in U.S. dollars. In Frankfurt, they trade in Deutsche Marks.] If GDRs trade on a single exchange, the most frequent choice (21 of 60) is Luxembourg. However, 12 GDRs trade on all three exchanges and 21 trade on both the London International Exchange and the Luxembourg Exchange. Besides trading on one or more of these exchanges, all GDRs either trade in the U.S. on PORTAL or are considered "PORTAL" securities in that they trade on a DOSM. So, all GDRs in our sample fall under SEC jurisdiction. If GDRs increase Indian firms' world market exposure, Indian stocks may become more susceptible to volatility spillovers especially from the markets in which the GDRs trade. To examine this conjecture, we use the S&P 500 and the *Bloomberg* European index as proxies for the U.S. and DOSM influences.

Measuring spillovers with daily data requires adjustments for trading time differences across markets. Figure 2 diagrams trading hours of Indian and U.S. markets and of European DOSM, all in Indian Standard Time. Trading hours in India overlap trading hours in all the DOSM, but not in the U.S. In the tests below, we use volatility estimates on calendar day t-1 for the S&P 500 and the European indexes to predict day t volatilities on the Indian stocks. Additionally (despite the overlap between Indian and European trading times), we also include day t's European volatility estimates to capture day t's Indian volatilities. We use the same timing conventions to estimate Indian stocks' foreign market betas. The spillover and beta results are virtually insensitive to whether we use day t-1 alone or combined with day t to estimate connections between Europe and India.

We estimate time-varying volatility with two methods. The first relies on work by Chesney, Ellliott, Madan, and Yang (CEMY, 1993) and Pastorello (1996). These authors propose a simple filtering procedure to recover a series of realized volatilities from a discrete time realization of a continuous time diffusion process. Let $P_{i,t}$ be the closing value of stock (or index) *i* on day *t* and $X_{i,t} = \ln (P_{i,t})$, CEMY and Pastorello show that

$$V_{i,t} = \frac{2}{\beta_i^2}\left[1 - e^{\beta_i(X_{i,t+1}-X_{i,t})} + \beta_i(X_{i,t+1} - X_{i,t})e^{\beta_i(X_{i,t+1}-X_{i,t})}\right] \qquad (1)$$

is an approximately unbiased estimator of asset i's return volatility at time t, where i=-2 /3 i2 and where and are, respectively, the mean and standard deviation of daily returns for asset i over the sample period. CEMY use this measure to construct point estimates of time-varying volatility and covariation with risk factors to test Merton's (1973) Intertemporal Capital Asset Pricing Model. We use it for point estimates for the Indian stocks and the Indian, European, and U.S. indexes to measure potential volatility spillovers.

Use of close-to-close prices with the CEMY method poses some challenges with our data. We use data only if the stock in question trades on the particular day and only if Indian and world markets are both open. Because of differences in holidays, the Indian market is not always open when other world markets are and vice versa. Differences in holidays, nontrading in individual stocks, and the absence of continuous bid-ask quotes imply that $(X_{i,t+1} - X_{i,t})$ in (1) is *not* always measured over equal horizons. Thus, variances measured by the CEMY method are not strictly daily variances.[12]

To remedy this problem, we also use Parkinson's (1980) extreme-value volatility estimator, defined as

$$\sigma_{i,t} = 0.601 * \ln\left(\frac{H_{i,t}}{L_{i,t}}\right) \qquad (2)$$

where $H_{i,t}$ and $L_{i,t}$ are the intra day high and low price for stock (or index) *i* on trading day *t*. Wiggins (1991) finds that, after an outlier screen is applied to the data, the extreme-value estimator is significantly more efficient than the close-to-close estimators he examines.[13] However, Ball and Torous (1984) warn that, as a class, high-low estimators "must more fully integrate the closed market effect" because observed (trading time) security price highs and lows may not correspond to actual (which includes overnight) security price highs and lows. Thus, even though the trading period over which volatility is measured is the same for each estimate with Parkinson's estimator, the assumption that security price dynamics are the same in open and closed markets is almost certainly incorrect. Hence, both the CEMY and the Parkinson estimators have limitations. Nevertheless, if the strengths of one method compensate for weaknesses of the other, using both methods should allow reasonable inferences.

Table 3 provides summary estimates of the CEMY and Parkinson estimates of volatility for the sample firms and for each of the indexes. CEMY estimates are the square roots of $V_{i,t}$ from equation (1). Parkinson estimates are as given by equation (2). The table reports means and medians of the estimates and of the mean lag one autocorrelation coefficients and mean cross-method correlation coefficients using 200 trading observations before and after the issue date. The Indian index is the BSE, the U.S. index is the S&P 500, and the European index is a *Bloomberg* index for which only the CEMY estimator is used because only closing prices are available.

Mean and median volatility estimates in Table 3 are approximately equal across methods.[14] The mean cross-method correlations are also positive (.492 to .657) and significant at the .01 level. However, they suggest that, on average, one method explains only 24 to 43 percent of the variation in the other. Thus, though both methods produce consistent estimates, each contains information the other does not have. The table also shows that lag one autocorrelations for the volatility estimates are positive and significant, especially for the Parkinson method. This finding suggests some form of autoregressive conditional heteroskedasiticity which we control for simply by including a one-period lagged volatility estimate in the regressions that follow.

We also perform robustness checks using time-varying conditional volatilities. However, because of the trading gaps discussed in footnote 12, time-varying volatility estimates based on ARCH and/or GARCH processes suffer from the same deficiencies as the CEMY method with our data. Hansen (1995) also argues that parameterizing conditional variances with GARCH methods requires assumptions about the parameters that may not be correct. Nevertheless, we attempt to impose the Glosten, Jaganathan, and Runkle (GJR, 1993) structure on conditional variances for individual firms. The numbers of GJR coefficients that are significant at the .10 level in our sample are 46 for the lagged conditional variance, 29 for the lagged squared error, and 13 for the asymmetric lagged squared error. Thus, the GJR structure is inappropriate for many firms in our sample. A simple ARCH process is somewhat more successful than the GJR process in describing conditional variances for individual Indian firms, but the ARCH model produces results that are similar to the results presented below. Thus, we report results only for the CEMY and Parkinson methods.

IV. EMPIRICAL RESULTS

Figures 3 and 4 present times series means of the CEMY and Parkinson estimates for the 60 firms in our sample, centered on the respective issue dates. Though the CEMY estimates exhibit more variability than the Parkinson estimates (possibly because they measure variability over longer horizons) both series show similar patterns. Both decline over time, and both show a spike at or near the issue date compared with observations in surrounding periods. The post-issue decline is consistent with evidence in BH(1997). However, the BH comparisons are market-wide comparisons in calendar time before and after general liberalization dates, while our comparisons are in event time before and after specific GDR issue dates. The mean issue-date spike for the CEMY (Parkinson) method is the eighteenth (first) largest spike in the total time series. These spikes are consistent with the hypothesis that imperfectly anticipated information is released when GDRs are issued.[15]

To measure the impact of GDR issues more formally, we now create time series dummy variables labeled "Before," "$Event_1$, " "$Event_2$," and "After." Observations corresponding to these labels are trading days -200 through -26, -25 through 0, 1 through 25, and 26 through 200, respectively.[16] Using the dummy variables, we run the following regression

$$Vol_{i,t} = a_1 * Before + a_2 * Event_1 + a_3 * Event_2 + a_4 * After + d * Vol_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

where $Vol_{i,t}$ is either the CEMY or the Parkinson volatility estimate and $\varepsilon_{i,t}$ is the error term. Isolating the periods immediately surrounding the issue date eliminates potentially short-lived volatility shifts attributable to the issue itself. To test the hypothesis of *permanent* shifts, we examine the equality of a_1 and a_4. Tests of the equality of these and other coefficients use White's (1980) standard errors. We run regressions for each Indian firm and for each index over the corresponding time interval. Mean and median coefficient estimates and p-values for each test are reported in Table 4.

