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International Cross-Listing and Order Flow Migration: Evidence from an Emerging Market

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ABSTRACT

Policymakers in emerging markets are increasingly concerned about the consequences for the domestic equity market when companies list stock abroad. We show that the effects of cross-listing depend on the quality of intermarket information linkages. We investigate these issues with unique data from the Mexican equity market. The impact of cross-listing is complex—balancing the costs of order flow migration against the benefits of increased intermarket competition. These effects are exacerbated by equity investment barriers that induce segmentation of the domestic equity market. Consequently, the benefits and costs of cross-listing are not evenly spread over all classes of shareholders.

THERE HAS BEEN A DRAMATIC INCREASE in the trading of foreign stocks as investors recognize the need for international diversification and as foreign companies seek to broaden their shareholder base and raise capital. As a result, the number of American Depository Receipt (ADR) listings on U.S. exchanges has also risen sharply. Though corporations view cross-listings as value enhancing, the changes in liquidity and volatility, and the cost of trading associated with order flow migration following cross-listing may adversely affect the quality of the domestic equity market. Such changes are especially important for emerging markets facing new competition from well-established, highly liquid markets abroad, and are the source of increasing concern among policymakers. There is also considerable academic interest in this topic, especially because the effects of cross-listing may be related to the

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degree of capital market segmentation.[1] We analyze these issues using new data on daily prices and volumes from 1989 to 1993 obtained from the Mexican Stock Exchange, the Bolsa Mexicana de Valores (BMV).

We develop a theoretical model to examine the impact of international cross-listing where investors acquire costly information. Our analysis highlights the importance of intermarket informational linkages or transparency. In particular, if intermarket price information is freely available, cross-listing results in an improvement in market quality. Intuitively, the provision of an alternative trading venue induces participation abroad by foreign investors who otherwise would not trade. With transparent markets, the increase in the total number of traders following cross-listing reduces spreads, increases the precision of public information, and increases liquidity in both markets.

In the opposite case, where intermarket information linkages are extremely poor, cross-listing reduces liquidity and increases volatility in the local market. Intuitively, cross-listing results in the diversion of informative order flow overseas, resulting in lower domestic market quality. The intermediate case, where information linkages are imperfect, is more complex. Heightened intermarket competition may narrow domestic market spreads, but order flow migration may result in lower domestic market liquidity and may increase price volatility. Our model provides a method to distinguish these outcomes from the data.

From an empirical perspective, the Mexican market is of particular interest. First, Mexico is an important emerging market, and previous studies of international listing have focused almost exclusively on large, liquid markets such as Britain, Canada, and Japan. Second, foreign listing is likely to have a significant impact on the domestic Mexican market because foreign investors (mostly U.S. nationals) account for more than 27 percent of holdings and up to 75 percent of trading in our sample period. Third, the BMV is open for trading during much of the time that United States equity markets are open. Consequently, an analysis of trading in Mexico provides a way to better understand the effects of international competition for order flow. Finally, as in many countries, Mexican companies issue multiple equity series that distinguish between foreign and domestic ownership. Because the diversion of order flow is likely to be manifested primarily in series open to foreign investors, this feature makes it easier to discern the effects of cross-listing.

Our empirical results demonstrate that the impacts of cross-listing are complex, reflecting the costs of order flow fragmentation as well as the benefits of increased intermarket competition. Specifically, we find that in those

[1] Karolyi (1996) provides an excellent survey of international cross-listing. See also Alexander, Eun, and Janakiramanan (1987, 1988), Chan, Fong, and Stulz (1995), Foerster and Karolyi (1993, 1994, 1996), Forster and George (1996), Howe, Madura, and Tucker (1993), Jayaraman, Shastri, and Tandon (1993), Jorion and Schwartz (1986), Kleidon and Werner (1996), and Urias (1994). Bekaert (1993), Eun and Janakiramanan (1986), and Stulz (1981), discuss equity investment barriers.

series open to foreign ownership, liquidity tends to decrease and price volatility increases, consistent with the migration of foreign investors. Interestingly, these effects appear to be mitigated by increased intermarket competition, which narrows spreads. Finally, although ADR listing is associated with positive excess returns, these benefits accrue largely to those series open to foreign investors prior to cross-listing. No such effects are present in a control group, indicating that our results are not driven by marketwide or macroeconomic factors. The fact that we find returns effects largely for shares already open to foreign investors might suggest that the cost of capital benefit of cross-listing is small. We do not want to push the interpretation of our findings too far, however. Consideration of the cost of capital also entails transactions costs and liquidity effects in both the domestic and foreign market, and the latter is not considered here, except for a very small subset of companies.

The paper proceeds as follows: The institutional features of the Mexican stock market and our data sources are described in Section I. A theoretical model to analyze the impact of cross-listing on the domestic market is developed in Section II. Section III contains our econometric methodology and results. Section IV concludes, and we offer some suggestions for future research.

I. Institutions and Data

A. The Bolsa Mexicana de Valores

The BMV, Mexico's only stock exchange, is a private institution owned by twenty-six Mexican-owned brokerage houses. The exchange operates from 8:30 a.m. to 4:00 p.m. local time (9:30 a.m. to 5:00 p.m. EST) from Monday to Friday, so that trading hours overlap to within an hour of U.S. markets. Orders are either sent to the BMV computer systems or worked by floor brokers through open outcry. Preopening orders can be entered by computer and are crossed automatically in a batch open, subject to certain price limits.

Our study focuses on twenty-five equity instruments issued by sixteen firms whose stock was traded as ADRs in the United States in 1993. Mexican equity instruments are of particular interest for our study in that each company may issue several different series of shares or tranches, each with different rights or shareholder bases. The major series are A, B, and C (or L and O) shares. For a nonfinancial company, series A shares may legally be held only by Mexican individuals or Mexican-controlled institutions. Shares have full voting rights and must collectively represent at least 51 percent of the voting shares.[2] Series B shares are open to all investors, regardless of

[2] Foreigners can participate through the Nacional Financiera trust where voting rights are stripped. In this case, the series designation changes to N or CPO.

nationality. Shares have full voting rights, but cannot collectively represent more than 49 percent of the voting shares.[3] Financial groups are not represented in the ADR sample.

Series C shares are open to all investors, but are limited to 30 percent of total capital. Companies also issue L and O series, which are available to all investors but carry limited or no voting rights. All series in our sample represent identical claims to the earnings of the firm.

Similar divisions are found in other countries (e.g., China and Thailand) where public policy seeks to restrict or control the foreign ownership of capital. They also may arise endogenously, as Stulz and Wasserfallen (1995) document for Switzerland. The divisions are important because they may induce internal equity market segmentation, as we describe below.

B. American Depository Receipts

Foreign companies wishing to trade equities (and debt) in the U.S. market often achieve this goal by issuing ADRs. The ADR represents shares held by a trustee in the Mexican market. The receipts, issued by a U.S. depository (Bank of New York, etc.), are then treated as U.S. securities for clearance, settlement, transfer, and ownership purposes. The depository is responsible for the payment of dividends (in dollars) to investors, for the distribution of information about the issuer, and for conversion between shares and ADRs.

The majority of ADRs, including those in our sample, are now sponsored by the issuer, which implies that the issuer has chosen a single depository to handle investor relations and that the costs associated with depository services are paid by the issuer. Alternatively, the issuer could leave the ADR unsponsored (although this is now rare), in which case investors are responsible for the costs of the depository's services.

