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Does ADR Listing Affect the Dynamics of Volatility in Emerging Markets?*

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Abstract
This paper analyzes the time-series variation in the return volatility of non-US stocks from emerging markets that are cross-listed on US exchanges. Unlike previous studies in the cross-listing literature, return volatility is modeled using conditional heteroscedasticity models. We find that firms' exposure to risks such as local and global market betas remain unchanged after cross-listing. Moreover, we do not identify notable changes in the dynamics of the volatility of cross-listed stocks after cross-listing except for leverage effects. We further show that the mean level of conditional variance is not affected after cross-listing. Thus, our results provide counter-evidence to the belief that foreign investor participation drives volatility upward.

1. Introduction

An ongoing debate exists among financial economists over the effects of financial liberalization on volatility in emerging markets. On the one hand, some researchers claim that foreign fund flows are very sensitive to slight changes in local factors; thus they drive volatility upward (Jayaraman et al., 1993; and Bae et al., 2004). On the other hand, some studies show that foreign investor participation has no significant impact on return volatility (Howe and Madura, 1990; Kim and Signal, 2000; and Bekaert and Harvey, 2000) and some studies present evidence of volatility reduction after liberalization (De Santis and İmrohoroğlu, 1997; Hargis, 2002). A way of liberalization at the firm level is the cross-listing of local stocks on international equity markets. International cross-listing is the simultaneous listing of local stocks on multiple stock exchanges and serves as indirect liberalization at the firm level. It also enables foreign investors to own local stocks without investing directly in local stock exchanges. If a firm cross-lists its stock on the organized or over-the-counter markets in the USA, then this kind of cross-listing is named American Depository Receipt (ADR) listing.

A body of literature focuses on this indirect liberalization, which is inherent in cross-listed stocks and analyzes the effect of cross-listing on the risk characteristics of the underlying stocks. However, the net impact is not obvious for several reasons. For instance, Domowitz et al. (1998) theoretically show that cross-listing may have either an increasing or decreasing impact on price volatility depending on the trans-

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parency of inter-market informational linkages where inter-market information is costly. With freely available price information, the international markets are tractable by foreign investors. This increases the total number of traders in both markets, which, in turn, reduces bid-ask spread, increases market liquidity, and thus reduces volatility. If information linkages are imperfect, investors will migrate to the international market. The decrease in the number of traders in the local market reduces liquidity and increases bid-ask spread and volatility. Consistent with the information-linkage theory of Domowitz et al. (1998), empirical studies document mixed results. Coppejans and Domowitz (2000), Ejara and Ghosh (2004), and Bayar and Onder (2005) provide evidence in favor of increased price volatility of underlying stocks after listing. Jayaraman et al. (1993) find that the return variances of ADR-issuing stocks are higher after listing, even after they are adjusted for market volatility, for the October 1987 crash, and for possible changes in return-generating processes.[1] Conversely, Howe and Madura (1990), Lau et al. (1994), and Martell et al. (1999) report no significant change in the overall stock return variance of listed firms.

As far as systematic risk is concerned, cross-listing may also cause change in risk exposures if the domestic market is segmented from global capital markets. Karolyi (1998) discusses that the systematic risk is composed of not only local systematic risk (local beta), but also global systematic risk (global beta) for cross-listed stocks. Observed positive abnormal returns around cross-listing are interpreted to be driven by reduced cost of capital as a consequence of a decline in systematic risk (Miller, 1999; Errunza and Miller, 2000). As the cross-listed stocks get integrated with global markets, exposure to global market fluctuations may increase and the role of local factors may diminish. Conceivably, Ramchand and Sethapakdi (2000) report a dampened local market beta and an increased global market beta with a net decline in the cost of capital after cross-listing, while Foerster and Karolyi (1999) document that the local market beta declines and the global market beta remains stable in the post-listing period for their overall ADR sample. Alternatively, a cross-listing program may lead to positive abnormal returns because of extended growth opportunities stemming from a new legal and regulatory environment facilitating easy access to outside capital markets without an accompanying change in risk exposures (Lee, 2002). In agreement with the discussion of Lee (2002), Jayaraman et al. (1993) find no systematic change in the local and US market beta and Sarkissian and Schill (2009) report insignificant changes in the local market beta from the pre- to the post-listing period in the presence of positive abnormal returns. Thus, risk exposures may either increase or decrease or remain unchanged after cross-listing, depending on the mechanism that causes stock prices to rise around cross-listing.