The regressions confirm what Figures 3 and 4 suggest. Post-issue volatilities of Indian firms differ significantly from pre-issue volatilities. Mean CEMY and Parkinson estimates of a_4 (.0157 and .0137) are approximately 10 percent lower than the corresponding estimates for a_1 (.0177 and .0155). Mean (median) p-values for tests of the hypothesis that $a_1 = a_4$ are .226 (.051) and .181 (.037) for the CEMY and Parkinson methods, respectively. Thus, a_4 is significantly different from a_1 at the .100 level for more than half our sample firms. In contrast, mean and median p-values for tests of the hypothesis that $a_1 = a_4$ for the U.S. and European indexes are all greater than .100. Thus, the decline in volatility for Indian stocks in Bombay does not appear to be caused by changes in volatility in foreign (U.S. and European) markets where the GDRs trade.

The volatility of the Indian index, however, declines in the same fashion as the volatility of the individual firms. This finding may be due to the clustering in our sample. If most GDRs were issued just before a decline in Indian market volatility, the volatility of individual Indian stocks would decline with the market. Alternatively, GDR issues may have contributed to a decline that would not have been as pronounced if GDRs had not been issued. We examine the evidence for these different interpretations below. However, we first decompose volatility into trading time and overnight volatility. Then, we examine the stability of overnight volatilities and the pervasiveness of our findings across individual stocks.

Table 5 reports results from regression (3) for overnight Parkinson estimates. Because our data do not have high and low prices for overnight trading, we substitute the absolute value of the ratio of the open price to the preceding close price for the high-low ratio in the Parkinson estimator. Overnight volatility is smaller than trading time volatility for all assets we examine, but especially for the U.S. index. Compared with a_1 and a_4 in Table 4, a_1 and a_4 in Table 5 are approximately 10 percent as large for the U.S. index, 30 to 40 percent as large for the Indian index, and 70 percent as large for individual Indian stocks. Nevertheless, the patterns in the tables are the same. There is a significant, permanent decline in the volatilities of most individual Indian stocks and of the Indian index, but no noticeable change for the U.S. index.

Table 6 examines the significance of the volatility shifts in more detail for the CEMY method and for the Parkinson estimator using trading time and overnight intervals. Each cell contains two numbers. The first is the total number of differences between a_1 and a_4 that are significant at the .10 level. The second is the number of significant shifts for which $a_4 < a_1$. With 60 independent experiments, we expect six differences to be significant by random chance alone. The numbers in Table 6 exceed the expected number at the .05 level for each asset class and each method. This finding underscores the variation in volatilities over time.

More interesting, however, is the direction of the movements. Random shifts should produce approximately equal numbers of significant upward and downward movements. However, the U.S. index has significantly fewer (8/25) significant negative shifts, while individual firms (27/36) and the Indian index (32/37) have significantly more negative shifts than chance alone would predict. The European index (14/18) also has significantly more negative shifts than chance alone would predict, but the total number of significant shifts is less than half the total number of significant shifts for the Indian index or for individual Indian firms. Though the numbers reported here are for CEMY estimates, Parkinson estimates support similar conclusions. Again, this evidence may suggest that events in our sample are dependent because of clustering, or that the clustering of independent events contributes to the dampening of market volatility occasioned by subsiding macroeconomic influences.

Before separating general market movements from individual firm effects, we look for potential volatility spillovers from the U.S. and Europe into the prices of individual firms. Though our results so far suggest that volatilities of Indian firms and the Indian index are related to each other but not to volatilities of the U.S. and European indexes, we have focused only on central tendencies. Differences in central tendencies in pre- and post-issue periods may not be good surrogates for correlations between volatility movements measured on a daily basis. To examine whether such correlations exist and whether they change after GDR issuances, we run the following regression

$$Vol_{i,t} = \bar{a} + b^{bef} * Before * Vol_{j,t-1} + b^{aft} * After * Vol_{j,t-1} + c * Vol_{BSE,t} + d * Vol_{i,t-1} + \varepsilon_{i,t} \quad (4)$$

where $Vol_{j,t-1}$ is the volatility estimate for the U.S. or European index and $Vol_{BSE,t}$ is the volatility estimate for the Indian index, and all other variables retain their previous definitions. Including $Vol_{BSE,t}$ and $Vol_{i,t-1}$ controls for concurrent changes in the volatility of the home index and for lagged changes in individual volatilities.

Results of regressions (4) are in Table 7. As expected, volatilities of Indian stocks relate directly to volatilities of the Indian market, with mean (median) estimates for c approximately equal to .5, and with median p-values all below .010. Similar results also hold for the coefficient (d) on own-firm lagged volatility. However, mean and median estimates of both b^{aft} and b^{bef} are small and insignificant. Tests of the hypothesis that $b^{aft} = b^{bef}$ yield p-values that are also mostly greater than .200. Thus, only scanty evidence exists that GDR issues expose home-market investors to volatility spillovers from the foreign markets into which the GDRs were issued.[17]

We also estimate domestic and foreign-market betas for Indian firms before and after GDR issues. To conserve space, we do not report the results of these regressions in a separate table. However, as with regressions (4), these regressions produce little evidence that U.S. and European markets influence Indian stock prices. At the .100 level, only four firms have significant pre- and/or post-issue U.S. betas. Only seven firms have significant pre-issue European betas, and only eight firms have significant post-issue betas. To the extent GDRs help integrate Indian markets with world markets, the insignificant foreign market betas and the insignificant coefficients in regression (4) are inconsistent with the evidence in BH. However, the limitations (discussed in Section II) Indian law still imposes on investors to own and trade Indian shares and/or GDRs may impede the process of impounding world market news into Indian firms' share prices.

In contrast to the insignificant foreign market betas, domestic betas are significant for 58 (56) of the firms in our pre-issue (post-issue) periods. The mean (median) pre-issue beta, .783 (.782), is also close to the mean (median) post-issue beta, .790 (.702). Only 17 domestic betas change significantly after the issue.[18] Of course, domestic betas need not change if firm and market volatilities move proportionately in the same direction.

To discern whether the decline in the volatilities reported above results from market movements only or from firm-specific events also, we separate the two effects with market model regressions. Specifically, we estimate firm-specific volatilities as the absolute values of residuals from regressions of Indian firms' returns against returns on the Indian index over trading days -200 through -25 and days +25 through +200. We then substitute these estimates for the CEMY and Parkinson estimates in regression (3). Thirty-six revised regressions (3) produce estimates of a_4 that differ significantly from the corresponding estimates of a_1. Of the significant differences, 25 are negative. The correlations between the differences (a_4-a_1) measured with the market model residuals and the CEMY (.895) and Parkinson (.395) methods are also significant. Thus, much of the decline in CEMY and Parkinson estimates appears to be firm-specific.[19] Whether the decline is also related to the GDR issue *per se* is the subject of our next series of tests.

Figure 5 depicts mean estimates of the firm-specific standard deviations from the market model regressions over four subperiods. The subperiods do *not* correspond to the dummy variable designations in regressions (3). Instead, we divide "Before" and "After" into halves to discern whether the post-issue decline is a natural progression from the pre-issue decline or a more immediate decline associated with the GDR issue. The graph supports the second view.