There are four issue types. A Level I issue is the simplest and results in ADRs that are traded in the U.S. over-the-counter ("pink sheet") market. No new capital is raised and the issuer is not required to comply with U.S. Generally Accepted Accounting Principles (GAAP) or full SEC disclosure requirements. Twelve of the series in our Mexican sample are traded as Level I ADRs. Level II issues involve listing existing shares on a U.S. stock market, and although no new capital is raised, this involves compliance with U.S. disclosure and exchange requirements. None of our series are in this category. Level III issues involve a combination of exchange listing and raising new capital. In addition to the requirements of a Level II

[3] Both A and B shares can be further divided into fixed (1 or F) and variable (2 or V) shares, all of which carry equal rights. Under statute, a company must carry a minimum level of capital, the fixed part, which can only be changed by vote of shareholders at an extraordinary meeting. The variable part changes whenever rights are issued or the company decides to buy back shares.

issue, a prospectus must be prepared and additional SEC disclosure requirements must be met. Five of the series in our sample are Level III ADRs. Finally, ADRs can now be placed privately with qualified institutional investors (and new capital can be raised) with minimal disclosure requirements under the 144A rule. Trading in the 144A market takes place through a set of market specialists and the Portal quote system. Six of the series in our sample of Mexican shares are traded in the 144A market.

After issuance, the supply of ADRs varies over time with market conditions. When an existing ADR is sold by a U.S. investor, it can either be transferred to a U.S. buyer or can be canceled by the depository and converted back into the underlying share. Similarly, the demand for ADRs can induce the creation of new receipts from the underlying shares. The depository extracts a fee (generally $5 per 100 shares) for conversion. Given this connection between the ADR and the underlying share market, cross-border arbitrage should align the prices of the two securities (adjusted for the exchange rate) subject to transaction cost bounds imposed by the conversion fee and bid-ask spreads. Conversations with traders suggest that profitable arbitrage occurs when price differentials depart from theoretical bounds, possibly because of delays in observing prices and quotes in the other market, differences in the responsiveness of prices to news events, or price pressure caused by noise trading.

C. The Data

The data used in this study were obtained from the BMV, and until now have not been publicly available. The sample used here consists of daily observations on prices, returns, and share volumes of twenty-five equity series. These series represent sixteen firms over the period from September 1989 through July 1993, all of which experienced an ADR listing over the sample period. Additionally, we gathered data on nine non-ADR companies with similar trading frequencies and characteristics to form a control sample to check the validity of our results. On average, there were 828 trading days per series.

Company names, acronyms, series identifiers, and ADR series listing for the twenty-five stocks our sample are provided in Table I. Of the 25 series, eleven are A class (including fixed and variable) shares, nine are B class shares, and the remaining five are C, L, or O (nonvoting) shares. The majority of the ADRs in our sample are traded over-the-counter or in the 144A market. Of the stocks in our sample, only three are listed on an exchange and for these stocks we have data on trading in the U.S. market as well as in the domestic market.

Table II shows the date of ADR listing, the average daily trading volume (in shares), the standard deviation of daily price changes (a measure of volatility), and the number of trading days before and after ADR listing avail-

Table I

Sample Stocks and Series Type

The table contains the stock series key, names of companies, and series type (A, B, C, and O) by company in our sample for stocks traded on the Bolsa Mexicana de Valores. The ADR series listings are in brackets: OTC, over the counter; 144A, private issue under SEC rule 144A; NAS, Nasdaq; NYSE, New York Stock Exchange; GDR, global depository receipt. Series not in our sample are in parentheses. An asterisk indicates that the ADR raised new capital for the issuer.

Series Key	Company Name	Series
CEM	Cemex	A[144A]*, B[OTC]
CER	Internacional de Ceramica	B[OTC]
CIF	Cifra	A, B[OTC], C
COM	Controladora Comercial Mexicana	B[OTC]
EPN	EPN	A, (B[OTC])
FEM	Fomento Economico Mexicano	B[144A]
GCA	Grupo Carso	A[144A]
LIV	El Puerto de Liverpool	O, C[GDR]*
MAS	Grupo Industrial Maseca	A[OTC]*, B
PON	Ponderosa Industrial	A, B[OTC]*
SAN	Corporacion Industrial San Luis	A[OTC]
SYN	Grupo Synkro	A, B[OTC]
TEL	Telefonos de Mexico	A[NAS]
TMM	Transportacion Maritima Mexicana	A[NYSE]*, L[NYSE]*
TTO	Tolmex	B[OTC]
VIT	Vitro	O[NYSE]

able for analysis for each stock, grouped by series type.[4] The dates of ADR listing vary widely across the sample, with the earliest being EPN, listed in December 1989 and the most recent being TMM, listed in June 1992.

There is a wide range in trading activity and volatility across stocks. Overall, 62 percent of the series experienced some increase in volume, but this figure is not statistically significantly different from 50 percent. The figure is slightly higher for the A shares, at 67 percent. Higher volume is observed for 63 percent of the B shares, and for about 60 percent of all shares with foreign ownership rights prior to international listing. However, it is difficult to discern a pattern to the changes in volume and volatility following ADR listing. We turn now to a more formal analysis of this issue.

[4] We use the standard deviation of price changes as our volatility measure for consistency with the volatility measure used in model estimation, which, in turn, is based on the theoretical analysis to follow. Though this measure of volatility is highly correlated with the return variance, there are a few stocks where, because of differences in the way these measures weight outliers, the volatility patterns differ by whether we use the standard deviation of returns or price changes.

Table II

Volume and Price Volatility by Stock Series

This table contains the summary statistics for all stock series in our sample of stocks traded on the Bolsa Mexicana de Valores for which an ADR was introduced. The month and year of the ADR introduction is given under ADR Listing. Volume Prior and Volume After are average daily shares traded, in thousands, before and after the listing, respectively. Volatility Prior and Volatility After denote the average standard deviations of daily price changes before and after the listing. Days Prior and Days After are the number of trading days in the sample before and after the listing. Superscript a denotes scaling by 10^2. Panel A lists results for the series restricted to Mexican ownership domestically, Panel B for B shares, open to foreign ownership, and Panel C for other unrestricted series.

	ADR Listing	Volatility Prior	Volatility After	Volume Prior	Volume After	Days Prior	Days After
			Panel A: A Series				
CEM	5/91	0.204	0.697	444	343	409	551
CIF	1/91	0.073	0.197	893	847	336	624
EPN	12/89	0.005	0.005	349	955	70	760
GCA	10/91	0.405	0.731	16	720	312	444
MAS	4/92	0.228	0.229	291	513	431	311
PON	5/91	0.003	0.005	144[a]	236[a]	417	543
SAN	7/90	0.062	0.047	289	82	219	741
SANAV	7/90	0.054	0.045	462	269	219	741
SYN	6/90	0.035	0.098	137	54	192	768
TEL	5/91	0.090	0.213	6797	1539	415	545
TMM	6/92	0.480	0.492	46	88	73	270
			Panel B: B Series				
CEM	5/91	0.281	0.661	175	374	166	551
CER	4/91	0.048	0.137	8	36	387	573
CIF	1/91	0.073	0.218	699	2228	336	624
COM	2/92	0.044	0.059	1199	774	203	353
FEM	4/91	0.101	0.257	396	1186	387	573
MAS	4/92	0.217	0.235	301	664	431	311
PON	5/91	0.010	0.011	357	177	417	543
SYN	6/90	0.035	0.083	23	26	192	768
TTO	9/91	0.182	0.346	615	466	388	455
			Panel C: Other Series				
CIFC	1/91	0.026	0.063	2618	3979	61	624
LIVC	6/92	0.214	0.385	103	480	685	275
LIVO	6/92	0.211	0.327	47	220	685	275
TMML	6/92	0.472	0.499	91	60	73	270
VITO	11/91	1.100	1.811	150	457	547	413

II. The Analytical Framework

A. The Model

Consider a domestically traded stock for which trading takes place sequentially at prices posted by floor traders or marketmakers. Both foreign and domestic investors can trade the stock; we extend the model below to discuss the impact of equity investment barriers in the form of ownership restrictions. Let n_d represent the number of domestic traders in a given day, n_f denote the number of investors who are foreign nationals seeking to trade in the domestic market, and let $N = n_d + n_f$ denote the total number of (actual, as opposed to potential) traders, where we suppress the time subscript for notational convenience.