The investigation of the behavior of firm-specific variation or idiosyncratic risk around ADR listing is another focus of concern for researchers examining the risk characteristics of the underlying stocks. ADR listing may alter the information environment and the amount of firm-specific information available to outsiders due to an enhanced level of disclosure in compliance with the US Securities and Exchange Commission (SEC) regulations and US Generally Accepted Accounting Principles (GAAP). Roll (1988) suggests that incorporation of more firm-specific information

[1] This finding is attributed to the additional information revealed during the increased trading time associated with the cross-listing.

into prices manifests itself as a higher level of idiosyncratic volatility. On the other hand, Dasgupta et al. (2009) discuss that market participants will have more accurate predictions about the future of the firm in an improved information environment with more firm-specific information available. Thus, the surprise part of stock returns diminishes, which suggests a decline in idiosyncratic volatility. Moreover, the commitment to a high level of disclosure associated with ADR listing may discourage the investors to collect firm-specific information, causing less private information to be incorporated into stock prices, and thus resulting in a lower level of idiosyncratic volatility (Fernandes and Ferreira, 2008). For instance, the extended analyst coverage with cross-listing (Lang et al., 2003) may trigger the production of market and/or industry-wide information rather than firm-specific information and lead to reduced idiosyncratic volatility (Chan and Hameed, 2006). Consistent with the opposite implications of the competing discussions about the effects of the improved information environment on idiosyncratic volatility, Fernandes and Ferreira (2008) show that the relationship between ADR listing and idiosyncratic volatility is not uniform and depends on the development stage of a country. ADR listing increases firm-specific stock-return variation in developed markets, whereas it causes a decline in emerging markets. Overall, the theoretical arguments for the impact of cross-listing on several risk characteristics provide mixed implications and therefore empirical investigation is needed to clarify these issues.[2]

In this paper, we study the impact of a particular liberalization at the firm level, namely, American Depository Receipt (ADR) issuance, on the risk characteristics of underlying stocks in a time-series framework. Whereas a large body of literature deals with stock price reaction to cross-listing,[3] in this study we concentrate on the risk implications of ADR listing. Specifically, we examine the changes in risk exposures, volatility dynamics, and the mean level of the conditional volatility of ADR-issued stocks from several emerging markets.

Our study extends the previous literature in several ways. First, we propose time-series methods to examine whether or not cross-listed stocks experience return volatility changes after their listing. Neglecting the time variation in return volatility may result in model misspecification and inefficient estimates. We employ EGARCH models in volatility specifications to model the volatility clustering observed in the data. Although some previous studies examine the return volatility of a market index using the GARCH family of models at the aggregate level, this is the first study to examine the return volatilities of ADR-issuing stocks in a time-series setting at the firm level. We first estimate the conditional volatility models before and after the listing and search for differences in the local and global market beta. Next, we extend the literature by investigating the coefficients of the conditional volatility equation of the cross-listed stocks over the pre- and post-listing periods. Thus, we can observe the changes in the dynamics of volatility. Finally, we investigate the changes in systematic risks and conditional volatility around ADR initiations, simultaneously, for the whole period for each firm, by using the ADR-listing dummy. We find no systematic impact of ADR listing on the risk exposures, volatility dynamics, and

[2] A brief review of the literature with major findings can be found in *Table 1*.

[3] See Alexander et al. (1988), Doidge et al. (2004), Errunza and Miller (2000), Miller (1999), and Varela and Lee (1993).

Table 1 A Review of Cross-listing Studies

Panel A	***Studies on Risk Exposures and Total Variance of Returns***			
Research Study	*Local Beta*	*Global Beta*	*Variance of Returns*	*Other Findings*
Howe and Madura (1990)	decrease	increase	no change	
Jayaraman et al. (1993)	no change	increase	increase	Positive abnormal returns on the day of listing.
Lau et al. (1994)			no change	Abnormal returns are positive around the acceptance date but negative during the listing and post-listing period.
Martell et al. (1999)			no change	The cumulative average excess returns increases in the 2-month prior the introduction date and exhibits a downward trend thereafter.
Foerster and Karolyi (1999)	decrease	no change	-	Positive abnormal returns after cross-listing.
Ramchand and Sethapakdi (2000)	decrease	increase	-	A decline in the cost of capital.
Sarkissian and Schill (2009)	no change	-	-	Large transitory abnormal returns around the listing, and economically significant cost of capital gains over the five to-ten year period after the listing.
Korczak and Bohl (2005)	increase	decrease	-	Improvement in market value, liquidity and price efficiency.
Panel B	***Information Environment of Cross-listed Stocks***			
Research Study	*Idiosyncratic Volatility*	*Information Environment*	*Analyst Coverage*	*Other Findings*
Lang et al. (2003)	-	improve	increase	Increased forecast accuracy, enhanced firm value.
Fernandes and Ferreira (2008)	increase	improve	increase	Cross-listing increases idiosyncratic volatility in developed markets, whereas it reduces it in emerging markets.
Dasgupta et al. (2009)	decrease	improve	-	
Panel C	***Market Quality Effects of Cross-listing***			
Research Study	*Price Volatility*	*Trading Volume*	*Liquidity*	*Other Findings*
Domowitz et al. (1998)	increase	increase	decrease	The effect of ADR listing on liquidity and volatility in the domestic market depends on the degree of quotation transparency between the domestic and the U.S. markets.
Coppejeans and Domowitz (2000)	increase	-	-	The increase in volatility is partly due to increases in volume traded in domestic market following listing and partly due to increase in the volatility of information.
Ejera and Ghosh (2004)	increase	increase	increase	Emerging market stocks gain relatively more than developed stock markets in terms of trading volume and liquidity.
Bayar and Onder (2005)	increase	decrease	decrease	Lack of integration between French and German capital markets.

the mean level of conditional volatility of the underlying stocks. These findings suggest that ADR-issuing firms do not experience adverse volatility effects.