Mean estimates of firm-specific volatilities are .0186, .0188, .0168, and .0156 for the first through fourth subperiods, respectively. Matched-pair tests of the hypothesis that sequential mean differences between firm-specific volatilities equal zero produce t-statistics of .12 (period 1 - period 2), 1.92 (period 2 - period 3), and 1.06 (period 3 - period 4). Thus, the most significant shift in firm-specific volatilities appears to occur immediately after the GDR issue. We also look at *median* differences between volatilities in sequential subperiods by computing Wilcoxon sign tests. These tests yield z-statistics of .77, 1.03, and 2.34. In contrast to the t-tests, therefore, the sign tests indicate that the most significant shift occurs between the third and fourth, rather than between the second and third, subperiods.

Our final robustness test on the timing of firm-specific volatility shifts ranks volatilities for each GDR issue across subperiods. If change is random, the subperiods should have approximately equal numbers of high, low, and medium ranks. The frequencies in Table 8, however, correspond closely to the subperiods. The first subperiod has the highest frequency (21) of the highest volatility ranks, and the last subperiod has the highest frequency (26) of the lowest volatility ranks. The second and third subperiods have the highest frequencies of the second- and third-largest ranks, respectively. A ^{2}-statistic with nine degrees of freedom rejects the hypothesis at the .001 level that volatility rankings are evenly distributed across subperiods. Diagonal entries suggest, instead, that the decline in firm-specific volatilities is a gradual shift before and after the GDRs were issued, rather than a sudden move associated specifically with the GDR issues. However, column-by-column tests of the hypothesis that frequencies in the respective subperiods have uniformly distributed rankings produce ^{2}-statistics (with three degrees of freedom) with p-values of .292, .753, .112, and .004. Thus, the significance of the tests using the total table derives mostly from deviations in the third and (especially) the fourth subperiods. On balance, therefore, Table 8 produces evidence that is consistent the t- and Wilcoxon sign tests above.[20]

Though our tests of the immediacy with which firm-specific volatilities decline after GDR issues produce some ambiguity, we now examine the extent to which such declines relate to changes in firm-specific profile variables. To do so, we again use differences in mean volatilities as in regressions (3). This attempt is consistent with event study attempts to explain cross-sectional variations in event period abnormal returns. It is also consistent with efforts by BH who model differences in *cross-country* volatilities as a function of differences in emerging market attributes across countries. Because we have only Indian firms in our sample, however, we focus on *cross-firm,* rather than cross-country, differences. Specifically, we run the following regression

$$\Delta Sd_i = Rule144A + RegS + Tandem + \lambda * \Delta Lev_i + \kappa * \Delta \mathrm{Prof}_i + \theta * \mathrm{Re}lindex_i + \phi * Seq_i + \nu * pos * ABSd_i + \pi * neg * ABSd_i + \varepsilon_i \qquad (5)$$

in which Sd_i is the difference (after-before) in firm-specific volatilities estimated from the market model regressions; *Rule144A, Reg S,* and *Tandem* are collectively exhaustive dummy variables that indicate the type of SEC provision under which the GDR was issued; Lev_i and $Prof_i$ are, respectively, percentage changes in debt-equity ratios and operating profit margins in year 0 compared with the respective means over years t-3 through t-1; $Relindex_i$ is the ratio from Figure 1 of the level of the Indian Index relative the World Index 25 days before the GDR issue; Seq_i is a sequence variable for i = 1, ..., 60, for the first through last GDRs issued in our sample; $ABSd_i$ is the standardized abnormal volatility for firm i during the issue period; and *pos* and *neg* are dummy variables indicating the sign of the issue period abnormal return. Justification for our use of these regressors follows below.

GDR issues in our sample raise equity and reduce financial leverage. If stock price volatilities change strictly because the balance sheet mix of debt and equity changes, the coefficient on Lev_i ( ) should be positive. However, GDR issues can also affect the asset side of the balance sheet when proceeds are used for investments. If reductions in business risk resulting from these investments combine with changes in financial leverage to induce larger changes in volatility, a small (i.e., less negative) value of Lev_i could be associated with a large (i.e., more negative) value of Sd_i, and would be negative. Thus, the sign of can be positive or negative depending on the use of funds and the impact on business risk.

In the Myers/Majluf (1984) pecking order, firms use external equity only when internal funds are not available and/or when external equity is overvalued. If internal funds for Indian firms are declining but external equity is overvalued because the market understands the declining cash flows but underestimates the risk in the pre-issue period [Healy and Palepu (1989)], we expect the coefficient on $Prof_i$ ( ) to be negative. The negative estimates of Sd_i for most firms in our sample, however, suggest that the market does not *underestimate* risk for these firms. A negative estimate of with Sd_i negative suggests that risk is declining while profitability is increasing. A positive , on the other hand, suggests that firms rely on external equity because internal sources are declining.

The concentration of GDR issues in Table 1 and the relative market performance in Figure 1 suggest a window of opportunity approach to fund raising. *Relindex* is our attempt to deal with that issue. If Indian managers time the market, we expect to be positive because managers would issue equity just before an increase in risk. A negative or insignificant estimate of would be inconsistent with that hypothesis.

Other things constant, BH (2000) argue that early issues of ADRs are likely to produce larger marginal effects than later issues, but that the marginal effect declines gradually with each issue. To accommodate that possibility, BH introduce a decay variable. Our simplified version of that variable is SEQ_i. If Sd_i is more (less) negative for early (late) GDR issues, we expect the coefficient on SEQ_i to be positive.

Finally, the higher issue period volatilities in Figures 3 and 4 are consistent with the hypothesis that imperfectly anticipated information is released on the issue date. To capture that information, we use $ABSd_i$. We partition $ABSd_i$ with the *pos* and *neg* dummy variables because, presumably, the decrease in volatility is “good news” and the subsequent reduction in volatility will be signaled by positive spikes in stock prices.

Table 9 shows results of regression (5). The first regression includes only the intercepts spliced by the SEC provision under which the GDR was issued. The next five regressions include the intercepts and one other (different for each regression) independent variable. The final regression includes all variables as listed in equation (5). The results support the hypotheses that Indian GDRs help reduce financial and business risk and that they help resolve the Myers/Majluf (1984) problem because firms issue external equity even when internal cash flows are increasing. The results provide weaker support for the hypothesis that early issues induce a larger decline than later issues. The regressions provide no support for the window of opportunity hypothesis or for the hypothesis that the issue-period spike in volatility signals the direction of future changes in volatility.

Though interesting, the regressions in Table 9 should be interpreted with caution because they are sensitive to variable definitions and to the inclusion or exclusion of certain regressors in the analysis. Expressing Lev_i and $Prof_i$ as raw (rather than percentage) changes in leverage and profitability produces insignificant estimates of and , respectively. Moreover, the price of the GDR relative to the price of the underlying share reflects how QIBs value the GDRs and should (given the hypotheses we consider) predict changes in volatility as readily as the variables we report. However, the relative price variable lacks predictive ability in these tests. Such weaknesses make our cross-sectional results more fragile than we would like.

Nevertheless, the regressions indicate that *firm-specific* mean volatilities are lower after Indian firms issue GDRs than they were before. The coefficients in the first regression in Table 9 are negative for each SEC provision, and they are significant for Rule 144A and tandem offers. This finding contrasts with those reported by Healy and Palepu (1989) for U.S. seasoned equity offerings. We also report some (albeit ambiguous) support for the hypothesis that the decline in volatilities is related to the GDR issue *per se*. To the extent that conclusion is correct, our evidence shows that part of the decline in volatility that BH document in emerging markets is attributable to firm-specific events, such as GDR issues. To the extent that conclusion is incorrect, however, it suggests that firm-specific volatilities in emerging markets may decline only gradually even after firm-specific events.

