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The Impact of Momentum Trades on Return Comovements and Asymmetric Volatility in Dual Listings

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Abstract

We empirically investigate the impact of volume on serial return comovements (continuation vs. reversal) and asymmetric volatility (inverse relation with excess return) of 175 ADRs and their underlying securities in 27 countries. We classify +/-/0 trade momentum days based on a joint distribution of volume and return and determine how momentum affects return comovements and asymmetric volatility. Our VAR estimates confirm asymmetric volume comovements, positive volume return correlations implying continuation, and non-monotonic effects of excess return on volatility among ADRs and their underlying home shares. Return comovements and asymmetric volatility are associated with momentum, size, and liquidity.

Keywords: ADR, Volume comovement, Return correlation, Volatility, VAR
JEL: G11, G15

1. Introduction

Using a panel of daily price and volume data on 175 ADRs listed on the New York Stock Exchange (NYSE later) and their underlying securities from 27 developed and emerging markets around the world over a period of 3-21 years, we empirically determine the impact of trading volume, specifically information vs. hedging or allocation motives implicit in trades on the return and volatility dynamics of cross listed securities. Further, we exploit the richness of the long time series data at our disposal to propose a time varying trade momentum indicator based on a joint distribution of excess volume and return and test whether this new momentum measure explains asymmetric return and volatility dynamics after controlling for available information, liquidity, and market frictions proxies.

Specifically, we build on Gagnon and Karolyi (2009) and Abramov et al. (2006) regarding volume and trades' effects on return spillover and asymmetric volatility respectively and ask the following questions:[1] How does volume surprise or unanticipated volume adjusted for volume comovements between pairs of cross listings impact return spillover, serial auto and cross correlations of and between ADRs and their underlying home securities? Further, how do auto and cross security volume surprises impact asymmetric volatility, the inverse relation between return and volatility of ADRs and their corresponding home listings? Finally, how do diverse trading motives, specifically, information, hedging, and most importantly momentum contained in trading volume affect the parameters corresponding to both volume surprise induced return spillover and asymmetric volatility?

Two existing strands of empirical research on the effect of volume or trades on securities return spillover and asymmetric volatility provide the foundation of our investigation. First, Llorente et al. (2002) test the empirical predictions in Campbell et al. (1993) and Wang (1994) that continuations (reversals) in volume induced return spillover observed by Conrad et al. (1994) with respect to domestic US securities are due to informed (hedging or allocation motivated) trades in small (large) and inactive (active) trading stocks. Gagnon and Karolyi (2009) extend this literature to cross listed securities at home and abroad and document that firms with low (high) levels of information asymmetry witness return reversals (weaker reversal or continuation) in one market following high trading in the alternate market; in addition, they report that return spillover, be it continuation or reversal, is more pronounced when it originates

[1] We use the term spillover rather broadly to indicate serial autocorrelations for a security and also serial cross correlations between matching pairs of securities. We also use the terms volume surprise and unanticipated volume interchangeably throughout the paper. In this paper, our primary interest is to analyze the impact of volume surprise on serial auto and cross correlations in returns and asymmetric volatility. We assume all trades are in round lots of one and hence ignore trade size effect on return spillover and asymmetric volatility. This assumption implies volume and number of trades are identical.

from the home rather than the host US market. Gagnon and Karolyi (2009) ignore volume comovements between corresponding pairs of cross listed securities and use a moving average filter for the purpose of computing unanticipated volume for a security. Their evidence suggests more liquidity than information content in volume, albeit scattered and limited. They find only a few country level significant determinants such as emerging vs. developed markets and capital control, which affect US to home volume return spillover but not the converse, home to US spillovers; on the contrary, their firm level significant determinants include primarily home and/or US liquidity measures affecting both US (home) to home (US) volume return spillover coefficients.