The remaining part of the paper proceeds as follows. Section two provides an overview of ADRs and their properties. Section three describes the data and presents preliminary statistics. Section four offers the methodology performed in each sub-period, separately. Section five extends the methodology to analyze the changes in the mean level of conditional volatility; and, finally, section six concludes the paper.

2. Background on ADRs

As our entire sample consists of ADRs, we provide some of their characteristics for a clear understanding of the data. ADRs are negotiable certificates that are listed on organized exchanges or on the over-the-counter markets in the USA. An ADR holder obtains ownership of shares of the foreign firms traded in their local markets. Thus, an ADR holder has all the rights (such as dividend and voting rights) that result from ownership of the shares. ADRs are treated as US securities, which are denominated and pay dividends in US dollars.[4]

There are several types of ADR programs. A Level I ADR program is the easiest way to access US capital markets because establishment of this program does not require full US Securities and Exchange Commission (SEC) registration or compliance with US Generally Accepted Accounting Principles (GAAP). Level I ADRs are traded on the over-the-counter (OTC) market. Level II and Level III ADRs are traded on organized stock exchanges such as NYSE, AMEX, and NASDAQ. Both Level II and Level III ADR programs require SEC disclosure and compliance with US GAAP. While Level III ADR programs are for raising capital, Level I and Level II ADR programs do not involve raising capital.[5]

ADR programs provide some advantages to both issuers and holders. From the ADR issuer's point of view, expanded market share, increased investor recognition, increased liquidity, and cheaper access to international markets can be major benefits. Holders can benefit from ADRs by eliminating the expense and complexities of investing directly in markets other than in the USA and diversifying their portfolio internationally. However, ADR-issuing firms may experience an increase in their stock-return volatility and/or risk exposures such as market betas after listing. An increase in market betas is an important issue for firms since it hurts them by increasing their cost of capital. Errunza and Miller (2000) mention that high equilibrium expected returns in the pre-liberalization period indicate a high cost of capital in an international asset-pricing framework. By using similar arguments, Ramchand and Sethapakdi (2000) argue that global equity issuance can make the underlying stocks less sensitive to domestic systematic risk (local beta) and more sensitive to foreign systematic risk (global beta) and state that changes in systematic risk are important because they affect the required rate of return on equity and hence the firm's cost of

[4] ADRs are created through the following process. First a broker purchases a non-US company's stocks in the local stock market. These stocks are submitted to the depositary's local custodian bank. Then depositary banks (such as Citibank or the Bank of New York) issue receipts (ADRs) against the underlying local shares on the US exchanges or on the over-the-counter markets.

[5] Another way of accessing US capital markets is through SEC Rule 144A or Regulation S Depositary Receipts. Both Rule 144A and Regulation S programs are capital raising programs. The trades for the 144A program take place through the PORTAL quote system, whereas the Regulation S program allows capital to be raised through the placement of depository receipts offshore with non-US investors. More information about ADRs can be found on the web site of the Bank of New York. (www.adrbny.com).

capital. Therefore, searching for the effects of ADR listing on the risk characteristics of stock returns has important implications.

3. Data and Diagnostics

Our data set consists of the first-time ADR listings of 14 emerging markets from 1990–2007. We use an event window of a minimum of 260 days (130 days before and after ADR listing) taking the issuance date as the event date. The event window is extended up to 520 days depending on available data. The ADR data set is obtained from the Bank of New York and contains a complete list of ADRs with information on the country, industry, type of depositary receipt, and effective date.[6] The data on daily closing prices for underlying shares of the local market, local market index return, and global market index return are obtained from *Datastream*. To construct our sample, we screened our data in the following ways. First, the issue of the first-time depository receipt listing in the USA was considered in order to capture the effects of the initiation of foreign investment on the underlying securities. Second, firms that are not tracked by *Datastream* or do not have daily closing price information covering the event window are dropped from the sample. We performed diagnostic tests to detect volatility clustering and included only those firms that exhibit time variation in volatility. Volatility clustering is detected by performing autocorrelation tests on the residuals of the following international asset-pricing model, through Ljung-Box Q-statistics.

$$R_t = \beta_0 + \beta_1 R_{L_t} + \beta_2 R_{M_t} + \varepsilon_t \quad (1)$$

where R_t is the daily log return of the underlying stock, R_{Lt} is the daily log return of the local market index, and R_{Mt} is the daily log return of the world market index. In regression equation (1), the returns of each ADR-issuing firm are regressed on both the local and world market index returns under the assumption of normality. Here, β_1 and β_2 are the slope coefficients for local return and global return and act as the domestic systematic risk and foreign systematic risk, respectively. Lastly, β_0 is the intercept and ε_t is the error term.