V. CONCLUSION

Volatilities decline for most Indian firms in our sample that issued GDRs into European and U.S. markets between 1992 and 1997. Variance reductions also occur in the Indian index. However, neither the European nor the U.S. index experiences similar declines. Only scanty evidence exists of volatility spillovers from Europe and the U.S. to India either before or after GDRs were issued, and evidence that foreign-market betas change (or are even significant in the pre- and post-issue periods) is equally weak. These findings are consistent with Bekaert and Harvey (1997 and 2000) and with Aggarwal, Inclan, and Leal (1999) who report that changes in volatility in emerging markets are more likely to come from local as opposed to global factors. However, the volatility changes are also firm specific. Thus, part of the gradual decline in volatilities that Bekaert and Harvey document may relate to firm-specific events that contribute to the liberalization process. Even following firm-specific events, however, the decline in firm-specific volatilities may be gradual.

Table 1

Calendar Time Distribution of Global Depositary Receipts (GDRs) Issues by Indian Firms

This table reports the calendar time distribution of equity-backed Global Depositary Receipt issues by Indian firms between 1992 and 1997. *Economic Times*, an Indian business daily similar to the *Wall Street Journal*, gives the month and year of each issue. Fifty firms in our sample issued one GDR; five firms issued two.

Calendar Time Distribution of Issues in Sample				
Year	***Total Sample***	***Rule 144A***	***Regulation S***	***Tandem***
1992	2	1	1	0
1993	6	2	4	0
1994	37	16	7	14
1995	4	0	1	3
1996	9	3	0	6
1997	2	0	0	2
Total	60	22	13	25

Table 2

Distribution of Sample by Exchange Where Indian GDRs Trade

This table summarizes Global Depositary Receipts issued by Indian firms between 1992 and 1997 by the exchange on which the GDRs trade. Data for the exchange come from *Bloomberg*. Diagonal cells indicate trading on a single exchange. Off diagonal cells represent cross-trading on multiple exchanges. Duplicating cells, which are mirror images, are left blank. The cells in the last column do not sum to 60 because they include cross-listings. The London International is a Designated Offshore Securities Market as per the SEC and is not the same as the London Stock Exchange.

Exchange					
Exchange	***London International***	***Luxembourg***	***Frankfurt***	***All Three***	***Total Traded Here***
London International	1	-	-	-	37
Luxembourg	21	21	-	-	56
Frankfurt	3	2	0	12	17

Table 3

Summary Estimates of Daily Volatility of Returns on Stocks of Indian Firms That Issued Global Depositary Receipts between 1991 and 1997

	Method of Estimating Volatility *	
Security	***CEMY***	***Parkinson***
Indian Firms in Sample		
Mean Volatility Estimate	.0209	.0228
Median Volatility Estimate	.0194	.0205
Mean Lag 1 Autocorrelation	0.206	0.387
Mean Correlation Across Methods	0.493	Na
Indian Index (BSE)		
Mean Volatility Estimate	.0123	.0078
Median Volatility Estimate	.0117	.0076
Mean Lag 1 Autocorrelation	0.184	0.383
Mean Correlation Across Methods	0.492	Na
U.S. Index (S&P 500)		
Mean Volatility Estimate	.0048	.0049
Median Volatility Estimate	.0045	.0046
Mean Lag 1 Autocorrelation	-0.010	0.220
Mean Correlation Across Methods	0.657	Na
European Index (Bloomberg)		
Mean Volatility Estimate	.0057	Na
Median Volatility Estimate	.0058	Na
Mean Lag 1 Autocorrelation	-0.049	Na
Mean Correlation Across Methods	Na	Na

* CEMY estimates are the square roots of the $V_{i,t}$ in equation (1). Parkinson estimates are as given by equation (2).

Table 4

Tests of the Hypothesis that Mean Daily Volatility is Stable over Long and Short Horizons Surrounding the Issuance of Global Depositary Receipts

$$Vol_{i,t} = a_1 * Before + a_2 * Event_1 + a_3 * Event_2 + a_4 * After + d * Vol_{i,t-1} + \varepsilon_{i,t}$$

Method/Firms	*Mean and Median Coefficient Estimates*				*Mean and Median p-values from Tests of the Hypotheses that*			
	a_1	a_2	a_3	a_4	$a_1 = a_2$	$a_2 = a_3$	$a_3 = a_4$	$a_1 = a_4$
CEMY								
Indian Firms in Sample	.0177	.0174	.0167	.0157	.313	.354	.284	.238
	.0168	.0151	.0148	.0155	.163	.293	.166	.054
Indian Index (BSE)	.0134	.0129	.0117	.0109	.174	.326	.231	.154
	.0135	.0111	.0103	.0106	.056	.213	.098	.022
U.S. Index (S&P 500)	.0046	.0053	.0050	.0049	.292	.461	.328	.321
	.0044	.0048	.0048	.0047	.159	.465	.218	.143
European Index (Bloomberg)	.0060	.0059	.0058	.0055	.419	.423	.349	.236
	.0061	.0058	.0060	.0055	.455	.475	.288	.189
Parkinson								
Indian Firms in Sample	.0155	.0159	.0148	.0137	.232	.348	.324	.181
	.0138	.0133	.0128	.0123	.124	.208	.178	.034
Indian Index (BSE)	.0082	.0079	.0108	.0072	.087	.282	.179	.032
	.0084	.0066	.0062	.0061	.003	.143	.055	.000
U.S. Index (S&P 500)	.0046	.0050	.0049	.0050	.389	.227	.268	.337
	.0046	.0048	.0049	.0047	.242	.146	.188	.164
European Index (Bloomberg)	Na	Na	Na	Na	Na	Na	Na	Na

Table 5

Tests of the Hypothesis that Mean Daily Overnight Volatility is Stable over Long and Short Horizons Surrounding the Issuance of Global Depositary Receipts

$$Vol_{i,t} = a_1 * Before + a_2 * Event_1 + a_3 * Event_2 + a_4 * After + d * Vol_{i,t-1} + \varepsilon_{i,t}$$

Method/Firms	*Mean and Median Coefficient Estimates*				*Mean and Median p-values from Tests of the Hypotheses that*			
	a_1	**a_2**	**a_3**	**a_4**	**$a_1 = a_2$**	**$a_2 = a_3$**	**$a_3 = a_4$**	**$a_1 = a_4$**
Parkinson (Overnight)								
Indian Firms in Sample	.0131	.0124	.0121	.0115	.316	.375	.338	.284
	.0111	.0094	.0102	.0097	.142	.357	.279	.141
Indian Index (BSE)	.0055	.0048	.0042	.0036	.177	.271	.142	.063
	.0058	.0036	.0038	.0036	.008	.210	.050	.003
U.S. Index (S&P 500)	.0004	.0005	.0004	.0004	.385	.497	.382	.459
	.0003	.0003	.0003	.0003	.307	.479	.344	.455
European Index (Bloomberg)	Na	Na	Na	Na	Na	Na	Na	Na

Table 6

Summary of Direction and Significance of Permanent Volatility Shifts among Indian Firms that Issue GDRs, Compared with Shifts in Volatility of Market Indexes in India, the United States, and Europe

	Method of Estimating Volatility		
Sample	***CEMY***	***Parkinson (Trading)***	***Parkinson (Overnight)***
Indian Firms in Sample			
Number of Significant Differences (.10 level)	36**	37**	28**
Significant Negative Differences	27**	29**	22**
Indian Index (BSE)			
Number of Significant Differences (.10 level)	37**	57**	48**
Significant Negative Differences	32**	44**	47**
U.S. Index (S&P 500)			
Number of Significant Differences (.10 level)	25**	29**	11**
Significant Negative Differences	8*	3**	5
European Index (Bloomberg)			
Number of Significant Differences (.10 level)	18**	Na	Na
Significant Negative Differences	14**	Na	Na

In 60 independent experiments, the expected number of differences between pre- and post-issue period volatilities that are significant at the .10 level is 6. If a difference is significant and the movement is random, approximately half of the differences should be positive and half negative. Double (single) asterisks, ** (*), in the table indicate rejection of those hypotheses at the .05 (.10) level.