We assume that arrivals of both domestic and foreign investors are governed by independent Poisson distributions with (possibly time-varying) parameters θ_d and θ_f, respectively. The choice of a Poisson distribution to model trader arrivals is a natural one since it arises in the limit from a more primitive model of the behavior of individual traders, as shown below. Using the properties of the Poisson process, the total number of traders arriving in a day of unit length follows a Poisson process with parameter $\theta = \theta_d + \theta_f$.

A.1. Security Prices and Trades

Following Glosten and Milgrom (1985), we assume trade size is one unit. Let x_k denote the desired order of trader k (who arrives at calendar time t_k), where we adopt the convention that $x_k = +1$ for a buy, -1 for a sell, and 0 if the trader chooses not to trade. Let $p_k(x_k)$ denote the stock's price as a function of the order and let μ_k denote the expected value of the asset at the time of the kth trade of the day from dealers' viewpoint based on the past history of trading. We assume that the quotation function is public information, and that the marketmakers' conditional expectation of the asset's value can be inferred from their quotes. This will indeed turn out to be the case.

To model the behavior of traders, we assume that trader k receives idiosyncratic human capital income, denoted h_k. At time t_k, trader k obtains a private information signal regarding the current value of the asset. Denote by y_k the *deviation* of the asset's fundamental value and the conditional mean based on public information. Thus, the expected value of the asset, given public information and the private signal y_k, is $y_k + \mu_k$. Let ρ^2 denote the variance of this estimate. We assume that investors maximize mean-variance expected utility functions, where a denotes the risk-aversion parameter. The investor's expected utility, u_k, conditional on entering the market is

$$u_k = (\mu_k + y_k + w_k - p_k(x_k))x_k + \mathrm{E}[h_k] - a\rho^2 x_k^2 - a\sigma_h^2, \tag{1}$$

where $w_k = -2a\mathrm{cov}(h_k, v_k)$ is the covariance between the asset's fundamental value (denoted by v_k) and the trader's idiosyncratic income. The term w_k reflects the additional value trader k places on the asset as a hedge against fluctuations in other income. The potential diversification benefits accruing from holding the risky asset create both information and liquidity motives for trade. The trader's optimization problem, given the prevailing quotes in the market, is to choose the optimal order $x_k \in \{-1, 0, 1\}$ to maximize expected utility, u_k.

As in Glosten and Milgrom (1985), the price facing trader k is $p_k(x_k) = \mu_k + sx_k$, where s represents both the order processing cost element of the bid-ask spread as well as any rents accruing to dealer market power. Note that dealers' conditional mean valuations can be inferred from the quotation function, as previously conjectured. Previous research suggests that this spread element is inversely related to the expected trading frequency, and we write $s = s(\theta)$, where $s'(\theta) < 0$. Dealers are ex post rational, that is, they set quotes that recognize the information conveyed by trade. We write the conditional valuation of the stock μ_k as $\mu_k = \mu_{k-1} + \lambda x_k$, where λ captures the information content of the trade. Formally, $\mathrm{E}[y_k|x_k = 1] = \lambda$ and $\mathrm{E}[y_k|x_k = -1] = -\lambda$. Higher perceptions of information asymmetry (in the form of more accurate private information signals y_k or less dispersion in liquidity motivations w_k) are manifested in higher values of λ.

An investor who, having gathered information, "arrives" planning to trade (as described below) may elect not to do so if the costs of trading exceed the possible expected profits and diversification gains. Using equation (1), the trader will place a buy order if $y_k + w_k > s + a\rho^2$, a sell order if $y_k + w_k < -s - a\rho^2$, but will not trade otherwise. Let ζ denote the probability that a trader, upon arrival, chooses not to trade where $\zeta = \mathrm{Prob}[x_k = 0] = \mathrm{Prob}[s + a\rho^2 > |y_k + w_k|]$. Observe that nontrading is an increasing function of s, the spread, and $a\rho^2$, the term capturing risk aversion.

A.2. The Entry Decision

Prior to making a decision about whether or not to trade, a potential trader must decide whether it is worth gathering information about fundamentals. Let c_k denote the idiosyncratic cost for agent k to obtain information in the domestic market; we assume that information is observed only after c_k is incurred. Thus, a potential trader will gather information only if the ex ante gain in terms of possible realized expected utility exceeds his or her costs of acquiring information. Let q denote the unconditional probability that a randomly selected potential trader's expected utility exceeds his or her costs of gathering information. The probability that a randomly selected potential trader will trade is given by a Bernoulli distribution with parameter q. The Poisson distribution for investor arrivals thus follows as the limiting case (with large numbers of potential investors) of independent Bernoulli trials. The parameters of the Poisson distribution for each investor group, θ_d and θ_f, are inversely related to the average costs of information acquisition for domestic and foreign investors. Formally, we can write $\theta_d = \theta_d(c_d)$, where c_d is the average cost of information acquisition for domestic investors, and $\theta_d(c_d)$ is a decreasing function of c_d. A similar expression holds for θ_f.

A.3. Price Dynamics and Volume

Using the fact that the expected number of arrivals in a given "day" is θ, the expected daily volume can be written as

$$\mathrm{E}\left[\sum_{k=1}^{N}|x_k|\right] = (1-\zeta)(\theta_d+\theta_f), \tag{2}$$

which is an increasing function of the arrival probabilities and a decreasing function of the spread element s, the degree of risk aversion a, and the variance of investor's priors regarding fundamental value, ρ^2. The price change from the opening price to the close of the day is given by

$$p_N - p_0 = \lambda\left(\sum_{k=1}^{N} x_k\right) + sx_N, \tag{3}$$

where p_0 denotes the opening price, which is determined in a batch market. In equation (3), the enclosed term represents the cumulative order imbalance, and the last term represents the effect of bid-ask bounce. Observe that the larger the parameter λ, the greater the impact on prices of a given order imbalance. Thus λ can be interpreted as an inverse measure of market liquidity.

We assume that the opening price is the sum of the previous day's closing price plus an innovation, ϵ. The innovation ϵ captures the effects of overnight information flows regarding changes in fundamental value, and is distributed with mean 0 and variance σ_ϵ^2, where the variance term is inversely related to θ. This assumption follows naturally from a more primitive model of the evolution of beliefs. For example, suppose the number of analysts following the stock, m, is roughly proportional to the mean number of investors likely to trade the stock (i.e., $m = \kappa\theta$, where $\kappa > 0$ is a constant), and each analyst independently obtains a noisy signal about the deviation of the value of the underlying asset from the previous close. Let τ^2 denote the variance of each analyst's signal, so that $\sigma_\epsilon^2 = \tau^2/\kappa\theta$; that is, the variance of public information is inversely related to the number of market participants. It is clear that the desired result would hold even if analyst forecasts were correlated, as long as the correlation were not perfect. Alternatively, recall that the market opens with a single-price batch auction, so that ϵ can be thought of as the difference between the previous day's close and the opening auction price. Given the presence of liquidity motivated traders, the opening price is a noisy but unbiased signal regarding fundamental value. If liquidity shocks are less than perfectly correlated, the variance of ϵ will decline with the number of traders.

The close-to-close price movement from day $t-1$ to day t is given by $p_N - p_0 + \epsilon$. Using equation (3) and the properties of the Poisson distribution, the variance of *intraday* price changes is $\sigma^2(p_N - p_0) = \omega + \lambda^2(1-\zeta)(\theta_d+\theta_f)$, where $\omega = (s^2 + 2\lambda s)\sigma^2(x_N)$. Observe that ω is an increasing function of the spread s and a decreasing function of market liquidity, measured by λ^{-1}. The variance of successive changes in closing prices is then

$$\sigma^2(\Delta p) = \gamma + \lambda^2(1 - \zeta)(\theta_d + \theta_f), \tag{4}$$

where $\gamma = \omega + \sigma_\epsilon^2$.