Second, Abramov et al. (2006) investigate the impact of informed (contrarian) and uninformed (herding or liquidity) trades on asymmetric volatility, the observed inverse relation between excess return and volatility of domestic US stocks and find empirical support for the seemingly counterintuitive implications in Wang (1993, 1994) and Campbell et al. (1993) that volatility must decrease (increase) with information (hedging or liquidity) motivated trades generating positive (non-positive) excess return. However, the impact of home and host market trades on the excess return volatility dynamics of cross listed securities is still unknown.

Empirically, we address those voids in the literature as follows. First, in a bivariate VAR model, we incorporate cross security volume for estimating trading volume forecasts of each ADR and its underlying home security, wherein the prediction errors denote unanticipated volume. Second, we estimate the VAR parameters, auto and cross serial return correlation coefficients along with those corresponding to two interaction variables, excess volume times returns for ADR and home securities to test the implications of information vs. hedging/allocation motives revealed in volume. We propose a new and unique trade momentum measure, a trinary indicator variable derived from a joint distribution of excess volume and return that allows us to split the sample into three separate subsamples of positive, negative, and zero (no) momentum days. We test for differences among the mean serial correlation parameter estimates corresponding to those momentum subsamples. Third, we estimate the parameters of yet another bivariate VAR model for volatility in which excess returns and excess volume times excess returns enter into each security's volatility function. We estimate the corresponding parameters of asymmetric volatility, relation between excess return and volatility for the momentum subsamples and test for significant differences, if any. Finally, in a regression setup, we determine the effect of momentum content in trading volume on those return spillover and asymmetric volatility parameter estimates after controlling for size, liquidity, market type (developed and emerging), and time overlap (large, small, and no) for our sample of cross listed securities.

Our empirical results find the following. First, there is overwhelming evidence of lag auto comovements for all ADRs and their underlying home securities volumes but asymmetric lag cross comovements in approximately 40 percent of ADRs but all of their corresponding home shares volumes. Second, first order serial return autocorrelations are largely negative while return cross correlations are uniformly positive for both ADRs and their corresponding home shares. While the number of significant coefficients associated with the volume induced correlations is somewhat limited, the mean auto and cross correlations are positive for both ADRs and their underlying home shares indicating continuation and hence information content in volume. Positive (negative) return spillover coefficients are strongly associated with momentum (non-momentum) trading days. Third, the mix of positive and negative coefficients corresponding to lag excess return and lag excess return times volume indicate departure from the existing evidence on asymmetric volatility, the inverse relation between excess return and volatility for both ADRs and their underlying home shares. Those departures are seemingly due to cross security excess return and volume effects and are related to joint volume return based momentum trading. Fourth, we find momentum content in trading volume is a significant determinant of asymmetric return spillover (continuation, reversal, or insignificant) and the relation between excess return and volatility even after controlling for firm size, liquidity, and market frictions denoted by emerging vs. developed markets and countries with different levels of trading time overlaps with the US. We interpret our overall evidence of the asymmetry in volume surprise induced return spillover and volume effect on asymmetric volatility as due to multiple trading motives including momentum contained in volume.

Our research contributes to the literature in multiple ways. First, our empirical results from a comprehensive set of dual listings from multiple developed and emerging markets contradict many of the results regarding unanticipated volume effect on return spillover in Gagnon and Karolyi (2009). In particular, we introduce a trade momentum indicator variable and provide evidence of multiple trading motives including information, liquidity, and momentum revealed through trades. Second, in our knowledge, this is the first study of its kind that examines unanticipated volume effects on the excess return volatility relations for a comprehensive set of dually listed securities from multiple developed and emerging markets. Third, we determine if trade momentum explains variations in the volume induced auto and cross correlation coefficients in return and the relation between excess return and volatility. Results from our study show short term predictability in return and volatility for cross listed securities and hence refute security level cross market integration, which in turn opens up potential for risk arbitrage that has direct practical ramifications for international portfolio management, especially in tactical asset allocation and hedging.