Table 7

Tests of the Hypothesis that with Constant Mean Effects and after Controlling for Movements in the Local Index, Daily Volatility of Indian Stock Prices is Equally Sensitive to Volatility in the United States or Europe before and after Indian Firms Issue Global Depository Receipts

$$Vol_{i,t} = \bar{a} + b^{bef} * Before * Vol_{j,t-1} + b^{aft} * After * Vol_{j,t-1} + c * Vol_{BSE,t} + d * Vol_{i,t-1} + \varepsilon_{i,t}$$

	Mean and Median Coefficient Estimates				***Mean and Median p-values from tests of the Hypotheses that***				
Sample*/*Method	b^{bef}	b^{aft}	c	d	$b^{bef} = 0$	$b^{aft} = 0$	c = 0	d = 0	$b^{bef} = b^{aft}$
j = S&P 500									
CEMY	.109 .067	-.044 -.075	.529 .518	.165 .157	.423 .400	.374 .307	.070 .000	.093 .019	.328 .283
Parkinson	-.100 .074	-.251 -.185	.574 .502	.314 .323	.278 .197	.326 .225	.128 .003	.007 .000	.202 .052
j = European Index (Lagged Only)									
CEMY	.102 .125	-.038 -.067	.529 .525	.164 .153	.365 .268	.408 .360	.084 .000	.098 .020	.370 .247
Parkinson	Na	Na	Na	Na	Na	Na	Na	Na	Na
j = European Index (Sum of Lagged and Concurrent)									
CEMY	.282 .283	.129 .059	.510 .486	.168 .149	.314 .238	.380 .397	.101 .000	.102 .024	.316 .208
Parkinson	Na	Na	Na	Na	Na	Na	Na	Na	Na

Table 8

Relative Ranks of Firm-Specific Volatilities Across Four Subperiods Before and After the Issue of GDRs by Indian Firms

Number of Times Volatility is Ranked	***Subperiod***			
	First	***Second***	***Third***	***Fourth***
Highest	**21**	16	14	8
Second Highest	15	**18**	11	15
Third Highest	13	13	**23**	10
Lowest	11	13	12	**26**

Table 9

Tests of the Hypothesis that Firm-Specific Changes in Volatilities Relate to Firm-Specific Changes in Firm Profile Variables, to a Market Timing Variable, and to Issue Period Standardized Abnormal Volatility

$$\Delta Sd_i = Rule144A + \mathrm{Reg}\,S + Tandem + \lambda * \Delta Lev_i + \kappa * \Delta \mathrm{Prof}_i + \theta * \mathrm{Re}lindex_i + \phi * Seq_i + \nu * pos * ABSd_i + \pi * neg * ABSd_i + \varepsilon_i$$

Coefficient Estimates (White's (1980) t-statistics)									
Rule 144A	*Reg S*	*Tandem*	λ	κ	θ	φ	ν	π	*Adjusted* R^2 *(N)*
-.0027 (-3.07)**	-.0005 (-0.29)	-.0021 (-1.87)*							-.013 (60)
-.0035 (-3.87)**	.0007 (0.31)	-.0024 (-2.11)**	-.0017 (-2.47)**						.064 (50)
-.0028 (-3.06)**	.0016 (0.66)	-.0021 (-1.88)*		-.0009 (-3.43)**					.049 (51)
.0038 (1.13)	.0056 (1.84)*	.0040 (1.22)			-.0049 (-1.92)*				.021 (60)
-.0048 (-3.97)**	-.0021 (-1.10)	-.0053 (-2.48)**				.0001 (1.77)*			.013 (60)
-.0025 (-2.47)**	-.0002 (-0.13)	-.0020 (-1.72)*					-.0001 (-0.30)	-.0082 (-0.82)	-.039 (60)
.0019 (0.48)	.0063 (1.41)	.0012 (0.29)	-.0018 (-2.61)**	-.0008 (-2.01)**	-.0052 (-1.99)**	.0001 (1.59)	-.0007 (-1.00)	-.0011 (-1.15)	.134 (50)

Figure 1. Comparisons between Indian Stock Price Movements and Movements in European and World Indexes. Data for the Bombay "Sensex" Exchange come from the PROWESS data base maintained by the Center for Monitoring Indian Economy (CMIE) in Bombay. Data for the European and World Indexes and for exchange rates to convert Indian Rupees to US dollars comes from Bloomberg. The indexes use price levels as of December 31, 1991 as a base (i.e., as 100). This date follows the inception of the New Industrial Policy in India by approximately six months.