Some summary statistics describing our final sample are provided in *Table 2*. Our sample consists of 173 stocks from 14 emerging markets with 94 stocks in Asia, 58 stocks in Latin America, and 21 stocks in Eastern Europe. The ADR listings cover a wide range of industries and are concentrated between 1999 and 2004, which is a relatively stable period in emerging markets.[7] Most of the listings take place through the 144A program on PORTAL. This may be due to the fact that the 144A program is a way of raising capital which does not require SEC disclosure and GAAP reporting. The mean level of market capitalization of the cross-listed firms in our sample is \$3,115 million, suggesting that the ADR-issuing firms are big. The distribution of market capitalization is positively skewed with a median of \$1,322 million. This indicates that there are some firms with extreme market capitalization values, which is also evident from the maximum value of \$43,744 million.

[6] Effective dates correspond to ADR-listing dates and are used as event dates.

[7] See Umutlu et al. (2010) for an analysis of volatility in emerging markets.

Table 2 Summary Statistics

Panel A ***Distribution by Industry***		***Panel B*** ***Distribution by Country***		***Panel C*** ***Distribution by Year***	
Industry	Frequency	Country	Frequency	Listing Year	Frequency
Aerospace & Defense	1	Argentina	7	1991	4
Automobiles & Parts	4	Brazil	29	1992	5
Construction & Materials	8	Chile	3	1993	6
Electricity & Equipments	10	Greece	5	1994	7
Telecommunications	11	Hungary	6	1995	8
Food Producers & Beverages	10	Indonesia	3	1996	9
Forestry & Paper	3	Korea	19	1997	14
General Finance	19	Malaysia	8	1998	9
General Retailers	5	Mexico	19	1999	17
Household & Personal Goods	7	Philippines	5	2000	21
General Industrials	26	Poland	3	2001	11
Media	4	Singapore	12	2002	12
Oil & Gas Producers	7	Taiwan	47	2003	20
Real Estate	5	Turkey	7	2004	9
Pharm., Biotech. & Chem.	5			2005	7
Tech. Hardware, Equip.	35			2006	7
Travel, Leisure & Goods	13			2007	7

Panel D ***Distribution by Listing Exchange***		***Panel E*** ***Distribution by Type of ADR***		***Panel F*** ***Market Cap. ($millions)***	
Listing Exchange	Frequency	Type of ADR	Frequency	Descriptive Statistics	
NYSE	40	Level I	44	Mean	3115.51
NASDAQ	10	Level II	30	Median	1322.13
Portal	76	Level III	20	Maximum	43744.50
OTC	44	144A	76	Minimum	10.64
Offshore	3	Reg. S	3		

Notes: Frequency distribution of ADR listings are classified by industry, country, year, exchange of listing and type. ADR listings data are obtained from the Bank of New York. All of the ADR-listed firms in our sample have at least 260 day closing price data around the event date, and all are first-time ADR issues and exhibit volatility clustering. Panel F presents the descriptive statistics for market capitalization of all firms in our final sample at the time of listing.

4. Comparison of Pre- and Post-Listing Periods in a Time-Series Framework

In this section we investigate the effect of ADR listing on the risk characteristics of the listed firms. We test whether a systematic change occurs after the listing date in the levels of the local market beta and the world market beta and the dynamics of the time-varying volatility of the cross-listed firms. We first split the sample into pre- and post-listing periods. This methodology allows us to analyze the two periods separately and to make comparisons about some basic characteristics of these periods. In the next section (Section 5), rather than splitting the data into pre- and post-listing periods, we conduct a full period analysis to model the risk-adjusted returns while accounting for the possible changes in risk exposures over time.

Unlike previous studies in the cross-listing literature, we employ the EGARCH framework to model the conditional heteroscedasticity. The EGARCH model has many appealing characteristics. First, it captures the time variation of volatility, which is an important empirical feature of return distributions. Second, it allows the good and bad shocks to have different effects on volatility. The ability to model the asymmetric effects of such shocks is one strong side of EGARCH models. Finally, unlike GARCH models, which require the estimated coefficients of the conditional volatility to be positive, EGARCH models impose no non-negativity constraints on the coefficients. The exponential form of conditional volatility in EGARCH model ensures that the implied value of conditional volatility is always positive. This property of the model eliminates some estimation problems of the parameters.