2. Hypotheses Development

In this section, we develop testable hypotheses regarding how volume content, specifically information vs. allocation but more importantly momentum that is jointly determined by unanticipated trading volume and return impact serial return comovements and the relation between excess return and volatility for cross listed securities. Brown et al. (2009) confirm trading volume reveal multiple trading motives including information, inventory, and momentum while Booth and Koutmos (1995) and Karolyi and Kho (2004) discuss return generating momentum strategies in the context of international investing. We deviate from the extant definition of momentum based on past performance, so called winners or losers and define trade momentum (also feedback trading) in terms of a return volume momentum where excess volume corresponds to high (low) trading when returns are higher (lower) than expected. Chordia et al. (2000) and Hameed et al. (2009) provide an empirical foundation for understanding volume shocks in anticipation of or response to return movements while Baruch et al. (2007) tie volume of cross listed shares to intra market asset return comovements. The design and implementation of this trade momentum indicator based on the joint distribution of return and volume is the most fundamental contribution of this research.

With that foreword, we move on to developing our first hypothesis related to volume comovements between pairs of cross listed shares. Pagano (1989), Chowdhury and Nanda (1991), and Menkveld (2008) propose theoretical models of multimarket trading volume with discretionary traders and conclude that any optimal trading rule includes the possibility that all or a substantial portion of trading is concentrated in only one market. Nevertheless, Halling et al. (2008) and Feng and Seasholes (2004) report empirical evidence of continued correlated trading in multiple markets presumably by captive non-discretionary investors in a market, who cannot access a complementary market due to trading barriers. Baruch et al. (2007) predict and empirically confirm that volumes for cross listed shares in multiple exchanges are determined by the return correlations with other assets within the respective market (exchange) and Gagnon and Karolyi (2010) explore how volume and return correlations along with correlated multimarket trading create arbitrage opportunities. Empirically, Moulton and Wei (2009) and Halling et al. (2013) report differences in liquidity and significant correlations between trading volumes of securities across multiple trading venues and confirm that the breakdown of trading volumes among those alternative venues depends on multiple trading barriers including time differences, legal systems (market/country specific), and time varying institutional ownership (security specific).

Hypothesis 1: ADRs and their underlying home shares trading volumes commove in response to their respective cross security trades, albeit asymmetrically.

Regarding trading volume impact on serial return autocorrelations for domestic US securities, Conrad et al. (1994) explore the nexus between trading activity and short horizon weekly return comovements for NASDAQ listed securities and report that high (low) activity stocks experience return reversals (continuation of positive correlation). Llorente et al. (2002) broaden the sample to include all US stocks listed on the NYSE and AMEX and test the empirical implications from Campbell et al. (1993) and Wang (1994), wherein they find that the return correlation continuation (reversal) for low (high) activity stocks is due to informed (allocation or hedging motivated) trading in small (large) cap stocks with high (low) level of information asymmetry, which also exhibit high (low) bid ask spreads.

Gagnon and Karolyi (2009) extend the above dynamic volume return literature to cross listed securities and thereby test the above predictions for serial return auto and cross correlations. In a comprehensive study of 556 ADRs and their underlying home securities, they follow a two-step process, wherein first they estimate the autocorrelation and cross correlation parameters along with their interactions with security specific unexpected trading volumes for each security using 50 days moving average for expectation. They confirm that firms with low (high) levels of information asymmetry witness return reversals (weaker or continuation) in one market following high volume in the alternate market; in addition, they find that return spillover, be it continuation or reversal, is more pronounced when it originates from the home market rather than the host (US) market. Thereafter, in the second stage, they estimate the parameters of several pooled univariate regression model where the volume induced spillover parameter is the dependent while the indirect information asymmetry measures like firm size, US and home liquidity, US institutional ownership, and legal system are the independent variables. They report limited support for their hypothesis that information content in unanticipated volume drives the return spillover asymmetry. Nevertheless, Gagnon and Karolyi (2010) document arbitrage opportunities with multimarket correlated trading. We contend that the asymmetric impact of volume on return comovement is likely due to time varying asymmetric proportions of trade momentum latent in trading data.