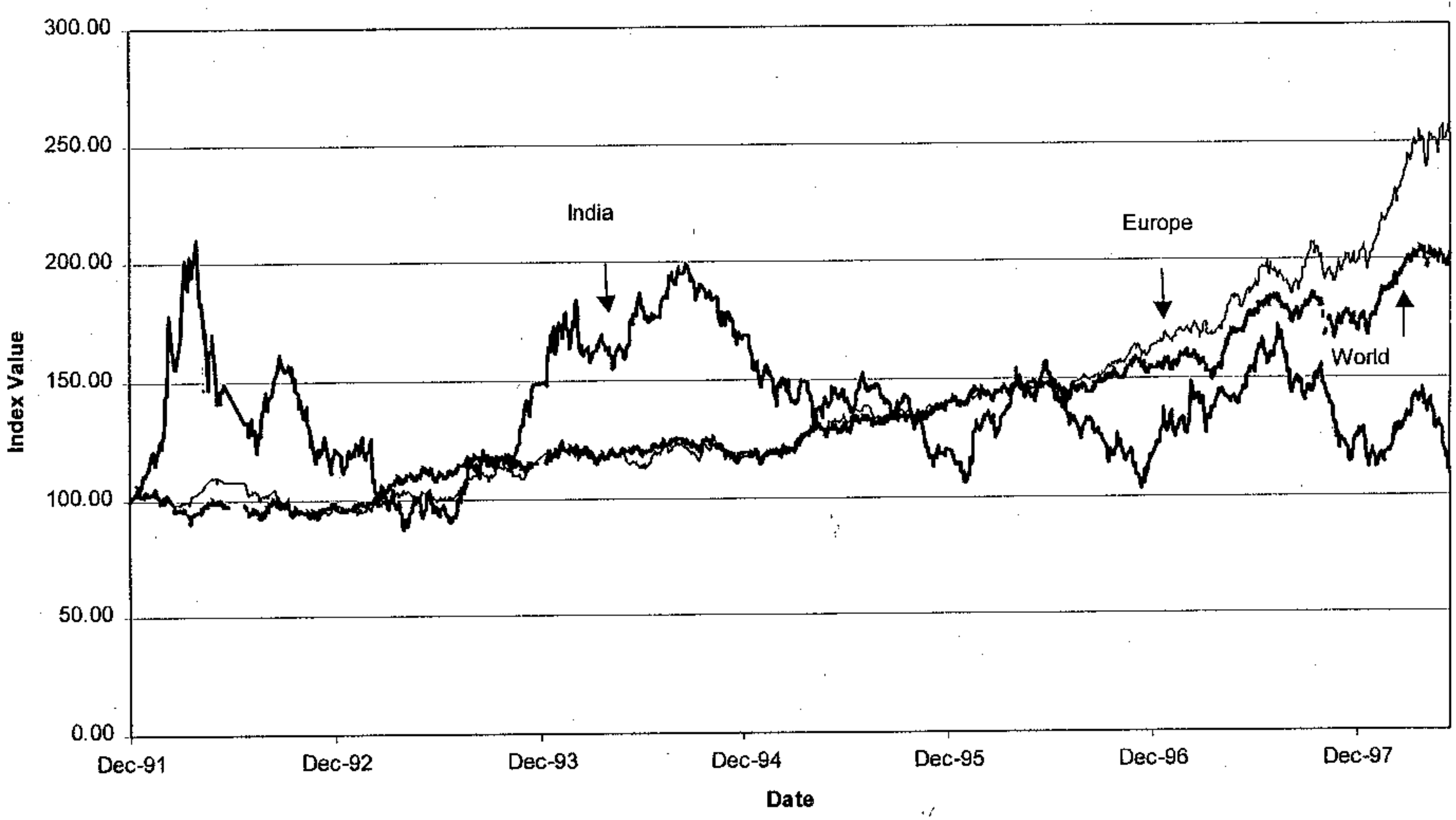


Figure 2

Trading Times of Indian and US Markets and European DOSM Expressed in Indian Standard Time

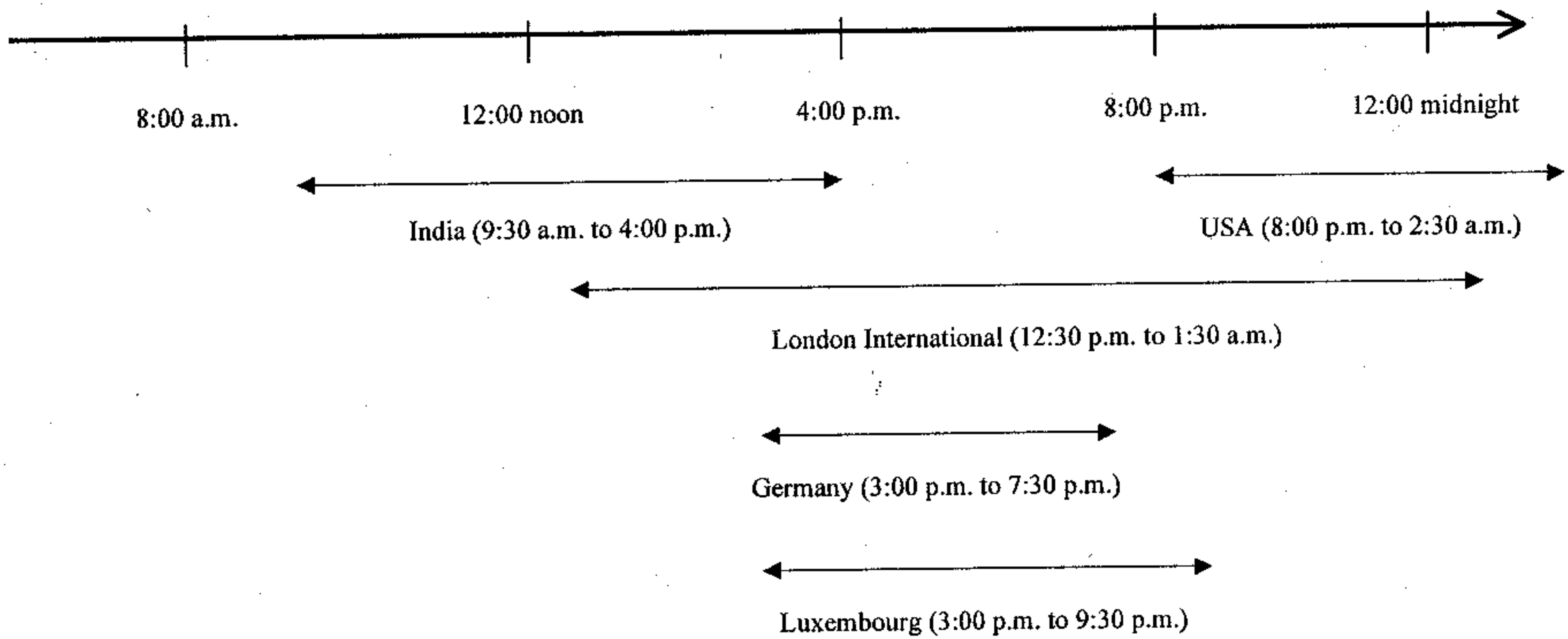


Figure 3
Mean CEMY Estimates of Volatility In Trading Time
Relative to the Issue of GDRs by Indian Firms

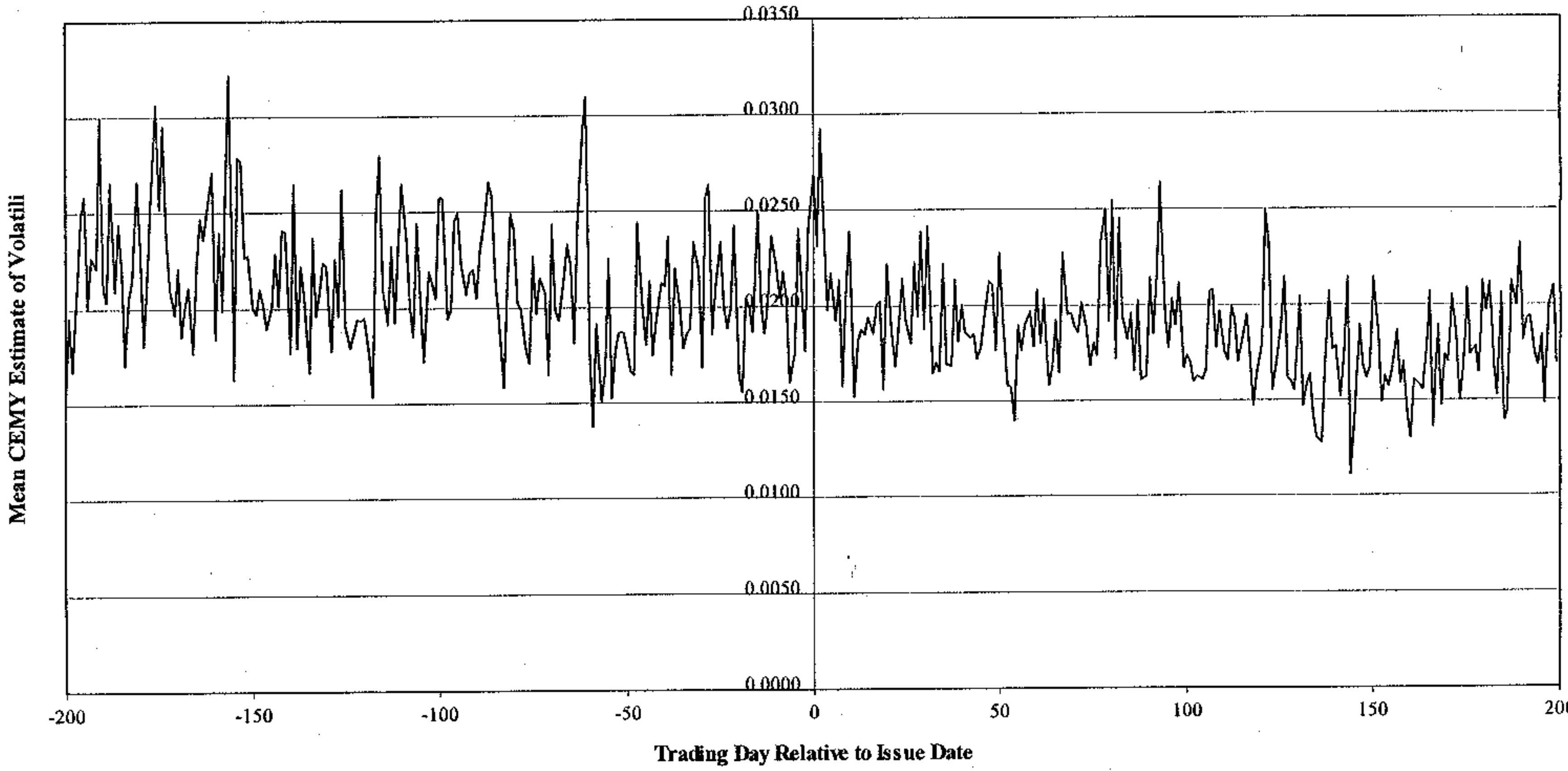


Figure 4
Mean Parkinson Estimate of Volatility in Trading Time
Relative to the Issue of GDRs by Indian Firms