Equation (4) has a natural economic interpretation. Specifically, price volatility has two components: The first component, γ, represents the volatility arising from the bid-ask bounce plus the variance of overnight public information. The second component, $\lambda^2(1 - \zeta)(\theta_d + \theta_f)$, represents the volatility induced by microstructure frictions including information asymmetry. Using equation (2), we see that this term is proportional to expected daily volume, where the proportionality coefficient is inversely related to market liquidity. Information asymmetry is not essential for this result; we would obtain an identical representation if marketmakers faced inventory carrying costs.

B. The Impact of International Cross-Listing

Suppose now that the risky asset is cross-listed on a foreign market. Let $P_k(X_k)$ denote the price quotation function in the foreign market at time t_k as a function of the trade, X_k, with the same signing convention as above. The impact of cross-listing will depend on the extent to which price information in the two markets is observable—that is, the quotation transparency. Formally, suppose that at the time of trade k, domestic marketmakers observe a signal about the prevailing price *quotation* function in the other market of the form $P_k(X_k) + Q_k$, where Q_k is a random variable with precision (the inverse of the variance) χ. The parameter χ is a summary measure of transparency that captures the quality of intermarket information linkages regarding quotes and prices. Note that the quotation function is, by assumption, a sufficient statistic for the underlying conditional mean beliefs in the other market so that transparency in this context is distinct from trade reporting. We discuss below three cases corresponding to different levels of transparency.

B.1. Market Integration ($\chi = \infty$)

With perfect quotation transparency, the precision of the signal regarding the foreign market, χ, is infinite and information on prices and quotes in both markets is freely available at all times. Denote by C_k the ex ante cost of entering the ADR market for investor k, and let c_k denote the cost of entering the domestic market. We assume that $C_k < c_k$ for some investor k, since otherwise there will be no gain to opening the foreign market. In this case, cross-listing will induce investors with high entry costs who would not otherwise enter the domestic market to gather information and enter the foreign market. Let Θ denote the trading intensity in the foreign market, and let θ^* denote the post-cross-listing intensity in the domestic market. The entry of new traders implies that the combined trading intensity in both markets increases following cross-listing, that is, $\Theta + \theta^* > \theta_d + \theta_f$.

Since there is a one-to-one mapping between dealer quotations and beliefs, dealers share common beliefs irrespective of their geographic location and trading histories. Costless arbitrage ensures that the price facing trader k is equalized across markets, so that $p_k = P_k = \mu_k + s^* x_k$, where s^* denotes the post-ADR order processing element of the spread. Our model suggests that $s^* < s$—in other words, that ADR listing decreases the spread. Intuitively, the spread element s is negatively related to the frequency of trading, which increases with the entry of new traders. This also occurs if integration lowers the costs of marketmaking services or if intermarket price competition reduces or eliminates any rent elements contained in s.

Since $\lambda = \mathrm{E}[y_k | x_k = 1] = \mathrm{E}[y_k | y_k + w_k > s + a\rho^2]$ is an increasing function of s, it follows that λ decreases following cross-listing, implying more liquidity and greater depth. We would obtain similar results if λ were interpreted as arising from inventory control costs instead of asymmetric information, because such costs are positively related to the expected time between trades and hence inversely related to the arrival rate. As the probability of trading is decreasing in s, and trading intensity increases, equation (2) shows that expected total volume will increase. However, the distribution of volume between the two market centers is a function of trading costs in the foreign market. It is possible, for example, that some traders who would otherwise trade domestically find it cheaper to trade abroad, so that volume in the domestic market falls. Such volume movements have no economic impact on security prices in an integrated market where the geographic distribution of trading volume is irrelevant.

Finally, it is likely that participation by new investors will reduce both elements of base-level volatility. Specifically, both γ (because s and λ fall) and the variance term σ_ϵ^2 may decrease. The latter occurs either because opening prices are more informative (represent more efficient aggregation of investor beliefs) or because the increase in trading activity induces entry by analysts who gather additional information. For example, the total number of analysts now following the stock is given by $\kappa(\Theta + \theta^*)$, which is greater than before cross-listing, and the variance of public information is now given by $\tau^2/\kappa(\Theta + \theta^*)$, which is less than that before cross-listing. In summary, when markets are informationally linked, entry by new investors following cross-listing improves standard measures of market quality in both domestic and foreign markets.

B.2. Fragmentation ($\chi = 0$)

The polar opposite case occurs when the precision of intermarket price information signals is zero ($\chi = 0$), that is, markets are not informationally linked. International cross-listing results in a migration of investors away from the domestic market for those investors for whom $C_k < c_k$, causing the trading intensity (and hence expected volume) in the local market θ to decline. The decrease in the expected number of market participants need not be confined to foreign traders, for some domestic investors may also find it cheaper to trade in the United States. The combined volume in both markets may increase with the entry of new investors into the ADR market. Even so, without quotation transparency the diversion of order flow abroad results in less efficient prices and lower market quality in the domestic market.

The decrease in expected trading activity should increase spreads in the domestic market because trading intensity decreases. Further, because λ is an increasing function of s, it follows that λ increases following cross-listing, reducing liquidity. Similar results would obtain if λ also captured inventory control costs inversely related to the arrival rate, θ, of traders.

Finally, trader migration increases both the base-level volatility term ω (because s and λ rise) and the variance of overnight public information flows σ_ϵ^2 in the domestic market. The latter occurs either because opening prices are less informative or because less information is gathered by domestic analysts. In summary, in the absence of quotation transparency, order flow migration following cross-listing lowers the standard measures of market quality in the domestic market.

B.3. Partial Fragmentation ($0 < \chi < \infty$)

When domestic marketmakers observe foreign prices with noise ($0 < \chi < \infty$), imperfect information linkages may result in *partial fragmentation*, where the effects of cross-listing are concentrated in some segments of the equity market. Such effects are likely to be exacerbated by internal market segmentation induced by barriers such as foreign ownership restrictions. In particular, Stulz and Wasserfallen (1995) show that ownership restrictions can induce segmentation between the assets held by foreign and domestic investors. If foreign investors currently trading in the domestic market obtain the greatest reduction in trading costs by moving abroad (as seems likely), the loss of order flow primarily occurs in the B series shares where foreign ownership is especially significant. In turn, the diversion of order flow in the B shares is likely to decrease market liquidity as marketmakers face higher inventory carrying costs.

The presence of arbitrageurs who observe intermarket prices and trade simultaneously exacerbates this problem. Let b denote the magnitude of transactions costs associated with arbitrage. An arbitrageur who has access to intermarket quotes will buy the domestic stock if $P_k(X_k = -1) - p_k(x_k = 1) - b > 0$ and sell if $p_k(x_k = -1) - P_k(X_k = 1) - b > 0$. From the viewpoint of a domestic marketmaker, there is a positive probability that the price in the foreign market reflects more recent information. This is especially so when trading activity in the ADR market greatly exceeds that of the domestic market (e.g., Telefonos de Mexico) so that price discovery essentially takes place abroad. Thus, with arbitrage present, the adverse selection costs of domestic dealers increase, so that λ rises and liquidity falls.

Conversely, transactions costs may fall in those segments of the equity market facing foreign competition (i.e., B series) as domestic marketmakers cut spreads in an attempt to retain order flow. To see this, recall that the probability a trader will buy or sell is given by $1 - \zeta$, which is inversely related to the spread element s. If the costs of information acquisition are identical in the two markets, a trader will direct the order to the market with the lowest spread. The threat of potential competition from foreign markets may induce domestic dealers to reduce s to remain competitive even as their adverse selection costs increase because, other things equal, an investor will trade in the market where $\lambda + s$ is the lowest. Such competition will be observed in the B series shares (assuming that s contains rent elements) which are open to foreign investors, but not necessarily in A shares where the migration of foreign investors is not a factor. No such effects are observed in the pure fragmentation case considered above because quotations in the other market are not observed by a trader at the time of order placement, eliminating dealers' incentives to compete on the basis of price.