Hypothesis 2: Trading volume casts asymmetric impact on return comovements between ADRs and their underlying home shares. The asymmetry is enhanced between momentum and non-momentum trades.

We further investigate how volume surprise denoting diverse trading motives including momentum impacts asymmetric volatility, the documented inverse relation between excess return and volatility. Asymmetric volatility in equities is well documented in the US and also in a few international equity markets for low frequency, weekly or monthly data (Booth and Koutmos [1995], Bekaert and Wu [2000], Wu [2001]). While leverage (a fall in stock price increases the debt ratio and consequently leverage risk implying price changes cause volatility) originally proposed by Black (1976) and feedback (large price decline is due to higher expected risk inferring changes in volatility move prices) due to Pindyck (1984) are the most common explanations attributed to observed asymmetric volatility in low frequency studies, both face criticisms including the contention that those explanations may not hold for higher frequency, say daily and intraday data. Bekaert and Wu (2000) argue that a security's asymmetric response (dampen increase but enhance decrease) to a positive or negative market shock creates asymmetric volatility. In contrast, French and Roll (1986), Jones et al. (1994), and Chan and Fong (2000) link asymmetric volatility to trading, particularly excess trading that occurs often in conjunction with high trading frequencies. Cutler et al. (1990), DeLong et al. (1990), and Froot et al. (1992) further separate trades by contrarian (informed) and herding (uninformed) and posit that the former increases trading risk while the latter presumably due to noise traders decreases trading risk, which translates into a similar increase or decrease in volatility.[2] Abramov et al. (2006) using daily buy and sale trades data test the implications of Campbell et al. (1993), Hellwig (1994), and Wang (1993, 1994) and conclude that informed (uninformed) trades do indeed reduce (increase) volatility and asymmetric volatility caused by return residuals is largely due to buy sale trades asymmetry. However, little or no empirical evidence exists with respect to asymmetric volatility in cross listed securities and further on the volume impact on asymmetric volatility in those securities, at home or abroad, partially due to the fact that ADRs are routinely

[2] Lo and Mackinlay (1990) and Sentana and Wadhwani (1992) propose two different market microstructure models based on asynchronous and feedback trading respectively to justify volatility changes over time in equity markets.

tossed out of samples in studies related to domestic listings in the US.

Hypothesis 3: ADRs and their underlying home shares display asymmetric volatility with respect to their own and cross excess return. Unexpected trading volumes of host and home securities further asymmetrically impact the relation between excess return and volatility. The asymmetry is most pronounced among positive, negative, and zero momentum trading days.

3. Institutional Structure of NYSE Foreign Listings, Data and Preliminary Results

3.1 Data description and Institutional structure of ADR Listings

As of December 31, 2012, 525 common and preferred equities of foreign corporations from 46 countries are listed on the NYSE and the NYSE Market among which 259 trade as ADRs (including Global Shares and NY Registry Shares) with primary listing in a domestic exchange located in a foreign country.[3] Table 1 provides a breakdown of our sample of 175 ADRs and their corresponding home country shares listed in 27 domestic exchanges located in 16 developed and 11 emerging markets (9 ADRs from Luxembourg and Argentina, which do not belong to the MSCI respective market indexes but are included anyway in the sample) respectively.[4]

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[3] Among the 525 NYSE and NYSE MKT listed ADRs from 46 countries, a majority of recently listed ADRs from China and also a few other emerging markets listed on NYSE MKT do not have a corresponding primary listing. All issuers from Canada and a few small nations/territories along with a majority of issuers from China have issued original listings (ORD) instead of ADRs (ORDs do not require sponsorship by a depositary bank- for more details, please refer to https://research.scottrade.com/knowledgecenter/Public/help/Article?docId=37010be1721740e0879fb4b3510db8ed; incidentally, those are also the two countries with the highest number of foreign issuers at the NYSE market. Global and NY registry shares are for securities from Netherlands and Luxembourg, which prohibit domestic companies from selling shares in another currency.