In the literature, time-varying volatility models are used to examine the effect of market liberalizations on aggregate-level volatility. However, our study is the first attempt to account for the time variation in volatility at the firm level. We estimate the following EGARCH (1, 1) model for the periods before and after the ADR issuance date for each firm in our sample.[8]

$$R_t = \beta_0 + \beta_1 R_{L_t} + \beta_2 R_{M_t} + \varepsilon_t \tag{2}$$

$$\ln(h_t) = \alpha_0 + \alpha_1 \left(\varepsilon_{t-1} / h_{t-1}^{0.5} \right) + \alpha_2 \left| \varepsilon_{t-1} / h_{t-1}^{0.5} \right| + \alpha_3 \ln\left(h_{t-1} \right) \tag{3}$$

where R_t is the daily log return of the underlying stock, R_{L_t} is the daily log return of the local market index, R_{M_t} is the daily log return of the world market index, and h_t is the conditional variance of ε_t, which is conditioned on the past information about the volatility forecast and volatility shocks of the previous period.[9] Enders (2004) argues that bad news may have a more pronounced effect on volatility than good news and defines the leverage effect as the tendency for volatility to decline when returns rise and to rise when returns fall. In other words, good and bad news may have asymmetric effects on volatility. In technical terms, the leverage effect is present if the value of α_1 in equation (3) is significantly negative. The idea is that if $\varepsilon_{t-1} / h_{t-1}^{0.5}$ is positive (which is an indication of good news or a positive shock) then $(\alpha_1 + \alpha_2)$ represents the effect of the shock on the conditional volatility. On the other hand, if $\varepsilon_{t-1} / h_{t-1}^{0.5}$ is negative (which is an indication of bad news or a negative shock) then $(-\alpha_1 + \alpha_2)$ represents the effect of the shock on the conditional volatility. If α_1 is significantly negative, bad news will have a larger effect on the conditional volatility than good news and thus an asymmetric effect arises.

4.1 The Effect of ADR Listing on Systematic Risk

Table 3 reports the averages of the local and global market betas of equation (2) before and after the listings along with location-difference test results. Location-difference tests are performed to determine if ADR listing causes any significant change

[8] This version of the EGARCH model is slightly different from the one introduced by Nelson (1991). Nelson (1991) specifies the log of conditional volatility as the following:

$$\ln\left(h_t\right) = \alpha_0 + \alpha_1 \left(\varepsilon_{t-1} / h_{t-1}^{0.5} - E\left[\varepsilon_{t-1} / h_{t-1}^{0.5} \right] \right) + \alpha_2 \left| \varepsilon_{t-1} / h_{t-1}^{0.5} \right| + \alpha_3 \ln\left(h_{t-1} \right)$$

This specification and the one that is defined in equation (3) produce the same coefficient estimates except for the intercept term. The difference between the intercept terms is $\alpha_1(2/\pi)^{1/2}$ when the error term follows a normal distribution.

[9] We also estimate a GARCH (1, 1) model but do not report the results, which are qualitatively the same as those of the EGARCH model.

Table 3 Difference Tests of Risk Exposures

Panel A	***Changes in Local Market Beta***			
Location	Pre-Listing Mean of Local Market Beta	Post-Listing Mean of Local Market Beta	Mean Difference *t*-test	Wilcoxon--Mann-Whitney Test
Asia	0.85	0.93	1.62	1.32
Latin America	0.75	0.77	0.27	0.11
Eastern Europe	0.83	0.90	0.89	0.40
All	0.81	0.87	1.54	1.19
Panel B	***Changes in Global Market Beta***			
Location	Pre-Listing Mean of Global Market Beta	Post-Listing Mean of Global Market Beta	Mean Difference *t*-test	Wilcoxon--Mann-Whitney Test
Asia	0.04	0.01	0.61	0.55
Latin America	0.03	0.01	0.34	0.05
Eastern Europe	0.12	0.19	0.45	0.23
All	0.05	0.03	0.38	0.33

Notes: Panel A and B provide the mean of the local and global market betas, respectively, across stocks in a region and the overall sample before and after the listing date. For each stock, the local and global market betas are estimated from the following regression equations for pre- and post-listing periods:

$$R_t = \beta_0 + \beta_1 R_{L_t} + \beta_2 R_{W_t} + \varepsilon_t$$

$$\ln(h_t) = \alpha_0 + \alpha_1 \left(\varepsilon_{t-1} / h_{t-1}^{0.5}\right) + \alpha_2 \left|\varepsilon_{t-1} / h_{t-1}^{0.5}\right| + \alpha_3 \ln\left(h_{t-1}\right)$$

in systematic risk. We first perform a parametric *t*-test, which tests the null hypothesis that the means of two normally distributed populations are equal. In our case, the parametric *t*-test examines whether the difference between the pre-listing and post-listing betas has a mean value of zero. The parametric *t*-test is based on the assumption that each of the two populations being compared follows a normal distribution. As the sample sizes in some regions are rather small (especially for Eastern Europe), deviations from normality may arise. To account for the possible non-normality issue, we perform a non-parametric Wilcoxon-Mann-Whitney test, which does not require the normality assumption and tests the null hypothesis that the local market beta is identically distributed with respect to the median before and after the listings. This test allows us to compare the pre-listing and post-listing betas if the normality assumption is violated and thus acts a robustness check to determine whether ADR listing causes systematic change in risk exposures. In summary, we test the following hypotheses in this section:

H_{10}: The local market beta does not change after ADR listing

H_{20}: The global market beta does not change after ADR listing

We conducted the tests over three regional groupings: Asia, Latin America, and Eastern Europe. As can be seen in *Table 3*, both the parametric and non-parametric tests do not indicate any significant changes in the local and global market beta for three of the regional groupings. Next, we pool all the ADR-issuing firms and conduct these tests over the whole sample. Both the parametric and non-parametric test results again show no statistically significant changes in systematic risks at the conventional levels. Consequently, the results in *Table 3* suggest that ADR listing does not change the systematic risks of ADR-issuing firms. These results are consistent with the growth opportunities hypothesis of Lee (2002), which offers no change in systematic risk associated with cross-listing, and are in line with the empirical find-

Table 4 Difference Tests of Volatility Dynamics

Panel A Changes in α_1				
Location	Pre-Listing Mean of α_1	Post-Listing Mean of α_1	Mean Difference *t*-test	Wilcoxon--Mann-Whitney Test
Asia	0.08	0.03	0.46	0.89
Latin America	0.09	0.01	1.04	0.68
Eastern Europe	0.04	- 0.05	1.42	2.01**
All	0.08	0.02	1.00	1.83*
Panel B Changes in α_2				
Location	Pre-Listing Mean of α_2	Post-Listing Mean of α_2	Mean Difference *t*-test	Wilcoxon--Mann-Whitney Test
Asia	0.28	0.28	0.04	1.17
Latin America	0.31	0.26	0.42	0.95
Eastern Europe	0.42	0.37	0.42	0.23
All	0.31	0.28	0.41	0.19
Panel C Changes in α_3				
Location	Pre-Listing Mean of α_3	Post-Listing Mean of α_3	Mean Difference *t*-test	Wilcoxon--Mann-Whitney Test
Asia	0.29	0.40	1.57	1.56
Latin America	0.26	0.19	0.72	0.94
Eastern Europe	0.20	0.51	1.99*	1.36
All	0.27	0.34	1.31	1.10

Notes: Panel A, B and C provide the mean of α_1, α_2 and α_3 coefficients, respectively, across stocks in a region and the overall sample before and after the listing date. For each stock α_1, α_2 and α_3 terms are estimated from the following regression equations for pre- and post-listing periods:

$$R_t = \beta_0 + \beta_1 R_{L_t} + \beta_2 R_{W_t} + \varepsilon_t$$

$$\ln(h_t) = \alpha_0 + \alpha_1\left(\varepsilon_{t-1} / h_{t-1}^{0.5}\right) + \alpha_2\left|\varepsilon_{t-1} / h_{t-1}^{0.5}\right| + \alpha_3 \ln\left(h_{t-1}\right)$$

** and * indicate 5% and 10% significance levels respectively.

ings of Sarkissian and Schill (2009), but are in contrast to those of Howe and Madura (1990) and Ramchand and Sethapakdi (2000).

4.2 The Effect of ADR Listing on Time-Series Volatility Dynamics

Martell et al. (1999), Jayakumar (2002), and Ejara and Ghosh (2004) investigate volatility changes due to cross-listing. However, their methodology ignores the time--series dynamics of volatility. Ignoring the time variation in volatility may result in a model misspecification problem. Here, we take into account the time-varying nature of volatility and examine the impact of cross-listing on volatility dynamics. More specifically, we investigate whether or not there is a change in the coefficients of the conditional volatility equation. For this purpose, the pre-listed estimated coefficients of α_1, α_2, and α_3 in equation (3) are compared with their post-listed values. *Table 4* summarizes the mean levels of the estimated coefficients for the pre- and post-listing periods. Panel A of *Table 4* shows a significant decrease in α_1 with respect to the Wilcoxon-Mann-Whitney test for Eastern Europe at the 5% significance level and for the overall sample at the 10% significance level. A negative mean value of α_1 (-0.05) in the post-listing period for Eastern Europe indicates that leverage effects arise after ADR listing, suggesting bad news has a larger increasing effect on volatility after ADR listing. This may be a reflection of an intensified foreign investor effect in relatively shallow markets. Given that the Eastern European stock exchanges have market capitalizations well below the size of many other emerging markets (Korczak and Bohl, 2005) with limited trading activity (Umutlu et al., 2010), the reactions of foreign investors to unfavorable firm-specific news may have more severe effects on volatility for Eastern European firms as compared to large firms with many domestic investors. The results for the overall sample support our foreign-investor-effect interpretation for volatility. For the overall sample, which is dominated by relatively large firms from Latin America and Asia, we observe a significantly closer value of α_1 to zero (0.02) in the post-listing period, which is an indication of decreasing asymmetric effects on volatility after ADR listing. This result for the overall sample, which is mainly composed of large stocks, can be interpreted as the diminishing marginal effect of foreign investors on volatility where many local investors exist.

As can be seen in Panel B of *Table 4*, neither the parametric nor the non-parametric tests indicate a significant difference in the α_2 coefficient of the conditional volatility equation for all the regional groupings and the overall sample. The parametric *t*-test in Panel C of the table signals an increase in α_3 in the post-listing period for Eastern Europe. However, the non-parametric tests do not signal any significant changes for Eastern Europe, other regions, and the overall sample. As the non-parametric tests are more reliable in small samples like Eastern Europe, we can conclude that there are no significant changes in α_3 due to cross-listing.