The impact of cross-listing on fundamental or base-case volatility in the partial fragmentation case is more complex. If intermarket information links are poor or if new investors in the foreign market have low quality information signals, base-level volatility will tend to increase. This occurs because the variance of the public information signal σ_ϵ^2 regarding overnight information flows increases as domestic trading intensity falls. In the case of Mexico, the small lack of complete overlap of trading hours with U.S. markets may contribute to this effect. It is also possible that exposure to a new, foreign factor may cause an increase in base-level volatility. For example, the covariance term w_k can lead to differences in valuations between foreign and domestic investors. Time variation in this factor may result in additional price volatility after cross-listing, because the market price represents an average of foreign and domestic valuations.

Alternatively, if intermarket information links are relatively good and the new investors participating in trading in the foreign market contribute significantly to price discovery, base-level volatility will fall as information aggregation improves. The net impact of cross-listing on the volatility of information flows is thus an empirical issue.

III. Empirical Results

A. Estimating the Changes in Liquidity and Volatility

Recall from equation (3) that price movements reflect two components: (i) base-level volatility arising from imperfect public information, and (ii) transitory volatility arising from trading frictions and information asymmetry. The latter term is the product of volume and a parameter that is inversely related to market liquidity. Given data on prices and volumes, we estimate jointly the changes in volatility and liquidity around ADR introduction. We proxy for the unobservable price variance term on day t with the squared price change on that day. When the number of traders is large, the cumulative price movements are approximately normal, and the expected absolute daily price change is proportional to the standard deviation of daily price changes. It also seems economically plausible that fundamental (or base-level) volatility may be related to price movements on the previous day. Accordingly, we estimate:

$$(\Delta P_t)^2 = \gamma_t + \delta_t(\Delta P_{t-1})^2 + \lambda_t V_t + \eta_t, \tag{5}$$

with time-varying parameters given by

$$\begin{aligned} \gamma_t &= \gamma_0 + \gamma_1 ADR_t \\ \delta_t &= \delta_0 + \delta_1 ADR_t \\ \lambda_t &= \lambda_0 + \lambda_1 ADR_t, \end{aligned} \tag{6}$$

where V_t is the volume on day t, ADR_t is a dummy variable taking the value 0 if date t is before the ADR listing and 1 otherwise, and η_t is the error term. Here, γ_t represents the base-level volatility, δ_t captures any dependency between current and past volatility, and λ_t reflects the responsiveness of price to volume. We expect that current volatility is likely to depend on past volatility, so that $\delta_0 > 0$.

Under integration, the ADR listing increases the flow of public information, reducing price volatility and increasing market liquidity, so that λ_1 and γ_1 are negative. Under fragmentation, the ADR listing decreases liquidity and increases price volatility so that λ_1 and γ_1 are positive. The partial fragmentation case implies a reduction in liquidity for those segments of the equity market where migration is most likely to occur.

We estimate the time-varying parameter model in equations (5) and (6) using generalized method of moments (GMM) estimators. Table III contains the coefficient estimates, with corresponding autocorrelation-heteroskedasticity consistent standard errors in parentheses, for all twenty-five series in the sample grouped by series type. There are several results of interest. First, the estimates provide support for the decomposition of price volatility provided by the theoretical model. In particular, the base-level volatility coefficient γ_0 is positive in all but one case (the exception is virtually zero), and the coefficient on volume λ_0 is positive in twenty-three of twenty-five cases as predicted.

Second, the median coefficient estimate of the base-level volatility coefficient γ_0 is 0.007 (the mean is 0.057) and the median coefficient γ_1 is 0.024 (the mean is 0.286), implying a dramatic increase in base-level volatility following the ADR listing. This increase is observed in twenty-one of the twenty-five series. In particular, fundamental volatility increases in thirteen of the fourteen series open to foreign ownership (i.e., the B, C, L, and O series) and in all nine of the B series shares, at generally high levels of

Table III

Generalized Method of Moment Estimates

This table contains coefficient estimates and heteroskedasticity-consistent standard errors (in parentheses) for the model

$$(\Delta P_t)^2 = \gamma_t + \delta_t(\Delta P_{t-1})^2 + \lambda_t V_t + \eta_t$$

$$\gamma_t = \gamma_0 + \gamma_1 ADR_t$$

$$\delta_t = \delta_0 + \delta_1 ADR_t$$

$$\lambda_t = \lambda_0 + \lambda_1 ADR_t.$$

The model is estimated by generalized method of moments, with equations for multiple stock series within a single company estimated jointly. The series represent all stocks traded on the Bolsa Mexicana de Valores for which an ADR was introduced. The variables ΔP_t and V_t are price change and volume (tens of millions of shares), respectively. The variable ADR_t is equal to zero prior to the date of the ADR listing and is one thereafter. Superscript a denotes scaling by 10^3. Panel A lists results for the series restricted to Mexican ownership domestically, Panel B for B shares, open to foreign ownership, and Panel C for other share series open to foreigners.

Series	γ_0	γ_1	δ_0	δ_1	λ_0	λ_1
			Panel A: A Series			
CEM	0.031	0.516	0.149	0.009	0.745	7.956
	(0.009)	(0.104)	(0.084)	(0.100)	(0.215)	(2.789)
CIF	0.007	0.048	0.054	0.005	−0.004	0.013
	(0.002)	(0.007)	(0.048)	(0.061)	(0.003)	(0.015)
EPN	0.015[a]	−0.003	−0.012	0.010	0.001	0.016
	(0.008)[a]	(0.014)	(0.021)	(0.021)	(0.000)	(0.009)
GCA	0.159	0.280	0.015	0.321	9.697	−6.488
	(0.067)	(0.187)	(0.031)	(0.091)	(6.957)	(7.456)
MAS	0.050	0.024	0.100	−0.018	0.982	0.281
	(0.011)	(0.019)	(0.076)	(0.111)	(0.442)	(0.572)
PON	−0.001[a]	0.021[a]	0.012	−0.119	0.063	−0.280
	(0.002)[a]	(0.005)[a]	(0.018)	(0.073)	(0.036)	(0.571)
SAN	0.006	−0.003	−0.011	0.060	0.001	0.033
	(0.001)	(0.001)	(0.032)	(0.047)	(0.001)	(0.010)
SANAV	0.005	−0.002	0.141	−0.078	0.000	0.009
	(0.001)	(0.001)	(0.064)	(0.075)	(0.001)	(0.004)
SYN	0.001	0.008	0.102	0.026	−0.002	0.066
	(0.000)	(0.002)	(0.095)	(0.167)	(0.001)	(0.049)
TEL	0.007	0.092	0.333	−0.320	0.003	−0.014
	(0.002)	(0.011)	(0.125)	(0.123)	(0.002)	(0.025)
TMM	0.280	0.005	−0.003	0.111	18.21	−8.422
	(0.090)	(0.107)	(0.073)	(0.080)	(3.925)	(7.585)