[4] We identify developed and emerging markets as per MSCI ACWI indexes of 23 Developed and 23 Emerging Markets as of July 2014 as listed in Table 1. As per MSCI ACWI components list, eight developed markets (Austria, Canada, Hong Kong, New Zealand, Singapore, Sweden) and seven emerging markets (Czech Republic, Egypt, Hungary, Malaysia, Qatar, Thailand, and UAE) do not have any ADR listed on the NYSE Market. In the paper, the securities listed under Hong Kong are in fact Chinese H-shares. Further 23 ADRs/home country shares are either preferred shares and/or do not have the necessary data and hence are excluded. Included in those 23 securities are two each from Colombia and Russia and one each from Peru and Turkey, which denote their entire

We briefly discuss below the institutional details of the ADR listing process at the NYSE and the corresponding ADR database to motivate the empirical framework adopted in this paper. A foreign corporation may qualify for listing on the NYSE, the main exchange for established mid to large cap companies or else they may list on the NYSE Market that is designed for relatively new and smaller companies, both of which currently (since 2012) support a designated market maker (DMM) for each listing along with access to Supplementary Liquidity Providers (SLP) usually for highly liquid securities. The NYSE and NYSE Market listing allows foreign corporations to market their securities to US investors in the form of depositary receipts known as ADRs, which may be unsponsored or sponsored by one of the designated US depositary banks. Conversely, ADRs allow US investors to invest directly in shares of foreign corporations. Prior listing in its home or another foreign jurisdiction is not mandatory for a foreign issuer and hence while at the beginning of the ADR program, only large and reputable foreign companies would enlist and raise capital in the US, since the mid-2000, many small unlisted foreign companies have bypassed their domestic capital markets and resorted to simultaneously issuing IPOs and ADRs in the USA; a majority of those foreign issuers with the exception of the Chinese firms have simultaneously or subsequently listed on a primary exchange in their respective home countries.

3.2 Descriptive statistics on ADR and their corresponding home security volume and return

We obtain daily data on closing prices, number of shares traded, and the value of traded

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ADR listings respectively and are therefore completely eliminated from the sample due to missing data. Two ADRs registered under Luxembourg show primary listings in Italy and The Netherlands. Hence our final sample consists of 175 securities from 27 developed and emerging markets.

shares (turnover) for one-to-one matched pairs of 175 sponsored ADRs mentioned above and their underlying home shares listed on the domestic Stock Exchanges in their respective home countries from Bloomberg data terminals (partially crosschecked with Datastream) for a period of approximately 3-21 years based on their availability beginning on or after July 1993.[5] Hence, the sample period for each pair of ADR and its underlying security begins from their respective initial trading dates from/after July 1, 1993 and ends on December 31, 2014 unless a security is delisted earlier. We also obtain similar data on prices and volume for NYSE and for those 27 developed and emerging markets (composite market indexes, wherever available), where our sample securities have their primary listings along with the USD to home currency exchange rates for all the countries in our sample.

For each security, we denote volume as $v_t^i = ln(N_t^i)$ and compute returns as $r_t^i = ln\left(\frac{P_t^i}{P_{t-1}^i}\right)$ where *N(i,t)* and *P(i,t)* denote the exchange ratio (the conversion rate between home shares and ADRs) adjusted number of trades and closing price respectively of the *ith* security on the *tth* day. As with security returns, we compute market returns as the difference in log index values between day *t* and day *(t-1)*.