5. Conditional Volatility Models with an ADR-Listing Dummy

Rather than performing separate analyses for the two sub-periods as we did in the previous section, we conduct a full-period analysis in this section. The advantage of this methodology is that we can model the risk-adjusted returns under the consideration of changes in the local and global market betas over time. We test the effect of ADR listing on the risk characteristics of individual firms using conditional volatility models with an ADR-listing dummy. We estimate the following modified EGARCH models by using the full data set for each firm:

$$R_t = \beta_0 + \beta_1 R_{L_t} + \beta_2 D * R_{L_t} + \beta_3 R_{W_t} + \beta_4 D * R_{W_t} + \varepsilon_t \tag{4}$$

$$\ln(h_t) = \alpha_0 + \alpha_1 \left(\varepsilon_{t-1} / h_{t-1}^{0.5}\right) + \alpha_2 \left|\varepsilon_{t-1} / h_{t-1}^{0.5}\right| + \alpha_3 \ln(h_{t-1}) + \alpha_4 D_t \tag{5}$$

where D is the dummy variable, which takes the value of 1 if the observation is from the post-listing period, and zero otherwise.[10] The other variables are as defined previously. We address two issues in this section. First, we examine whether the mean level conditional volatility changes in the post-listing period, by observing the significance of the ADR-listing dummy, α_4, in equation (5). Second, we check the robustness of our results in Section 4.1 regarding the systematic risk under an alternative model specification. The significance of α_4 in equation (5) determines whether the mean level of conditional volatility, computed by (α_0 + α_4), changes after cross-listing. Simply, we test the following null hypothesis:

[10] A similar model is used by Foerster and Karolyi (1999) without accounting for the clustering in return volatility.

H_{30}: The mean level of conditional volatility does not change after ADR listing.

If α_4 is found to be significantly positive, it is concluded that ADR listing increases the mean of the conditional volatility. On the contrary, if α_4 is found to be significantly negative, then it is inferred that the mean of the conditional volatility decreases after listing. Finally, if α_4 turns out to be insignificant, it is interpreted that the mean level of conditional volatility is not affected by ADR listing.

Meanwhile, the time dummy enters equation (4), the mean equation, via interaction terms. These interaction terms detect potential changes in the systematic risk after the listing date. More specifically, the coefficients of the interaction terms, β_2 and β_4, capture whether a change occurs after the listing period in the values of β_1 and β_3, respectively. For instance, while β_1 is the local market beta for the pre-listing period, $(\beta_1 + \beta_2)$ is the local market beta for the post-listing period. Similarly, β_3 represents the global market beta for the pre-listing period, whereas $(\beta_3 + \beta_4)$ represents the global market beta for the post-listing period. Thus, a positive (negative) and significant coefficient for the interaction term is interpreted as an increase (decrease) in the particular risk exposure after the listing date. If the coefficients of the interaction terms appear to be not significantly different from zero, then we conclude that there is no change in the systematic risks after the listing and the systematic risks are equal for the pre- and post-listing periods.

The summary results are presented in *Table 5*.[11] In Asia, although 16 out of the 94 listed firms experienced a statistically significant decrease in their local market betas (β_2), 19 firms experienced a significant increase. The remaining 59 firms do not encounter any significant change in their local market betas. The changes in the global market betas (β_4) are even more limited, with 7 decreases and 4 increases. The great majority of the Asian firms (83 out of 94) do not experience a significant change in their global market betas. For Latin American firms, we detect 12 significant decreases and increases and 34 insignificant changes in the local market betas. Like Asian firms, very few Latin American firms exhibit variation in global market beta, with 5 decreases and 3 increases. The remaining 50 out of the 58 Latin American firms exhibit no change in global market beta after ADR listing. Unlike Asia and Latin America, the total number of significant changes (increases plus decreases) in the local market beta is higher than the number of insignificant changes in Eastern Europe. We observe 6 significant decreases, 8 significant increases, and 7 insignificant changes. However, the numbers of positive and negative significant changes do not greatly outweigh each other and therefore it is hard to infer that ADR listing has a systematic impact on the local market beta for Eastern Europe as well. The analysis of the β_4 coefficients of Eastern European firms reveals that 18 out of the 21 firms' global market betas remain unchanged, indicating no systematic change after ADR listing. Finally, the results of the overall sample show that there is no significant change in the local market beta after the listing date for 100 out of the 173 firms. However, we find 34 significant decreases and 39 significant increases for the local market beta, with no indication of a general tendency toward an up or down movement. These results suggest that ADR listing does not lead to a systematic change in

[11] Full estimation results for each stock in the sample are presented in *Table 6* in *Appendix* and can be reached via http://journal.fsv.cuni.cz/.