Table III—*Continued*

Series	γ_0	γ_1	δ_0	δ_1	λ_0	λ_1
			Panel B: B Series			
CEM	0.114	0.475	−0.066	0.205	0.098	4.457
	(0.025)	(0.089)	(0.032)	(0.061)	(0.063)	(1.741)
CER	0.002	0.015	0.048	0.045	0.714	0.173
	(0.001)	(0.003)	(0.049)	(0.079)	(0.264)	(0.445)
CIF	0.005	0.070	0.110	0.024	0.025	−0.012
	(0.001)	(0.012)	(0.093)	(0.120)	(0.019)	(0.034)
COM	0.001	0.004	0.130	−0.048	0.019	0.005
	(0.000)	(0.000)	(0.085)	(0.095)	(0.006)	(0.016)
FEM	0.018	0.093	0.075	0.126	0.007	−0.023
	(0.002)	(0.012)	(0.055)	(0.100)	(0.018)	(0.028)
MAS	0.038	0.030	0.182	−0.072	0.808	−0.214
	(0.009)	(0.017)	(0.088)	(0.108)	(0.281)	(0.373)
PON	0.010[a]	0.013[a]	0.194	−0.101	0.001	0.001
	(0.002)	(0.003)	(0.058)	(0.092)	(0.004)	(0.000)
SYN	0.001	0.003	0.027	0.051	−0.004	0.853
	(0.000)	(0.001)	(0.043)	(0.072)	(0.008)	(0.424)
TTO	0.045	0.074	0.209	−0.113	0.053	2.656
	(0.006)	(0.037)	(0.114)	(0.134)	(0.055)	(0.809)
			Panel C: Other Series			
CIFC	0.001	0.006	0.119	−0.022	0.001	−0.001
	(0.000)	(0.001)	(0.171)	(0.175)	(0.000)	(0.001)
LIVC	0.027	0.159	0.149	−0.141	2.020	−0.653
	(0.006)	(0.033)	(0.073)	(0.087)	(0.142)	(0.334)
LIVO	0.045	0.050	0.095	0.075	0.792	1.031
	(0.007)	(0.023)	(0.050)	(0.114)	(0.212)	(1.034)
TMML	0.026	−0.052	−0.058	0.133	21.50	15.63
	(0.143)	(0.158)	(0.043)	(0.055)	(16.46)	(27.40)
VITO	0.555	5.267	0.109	−0.101	82.49	−84.48
	(0.302)	(1.164)	(0.060)	(0.063)	(27.28)	(27.40)

statistical significance. Though previous studies (see, e.g., Jayaraman, Shastri, and Tandon (1993), and Karolyi (1996)) document an increase in the return variance following international listing, our analysis shows that the change in volatility is due to factors unrelated to volume, that, in fact, the change is the result of changes in the information structure. The coefficient δ_0, which captures the sensitivity of current volatility to past volatility shocks, is positive in twenty-one of the twenty-five cases, as expected, and does not change in any systematic way after cross-listing.

Third, the shifts in the liquidity coefficients following ADR listing are differentiated by series type. In six of the eleven A series shares (which are restricted to Mexican nationals), cross-listing is associated with a decrease in liquidity (i.e., λ_1 is positive), and in three of those six the decrease is statistically significant at the 1 percent level. By contrast, of the five cases where liquidity increased in A series shares, none is statistically significant. In the B shares, which are open to both foreign and domestic investors, the evidence for a reduction in liquidity upon cross-listing is far more compelling. Indeed, in the B series shares, liquidity falls in six of the nine cases, four of which are statistically significant at the 1 percent level, and of the three cases where liquidity increases, none is statistically significant. The changes in liquidity in the remaining five series (C, L, and O) do not exhibit a systematic pattern.

We also perform some tests to ensure that our results are not driven by potential nonlinearities in the volatility-volume relation. A common diagnostic method to detect nonlinearities is to examine the pattern of residuals. Misspecification would be manifested in the form of serial correlation in the residuals. For example, if the true relation were concave, the predicted volatility on a high-volume day is too high, generating a negative residual. Because high-volume days are likely to be clustered in time, this form of misspecification will result in serial correlation in the residuals. However, Lagrange multiplier tests for serial correlation in the residuals of the model fail to reject the null of no serial correlation in all but two cases in the sample. On this basis, if there is some nonlinearity, it must be minor, relative to the linear relationship predicted by theory. Estimates of various semiparametric nonlinear models also support our use of a linear specification.[5]

In summary, our results thus far suggest that ADR listing is associated with a general increase in base-level volatility unrelated to volume. There is evidence of reduced liquidity in the form of an increased sensitivity of price variability to volume, especially in the B series shares, which were open to foreign ownership prior to the international cross-listing. For the case of shares for which ownership was restricted to residents of the home country prior to ADR listing, as with shares with limited voting rights, the results are inconclusive.[6] These findings reject the integration hypothesis, but are consistent with both fragmentation hypotheses discussed above.

B. Computation and Testing of Implicit Spreads

Our model suggests that cross-listing may induce changes in the bid-ask spread. Unfortunately, without quotation data we cannot directly make inferences about the bid-ask spread. Roll (1984) uses the covariance in suc-

[5] Models estimated using squared volume, for example, produce the same qualitative results as reported here. Other nonlinear alternatives are tried, with the same result. We also conduct direct tests for nonlinearity, as exposited in Granger (1995), and cannot reject the null of a linear model in all but two cases.

[6] The precise series (A, B, etc.) for which the ADR is listed appears not to matter in the analysis. We match the precise series for eleven companies: CEM (B), CIF (B), SAN (A), PON (B), GCA (A), MAS (A, B), SYN (B), TEL (A, L), LIV (C), VIT (O), leaving us with five companies for which we can differentiate between ADR and non-ADR series, the results for which contribute no additional information to the analysis.

cessive price changes to make inferences about the size of the bid-ask spread when bid-ask quotations are unavailable. We use a related approach by George, Kaul, and Nimalendran (1991) (GKN) which offers several extensions to Roll's model, including adjustments for potential serial correlation in returns. Our approach to estimation differs slightly from GKN in the way we adjust for autocorrelation and by our use of GMM to jointly estimate the underlying parameters of the implicit spread. The GMM technique is attractive for several reasons, but most importantly because we can construct a new statistic to test the change in implicit spreads following the ADR listing. Since the GKN procedure is well known, we will concentrate in this section on the development of this test statistic.[7]

The modified GKN estimate of the spread can be written as $S = 2\sqrt{-\psi(\Gamma)}$ where ψ is the covariance between returns at times t and $t + 1$. The vector $\boldsymbol{\Gamma}$ contains parameters relating to the GKN prefiltering process, as well as the mean and variance of the adjusted returns. Let the subscripts 0 and 1 denote before and after ADR introduction, respectively. The change in the implicit bid-ask spread following the ADR listing is $h(\psi_1,\psi_0) \equiv S_1 - S_0$, where $s_1 = 2\sqrt{-\psi_1(\Gamma)}$ and $S_0 = 2\sqrt{-\psi_0(\Gamma)}$. The hypothesis of interest is whether the change in spreads is equal to zero:

$$H_0\colon h(\psi_1,\psi_0) = 0. \tag{7}$$

We estimate the vector $\boldsymbol{\Gamma}$ using GMM; Hansen (1982) proves that the GMM estimate, ψ_Γ^G is consistent and asymptotically normally distributed under very weak conditions. Standard arguments imply that the statistic

$$h(\psi_1^G,\psi_0^G)^2\Sigma^{-1} \tag{8}$$

is distributed as χ^2 (1) under the null hypothesis of equation(7), where Σ is the (scalar) variance of $h(\psi_1^G,\psi_0^G)$. A series of mean-value expansions yields

$$\Sigma = \nabla_\psi h(\psi_1,\psi_0)' \nabla_\Gamma \psi(\Gamma)' \Omega_\Gamma \nabla_\Gamma \psi(\Gamma) \nabla_\psi h(\psi_1,\psi_0),$$

where $\nabla_\psi h$ and $\nabla_\Gamma \psi$ are the gradient vectors of $h(\psi_1,\psi_0)$ and $\psi(\Gamma)$, respectively, and Ω_Γ is the variance-covariance matrix of the estimated vector $\boldsymbol{\Gamma}$. This expression can be used to compute the test statistic in expression (8) given GMM estimates of the spread before and after ADR introduction, computed in the standard way.

Information with respect to the tests of changes in implicit spreads after ADR listing is provided in Table IV. The difference in spreads across the two periods is reported with the computed significance level of the test against the null hypothesis of a zero difference in the spread. The estimated spread

[7] Estimates of bid-ask spreads based on indirect methods such as the GKN model may be subject to misspecification biases as shown by Jones and Lipson (1995).