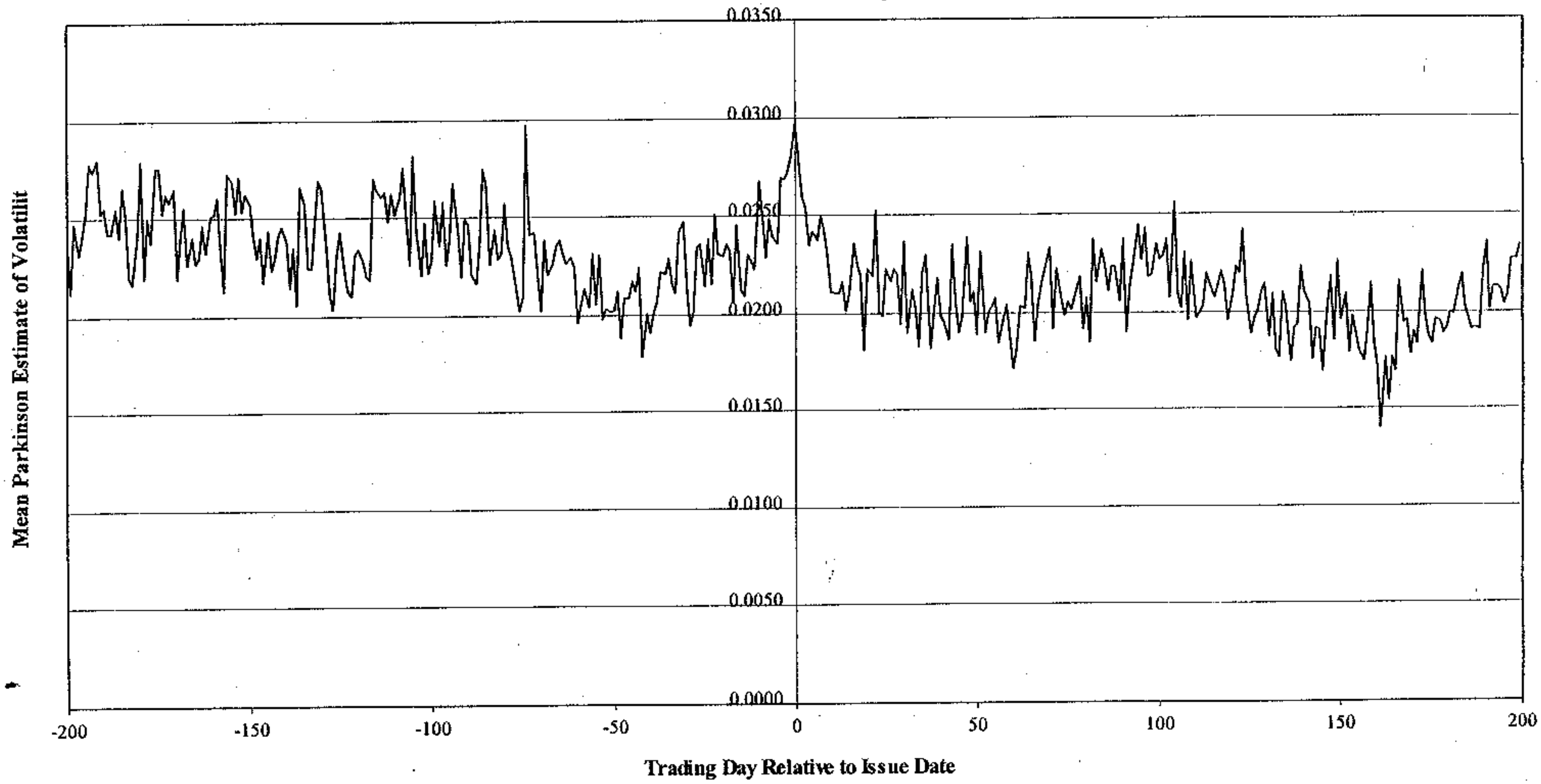
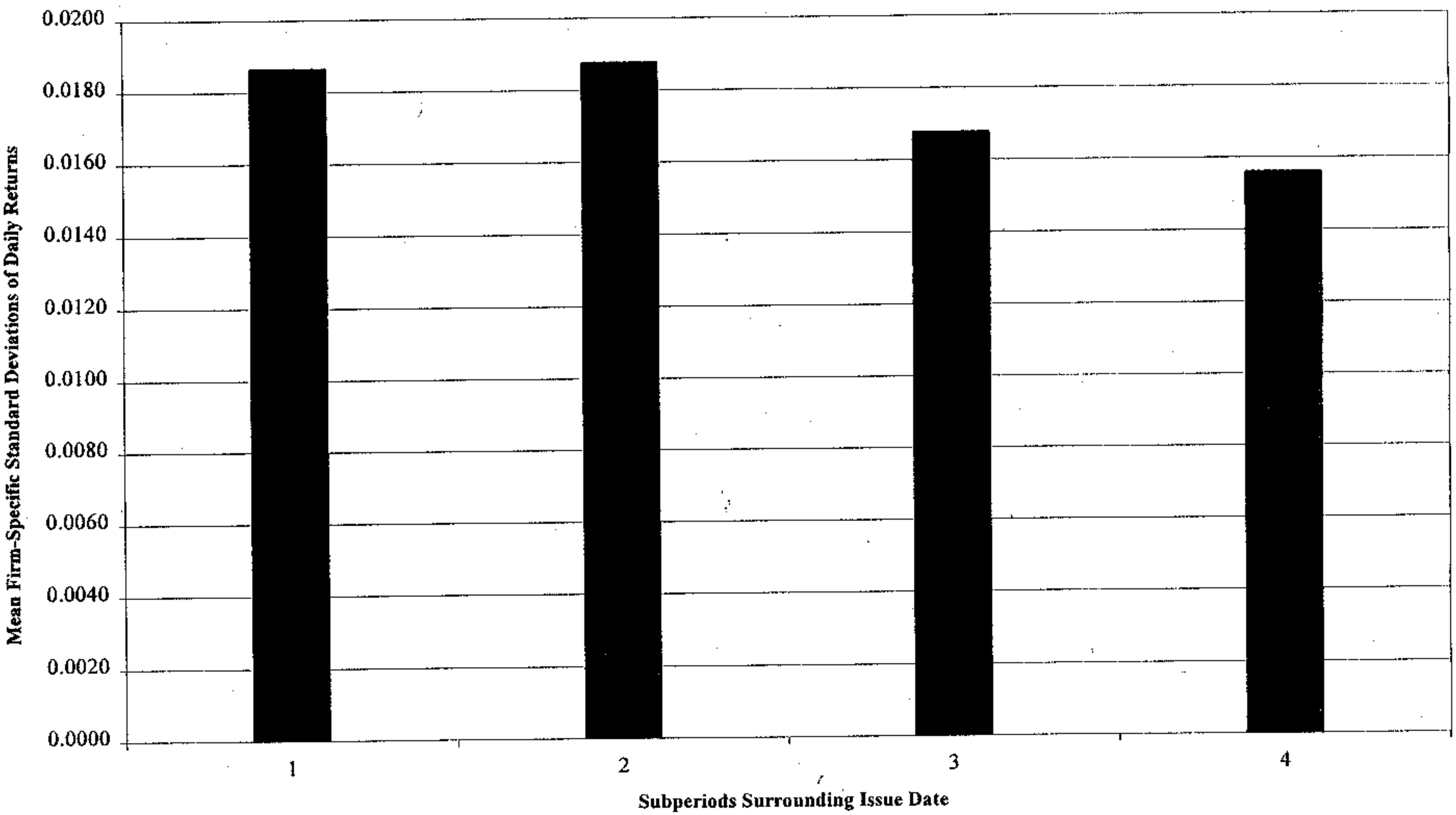