Table 5 Summary Results of *t*-Statistics for the EGARCH(1,1) Model with ADR-Listing Dummy

Location	Number of firms	*t*-statistic Frequencies								
		β_2			β_4			α_4		
		$t \le t0.05$	$t0.05 < t < t0.95$	$t \ge t0.95$	$t \le t0.05$	$t0.05 < t < t0.95$	$t \ge t0.95$	$t \le t0.05$	$t0.05 < t < t0.95$	$t \ge t0.95$
Asia	94	16	59	19	7	83	4	7	76	11
Latin America	58	12	34	12	5	50	3	7	43	8
Eastern Europe	21	6	7	8	2	18	1	1	18	2
All	173	34	100	39	14	151	8	15	137	21

Notes: The frequency of *t*-statistics at the 10% significance level is reported for the coefficients of interaction and dummy terms, namely β_2, β_4 and α_4. Full estimation results for each stock are presented in the *Appendix*.

The following model is estimated for the whole period for each stock in the sample:

$$R_t = \beta_0 + \beta_1 R_{L_t} + \beta_2 D * R_{L_t} + \beta_3 R_{W_t} + \beta_4 D * R_{w_t} + \varepsilon_t$$

$$\ln(h_t) = \alpha_0 + \alpha_1 \left(\varepsilon_{t-1} / h_{t-1}^{0.5}\right) + \alpha_2 \left|\varepsilon_{t-1} / h_{t-1}^{0.5}\right| + \alpha_3 \ln\left(h_{t-1}\right) + \alpha_4 D_t$$

any direction since the numbers of positive and negative changes are close to each other and we do not observe a significant change for a majority of the firms. The findings are similar for the global market beta as well; 87% (151 out of 173) of the firms do not undergo a significant change in global market beta. Thus, we conclude that there is no change in the systematic risk exposures of the ADR-listed firms. This result is in line with our previous findings.

Next, we focus on the coefficient of the ADR-listing dummy (α_4) in equation (5) to see the effects of the listing on the mean level of conditional volatility. The general criticism about liberalization is that it drives volatility upward. So if this assertion is true, an increase in the mean level of conditional volatility after the listing should be observed. An increase in the conditional volatility manifests itself in the form of a positive and significant α_4 coefficient in the variance equation. On the other hand, a negative significant α_4 coefficient is interpreted as a decrease in conditional volatility, whereas an insignificant coefficient estimate is interpreted as invariability. We observe 76 insignificant estimates of α_4 out of a total of 94 estimates for Asia, 43 out of 58 for Latin America, and 18 out of 23 for Eastern Europe. All these results indicate a strong invariability in conditional volatility for every regional grouping. The results of the overall sample show an insignificant estimate of α_4 for a vast number of firms (137 out of 173). Only 21 firms have a significant positive coefficient, and 15 firms have a significant negative coefficient for the time dummy. These findings suggest that the mean level of conditional volatility is not affected by ADR listing either.

6. Conclusion

In this paper we investigate whether ADR listing affects the volatility dynamics and risk characteristics of the stocks in their local markets. A clear understanding of the role of foreign investors in the economy is crucial for policy makers. For instance, if foreign funds have negative impacts on the local economy or on the firm in which they are invested, restrictions on foreign fund movements can be put into use. Unlike previous studies, we employ a time-series framework to handle the impact of cross-listing on the return volatility of the underlying shares in the context of ADRs from emerging markets. We first perform our analysis on the pre- and post-listing periods separately to compare the risk characteristics of the two periods. We find that there is no statistically significant change in the local and global market betas after cross-listing. Moreover, we document no important change in the dynamics of the volatility due to listing except for leverage effects. The full period analyses show that the mean level of conditional volatility is not subject to change after ADR listing and that our results for systematic risk are robust to alternative model specification. Therefore, we conclude that the ADR listing of stocks does not systematically affect the risk characteristics of the underlying shares. Since our results hold on average, the conclusions drawn are valid for an average stock or a portfolio.

Our results for volatility dynamics are in conformity with the theoretical implications of Domowitz et al. (1998), which suggest that the impact of cross-listing on volatility depends on the degree of quotation transparency between the US market and the domestic market. Given that each market has its own information linkage characteristics, the mixed results in different stock exchanges are consistent with the theory. Our finding of no change in systematic risk can be explained in the context of growth opportunities associated with cross-listing without an accompanying change in risk exposures (Lee, 2002). Finally, our finding of no systematic change in idiosyncratic volatility is consistent with the offsetting effects of improved firm-specific information due to higher levels of disclosure standards and reduced private information as a consequence of a possible increase in the production of market-wide information.

The results of this study have important implications for portfolio managers, policy makers, and firms' financial managers. Holders of stocks that are cross-listed on US exchanges are not subject to adverse volatility effects due to listing. Therefore, portfolios that contain these stocks will not experience a change in their risk return profiles. Moreover, change in risk exposures such as the market beta also has implications for financial decisions, as it may affect the cost of capital of firms. Since ADR-issuing firms do not experience significant market beta changes, it is unlikely that ADR issuance matters for the financing decisions of managers.

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