Table IV

Tests of Spread Equality across ADR Listing

This table contains the differences in the implicit bid-ask spread after the ADR listing less the implicit spread before the ADR listing, denoted as ΔS, using the method of George, Kaul, and Nimalendran (1991). Prob(ΔS) is the significance level for a test against the null hypothesis of zero difference in the spread following the ADR listing.

	A		B		Other	
Series	ΔS	Prob(ΔS)	ΔS	Prob(ΔS)	ΔS	Prob(ΔS)
CEM	−0.004	0.083	−0.095	0.003	—	—
CER	—	—	0.034	0.001	—	—
CIF	0.016	0.042	−0.003	0.076	−0.001	0.521
COM	—	—	0.000	0.822	—	—
EPN	0.000	0.837	—	—	—	—
FEM	—	—	−0.001	0.177	—	—
GCA	−0.135	0.001	—	—	—	—
LIVO	—	—	—	—	−0.032	0.015
LIVC	—	—	—	—	−0.036	0.007
MAS	−0.018	0.123	−0.021	0.050	—	—
PON	0.001	0.180	0.001	0.410	—	—
SAN	−0.007	0.175	—	—	—	—
SANAV	−0.004	0.215	—	—	—	—
SYN	−0.002	0.696	−0.013	0.067	—	—
TMM	−0.018	0.774	—	—	−0.003	0.899
TTO	—	—	−0.005	0.055	—	—
VIT	—	—	—	—	0.000	—

decreases in seventeen of twenty-two series that experienced changes sufficient to allow computation of the significance level. These decreases tend to be concentrated in series that allowed foreign ownership prior to the ADR introduction. Specifically, of the thirteen series open to foreign ownership where spreads did change, there was a decrease in ten series, seven of which were statistically significant at the 10 percent level. This is especially surprising because one component of the spread, captured by the adverse selection parameter λ, tended to also increase. This suggests that the decrease in spreads reflects a general decline in the order-processing element of the spread (s in our model), perhaps reflecting increased intermarket competition.

The decline in spreads for share issues open to foreign ownership, associated with a decrease in liquidity and an increase in return volatility unrelated to volume, is not consistent with the fragmentation hypothesis, but fits the partial fragmentation hypothesis. Indeed, Foerster and Karolyi (1994), in their study of cross-listed Canadian stocks, find that changes in trading costs are related to both domestic and foreign volume. Such effects are most likely to be observed in issues open to foreign investors, because these investors are probably the most likely to obtain lower transaction costs in U.S. ADR markets.

There is additional support for the partial fragmentation hypothesis. Domowitz, Glen, and Madhavan (1997) examine the prices of a different sample consisting of *purely domestically* traded Mexican stocks subject to ownership restrictions that distinguish between individual and institutional investors and between foreign and domestic investors. They find price differentials between restricted and unrestricted stock (in a manner predicted by Stulz and Wasserfallen (1995)), which suggests that these investment restrictions can cause segmentation. If this were not the case, the partial fragmentation hypothesis clearly could not explain our findings.

C. Stock Price Effects

To investigate the effects of ADR listing on domestic stock prices, we form equally weighted portfolios of the underlying Mexican shares for 101 trading days around the listing day of ADRs listed from December 1989 through June 1992. The portfolios considered are: (i) All shares, (ii) A Series Shares, (iii) B Series Shares, and (iv) Level III ADRs (shares for which additional equity capital was issued upon listing.) We estimate the daily excess return, computed as the residuals from the standard market model estimated from the earliest day for which observations are available by stock up to 51 days *prior* to the listing date (day 0). Shares with fewer than 75 days of data prior to day -51 are excluded from the portfolios.

Table V contains the average daily cumulative excess returns, in percent, for the five portfolios considered. The figures in parentheses represent the significance levels for a statistical test that cumulative returns are zero. Although the cumulative excess returns for all shares are positive from day -40 onward and total 6.77 percent by the date of listing, these returns are not statistically significantly different from zero. The breakdown by series type shows that the excess returns for all shares derive largely from the B shares. Indeed, by day 0, the cumulative excess return is 14.4 percent and this is statistically significant at the 10 percent level. By contrast, the A shares show smaller positive excess returns and the cumulative returns are not statistically significant. There is little evidence of any systematic price effects associated with Level III ADRs, possibly because any benefits from cross-listing are spread over longer periods or are anticipated further in advance. Indeed, Foerster and Karolyi (1996) find significant abnormal returns for a portfolio of 160 foreign firms in the year prior to cross-listing.

D. Economy-Wide Effects

The effects we attribute to international cross-listing may reflect economy-wide economic or political effects (see, e.g., Bailey and Chung (1995)) over the sample period. To investigate this issue, we gather data on nine companies traded on the BMV for which there are no associated ADRs listed over the sample period with comparable trading volume and market capitaliza-

Table V

Cumulative Excess Returns around ADR Listing

This table contains average daily cumulative excess returns, in percent, for equally weighted portfolios of the underlying Mexican shares for 101 trading days around the listing day of ADRs listed from December 1989 through June 1992. Significance levels for a test that cumulative returns are zero are given in parentheses. Daily excess returns are computed as the residuals from the standard market model, estimated from the earliest day for which observations are available by stock up to 51 days prior to the listing date. Mexican shares with fewer than 75 days of data prior to day 51 before listing are excluded from the portfolios. Each column head signifies the portfolio considered: All shares, A shares, B shares, and Level III (shares for which additional equity capital was issued as part of the ADR listing).

Day	All Shares	A Shares	B Shares	Level III
−50	−0.10	−0.09	−0.16	0.08
	(0.93)	(0.96)	(0.88)	(0.90)
−40	1.49	2.46	2.96	0.54
	(0.71)	(0.57)	(0.48)	(0.92)
−30	3.56	2.89	7.22	4.05
	(0.53)	(0.62)	(0.21)	(0.48)
−20	5.35	5.19	9.82	3.91
	(0.44)	(0.45)	(0.17)	(0.62)
−10	6.69	4.61	13.3	4.65
	(0.37)	(0.54)	(0.09)	(0.53)
0	6.77	4.86	14.4	4.75
	(0.41)	(0.56)	(0.09)	(0.60)
+10	6.35	4.71	17.2	1.41
	(0.48)	(0.61)	(0.07)	(0.89)
+20	5.50	2.97	16.9	2.34
	(0.55)	(0.72)	(0.10)	(0.78)
+30	6.80	3.15	19.6	1.79
	(0.50)	(0.73)	(0.07)	(0.86)
+40	5.12	1.46	18.8	−2.01
	(0.63)	(0.88)	(0.11)	(0.83)
+50	2.62	−1.93	17.9	−3.26
	(0.79)	(0.92)	(0.15)	(0.75)

tion to our ADR sample.[8] Series A, B, C, and O shares are represented in the control group, as well as disparate industries including brokerage, chemicals, banking, paper, and steel.

We analyze these series with respect to base-volatility changes, liquidity shifts, price effects, and potential impacts on returns. Equations (5) and (6) are first estimated for all nine series, but with the dummy variable for ADR introduction set in the middle of the period over which ADRs were introduced. We also estimate the same equations using intervention analysis, a

[8] The control companies are Grupo Industrial Alfa (Series A, holding company); Quimica Borden (Series B, chemicals); Grupo Bursatil Mexicano (Series C, brokerage); Corporacion Mexicana de Aviacion (Series C, holding company); Banco Internationale (Series B, banking); Kimberly Clark de Mexico (Series A, cellulose and paper); Multibanco Comermex (Series B, banking); Banca Serfin (Series B, banking); and Tubos de Acero de Mexico (Series O, steel).

procedure that uses a likelihood ratio test to detect statistically significant periodic shifts in volatility and liquidity. Under both approaches, we cannot reject the hypothesis that there are no changes in base-level volatility and liquidity for all series at reasonable levels of significance. Indeed, significance levels ranged from a low of about 0.80 to 0.99. Price changes are more pronounced in the ADR sample, with a positive price change that is 56 percent greater than for the change for control group (computed using a midpoint date), but these differences are economically small. We find no differences in the level of returns between the ADR sample and the control group. These results indicate that our results are unlikely to be the result of economy-wide effects. These results also suggest that the negative effects on liquidity documented for some ADR stocks had no significant spillover effects to non-ADR stocks.