Figure 5
Mean Estimates of Firm-Specific Standard Deviations of Daily Returns for Indian Firms that Issued GDRs in Four Subperiods Surrounding the Issue Date



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END NOTES

1. The next most frequent issuers account for only 7.65% (Taiwan) of the equity GDRs issued under Rule 144A. These statistics are taken from the Bank of New York's comprehensive listing of all GDRs issued through July 1998 and from Bethel and Sirri (1998). Bethel and Sirri (p. 31) report that securities sold in the private markets in 1991 accounted for only 2% of the securities sold in public markets. By 1997, Rule 144A issues had catapulted to 20% of the dollar amount of issues sold in public markets. Between 1991 and 1997, the aggregate dollar volume of 144A debt issues was 591.4 billion. Chaplinsky and Ramchand (2000) analyze Rule 144A issues of foreign and domestic debt. The aggregate dollar volume for common equity was 27.0 billion dollars. Indian GDRs account for about 22% of that dollar volume.

2. Jayaraman, Shastri, and Tandon (1993) document increased volatility after foreign firms issue ADRs. They argue, based on a model they cite by Freedman (1989), that cross listings allow informed traders to trade on long-lived information in multiple markets. Though the increased trade in Freedman's analysis increases volatility, it is, nonetheless, good because it improves market efficiency. Whereas Jayaraman et al. study ADRs issued predominantly by English and Japanese firms, we examine Rule 144A and Regulation S GDRs issued exclusively by Indian firms.

3. Efficient markets should process information on announcement (not issue) dates. However, information regarding terms of GDR issues is often not revealed until just before the issue date. Thus, our use of issue dates is not incompatible with market efficiency. Conrad (1989) also finds that most of the stock price response to option introductions in the U.S. occurs when options are actually introduced, rather than when they are announced.

4. See "Depositary Receipts: Citibank 1999 Year-End Review" and the Bank of New York DR summary.

5. The discussion in this section closely follows Bethel and Sirri (1998) and Bloomenthal (1998). Broadly defined, QIBs are 1) institutional investors whose *own* securities portfolios equal at least $100 million, 2) banks and savings and loans that, besides the $100 million portfolio requirement, also have $25 million or more in net assets, and 3) securities dealers registered under the Exchange Act who have at least a $10 million portfolio. An entity wholly owned by any QIB, except a bank or insurance company, is also a QIB.

6. These markets include Amsterdam, Australia, Brussels, Frankfurt, Hong Kong, London International (not the London Stock Exchange), Johannesburg, Luxembourg, Milan, Montreal, Paris, Stockholm, Tokyo, Toronto, Vancouver, and Zurich.

7. Physical settlements occur through the Clearing House, while book-entry settlements occur through depositaries. Funds settlements take place through designated clearing banks. The Clearing Corporation strictly enforces penalties for the noncompliance with settlement procedures. These details come from various publications of the Securities and Exchange Board of India

8. See Business Line; Jan. 27, 2000 and Economic Times; Oct. 5, 1999.

9. Because these Foreign Institutional Investors are from all over the world, the actual number of U.S. Foreign Institutional Investor's that qualify to be QIBs must be significantly less than 200.

10. Fifty firms in our sample issued one GDR; five firms issued two. There were 11 issues by conglomerates and 11 by textile firms. There were five issues by automotive companies and five by chemical firms. There were four issues by

pharmaceutical firms and four by telecommunications firms. The fertilizer, hotel, and mining industries each had three events in the sample. No other industry had more than one event.

11. Though there is a clustering of GDR issues in the event years, there is no similar clustering across months, or days of the month as documented by Korajczyk, Lucas, and McDonald (1991) for U.S. offerings.

12. On average, for the 60 firms in our sample, 486 business days are needed to get the 401 trading days for the analysis. The additional 85 days, which came from adjustments for holidays in the Indian, European, and U.S. markets and from nontrading in India, were not uniformly spaced across the 401 observation interval. One firm had a gap of 29 business days between two observations with return data. Though that was the largest gap in our sample, over half the sample had at least two successive return observations separated by nine business days.

13. Variations of Parkinson's estimator are discussed in Garman and Klass (1980), Ball and Torous (1984), and Kunitomo (1992).

14. Annualized standard deviations equal .3304 and .3605 for the CEMY and Parkinson methods, respectively. By comparison, BH estimate the annualized standard deviation for India to be .2716. Since our estimates are for individual securities and their estimate is for a portfolio, our estimates are consistent with their estimate.

15. Using issue-date abnormal returns, Pinegar and Ravichandran (1999) argue that this effect reflects at least a partial resolution of information asymmetries between Indian firms and international and home-market investors.

16. The results are qualitatively the same when we use only a 10-day window before and after the issue date.

17. Karolyi and Stulz (1996) find that the size of the market movement influences correlations across markets. Therefore, we also run regression (4) for each firm using only the quartile of the largest lagged volatility estimates from the U.S. and European indexes. The mean (median) p-values for tests of the hypothesis that Indian firms became more susceptible to large shocks from the U.S. or European markets after the GDRs were issued are .34, .39, and .36 (.28, .32, and .29) for the Parkinson, CEMY (U.S.), and CEMY (European) methods, respectively. Thus, the post-issue susceptibility to large shocks from foreign markets is insignificantly different from the pre-issue susceptibility for most firms in our sample.

18. These findings contrast with findings in Ramchand and Sethapakdi (2000) who report that the domestic (foreign) component of systematic risk decreases (increases) following global equity issues by U.S. firms. Ramchand and Sethapakdi interpret their evidence to be consistent with market segmentation hypotheses. Though the Indian market is undoubtedly segmented from other world capital markets, our evidence is more consistent with the hypothesis that GDR issues help Indian firms resolve firm-specific information asymmetries.

19. Instead of market model regressions, we also estimate changes in firm-specific volatilities by adding time-varying volatilities of the local index, $Vol_{BSE,t}$ to regression (3) and comparing a_4 and a_1. Using this approach, we detect 25 (33) significant differences with the CEMY (Parkinson) method, 18 (22) of which are negative. Thus, these results are generally consistent with the results based on market model regressions.

20. Dividing "Before" and "After" into three, as opposed to two, periods each provides stronger evidence of a pre-issue decline. However, if early issues by some firms cause the market to anticipate future issues by other firms, even a pre-issue decline may be consistent with the hypothesis that the decline is associated with the GDR issue. The clustering in our sample makes this argument all the more plausible if partial anticipation influences volatilities.