E. The U.S. ADR Market

The U.S. ADR market provides an additional perspective on our results. As shown in Table I, most of the ADRs in our sample are traded in the 144A market (where qualified institutional buyers can trade securities that do not meet strict disclosure requirements) or in the over-the-counter market. Because transactions in informal upstairs markets need not be disclosed, they do not appear on the ticker tape, and hence data are unavailable for these securities in public databases. We obtain information on trading volumes for three of the ADRs traded in the United States for which such data are available. These stocks are actively traded and account for the majority of market value of the sample. We use the U.S. ADR data to directly measure the extent to which cross-listing results in a broadening of participation abroad.

Table VI contains summary statistics on BMV-listed share returns and their corresponding U.S.-listed ADR returns in issues for which trading information in both markets is available. The table also contains the details of statistical tests of equality of average daily returns. The average returns in the two markets are very similar but are generally not *identical*, suggesting that there are opportunities for profitable cross-country trading. Our conversations with traders in Mexico and the United States suggest that this is the case, which is consistent with our presumption that the two markets are not perfectly transparent. It is also possible that the differences in average daily returns between the two markets reflect nonsynchronous trading (since the opening and closing times in Mexico and the United States do not perfectly overlap), the effect of currency movements that affect dollar-denominated returns, or bid-ask bounce.

We are also interested in the extent to which the U.S. markets divert order flow away from the domestic markets. Following Foerster and Karolyi (1994), we compute three summary statistics about the gains in order flow and total volume in shares for which information is available for trading in

Table VI

Summary Statistics on Returns

This table contains summary statistics on Bolsa Mexicana de Valores (BMV)-listed share returns and their corresponding U.S.-listed ADR returns in issues for which trading information in both venues was available. The first three rows contain average daily percentage returns on the BMV, prior- and post-ADR introduction, and percentage returns for the U.S. ADR, respectively. The remaining rows contain statistical significance levels for tests of equality of average daily returns. "6 mos" denotes a test based on daily returns measured over the six months before and/or after the month of ADR introduction. For example, BMV = BMV denotes a test of equality for shares traded on the BMV before and after ADR introduction; BMV = BMV (6 mos) tests returns for equality over the six-month period before and after the ADR month.

	VIT O	TMM A	TMM L
BMV prior	0.22	0.16	0.21
BMV post	0.04	0.28	0.26
U.S. ADR	−0.06	0.34	0.32
BMV = U.S.	0.94	0.85	0.83
BMV = U.S. (6 mos)	0.98	0.85	0.83
BMV = BMV	0.11	0.48	0.78
BMV = BMV (6 mos)	0.33	0.68	0.87
BMV prior = U.S.	0.08	0.34	0.56
BMV prior = U.S. (6 mos)	0.32	0.60	0.73

both the U.S.-listed ADR and the underlying Mexican share on the BMV. Specifically, Table VII shows the percentage gain in daily order flow in Mexico after ADR introduction in the United States (termed "Order Flow"), computed as the ratio of average daily dollar volume post-ADR listing to average daily volume prior to listing, less one. We also compute U.S. Flow, the ratio of the average daily dollar volume in the U.S. ADR market to the average daily volume traded on the BMV, less one. This statistic captures the size of the U.S. market relative to the prelisting domestic market. The percentage gain in total volume postlisting is the sum of U.S. Flow and Order Flow.

Order flow is negative for TMM L shares, suggesting order flow migration. For VIT O shares and TMM A shares, however, order flow is positive, indicating a net increase in volume. Interestingly, the U.S. market appears large relative to the pre-listing domestic market. This is consistent with our hypothesis that the increase in fundamental volatility is due to the shift to price discovery abroad. Overall, volume rose in three stocks, the exception being TMML which experienced a modest decline in total volume. In summary, the results from the ADR market provide some evidence consistent with order flow migration, but it is difficult to discern a general pattern given the limited sample available to us. The most comparable study, by Foerster and Karolyi (1994) for Canadian stocks, also finds considerable variation in the extent of order flow migration across companies.

Table VII

Gains in Order Flow across Markets after ADR Listing

This table contains three summary statistics relating to gains in order flow and total volume in shares for which information was available for trading in both the U.S.-listed ADR and the underlying Mexican share on the Bolsa Mexican de Valores (BMV). The column marked Order Flow contains the percentage gain in daily order flow in the Mexican market after ADR introduction in the United States, computed as the ratio of average daily dollar volume prior to ADR introduction to average daily dollar volume post introduction, less one. The column marked U.S. Flow contains the ratio of the average daily dollar volume in the U.S. ADR market to the average daily dollar volume traded on the BMV prior to ADR introduction, less one. The column marked Total Flow is the percentage gain in total volume after ADR introduction, computed by summing the first two columns, plus one.

Stock	Order Flow	U.S. Flow	Total Flow
VIT O	67%	−86%	81%
TMM A	177%	−76%	201%
TMM L	−24%	−90%	−14%

IV. Conclusion

Despite the rapid increase in the number of internationally cross-listed securities, relatively little is known about the impact of such actions on the domestic market. This topic is especially important for emerging markets that are smaller and less liquid than the foreign market where cross-listing occurs. Our theoretical analysis highlights the importance of intermarket information linkages in determining the impact of international cross-listing on measures of domestic market quality including the precision of public information, market depth, and bid-ask spreads.

We use data from the Mexican equity market to distinguish empirically between the possible effects of cross-listing on domestic market quality predicted by our theoretical analysis. The Mexican market offers a unique opportunity to analyze questions relating to intermarket competition. The domestic market faces direct competition from U.S. ADR markets during exchange hours, and foreign ownership restrictions allow us to better understand the potential effects of order flow migration by foreign investors following cross-listing.

We demonstrate that the traditional dichotomy between market integration and fragmentation is inappropriate in considering the effects of foreign listing. Rather, international listing embodies aspects of both the benefits from increased intermarket competition and the costs of order flow diversion. In general, ADR introduction is associated with an increase in the variance of public information flows unrelated to the volatility induced by changes in liquidity and trading activity. This is not consistent with market integration. These effects are especially concentrated in those equity series open to foreign participation prior to cross-listing. Such series also show a reduction in liquidity manifested by a heightened sensitivity of price variability to volume, possibly the result of the migration of foreign investors. However, such shares also experience a decline in the implicit bid-ask spread following ADR introduction, which is consistent with increased competition among domestic liquidity providers to retain order flow following cross-listing.

Our analysis suggests several new directions for further analysis. First, our findings suggest that corporate governance issues may play an important role in a firm's decision to cross-list its stock because the costs and benefits of cross-listing are not uniformly distributed across all share series. For example, consider a closely held company where controlling ownership is concentrated in the A series shares. Following cross-listing, the costs associated with order-flow migration (in terms of liquidity and price volatility) will largely accrue to other series where trading occurs, whereas the benefits (in terms of increased ability to access international capital markets) accrue to the firm as a whole.

Second, the effects of cross-listing are likely to vary systematically across securities and across nations. For example, the extent to which intermarket competition can reduce spreads depends on intramarket competition among domestic dealers, which in turn may differ with market capitalization. Similar remarks apply to companies in nations where, by virtue of geography or technology, intermarket information linkages are of high quality.

Finally, the impact of foreign equity ownership restrictions is an important public policy issue; our results suggest that such restrictions are sources of intramarket segmentation, but do not explain why such restrictions may be binding. These are topics for future research.

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