Table 2, Row 1 (All sample) reports summary descriptive statistics on daily trading volume and returns for the entire sample. The exchange ratio adjusted daily trading volume for ADRs and home securities are 4.85 million and 16.07 million shares with corresponding standard deviation of 2.76 million and 8.06 million shares respectively

[5] In terms of data availability, the earliest ADR- home share pair in our sample is Shanghai Chemical Corporation (Hong Kong:SHI) for which data is available continuously since July 1993 while the latest one is Brasilagro (Brazil: LND) for which the data is available from February 2011.

while the annualized sample mean returns for ADRs and home shares are 4.79% and 6.05% with corresponding realized volatility measured by standard deviation of returns of 22.4% and 16.0% respectively. The computed t-statistics, -57.1 (significant at less than 1% level) and -0.16 (not significant) for differences in means in volume and returns respectively between the ADRs and home shares portfolios point to significant differences in volume but none so for returns.

For our ensuing analysis, we break down our sample of 175 cross listed securities into two sets, one of two and another of three mutually exclusive subsamples based on their primary listing countries. The set of two portfolios include ADRs and their underlying with primary listing in developed or emerging markets while the set of three consists of ADRs and their underlying home securities whose primary listing locations are in regions where the trading times share different overlap hours with those of the US EST. The extent of overlap between different world time zones and that of the Eastern US time is classified into three groups as follows: Time overlap '0' (no overlap later) denotes Asia and Australia with no time overlap, time overlap '-1' (low overlap later) denotes Europe, the Middle East, and Africa with less than 33% overlap; and time overlap '+1' (high overlap later) denotes South and North Americas with greater than 33% overlap. The two market portfolios and three trading time overlap regions portfolios proxy market frictions and trading barriers, which are higher in emerging markets and in certain regions compared to those in developed markets primarily in Europe. Such barriers allow investors with privileged access to certain markets earn arbitrage profits, which may account for some of the differences in trading performances between certain ADRs and their underlying home shares.

Table 2 further reports summary descriptive statistics on daily trading volume and returns for the above five subsamples of ADRs and their underlying securities along with the corresponding t-statistics for differences between portfolio means, where applicable. Based on the respective subsample portfolio means reported in Table 2, emerging markets' volumes (8.20 millions and 22.93 millions for ADRs and home shares respectively) confidently (t-statistics -70.21 and -47.04) surpass developed markets' (2.49 millions and 11.01 millions for ADRs and home shares respectively); volumes in markets with no overlap (5.61 millions and 29.76 millions for ADRs and home shares respectively) edge significantly (t-statistics -43.22 and -60.90) over those in markets with low overlap (2.73 millions and 10.97 millions for ADRs and home shares respectively). Ironically, the ADR mean volume (11.10 millions) in the high overlap markets portfolio tops those in both low and no overlap portfolios (t-statistics (57.0 and 35.43) but lags significantly (t-statistics -37.03 and -73.69) behind both of those portfolios in terms of home share mean volume (6.38 millions). In all three portfolios except the high overlap portfolio, trading volumes in home shares are significantly (at less than 1 percent) higher than those in ADRs. Moulton and Wei (2009) confirm liquidity differences between high and low overlap markets.

With respect to returns, the subsample portfolio statistics in Table 2 find means of emerging markets' returns lag behind those of developed markets' for both ADRs and home shares; mean portfolio returns from low overlap markets edge over those in markets with no overlap for both ADRs and home shares. The only exception is high overlap markets, specifically South America where the ADR annualized mean return (-2.52%) is negative and well below that of home share (7.31%). The above differences, however are not statistically significant. Similarly, sub-portfolios of ADRs and their corresponding home shares show some differences between their mean returns, albeit not significantly. The risk and returns mapping for the emerging and developed markets portfolios supports the conventional wisdom that emerging markets are riskier than developed markets and hence investors demand higher returns in emerging markets (Ferson and Harvey [1993], Erb et al. [1996], Beakert et al. [2014]).

The descriptive statistics related to volume, return, and volatility for individual ADRs and their corresponding home securities (not reported to conserve space) indicate large spreads, albeit some of those differences among the securities may be due to the varying lengths of their time series. First, for a majority of securities, trading volumes in home shares adjusted for exchange ratio are conspicuously larger than those in ADRs. However, there are 26 securities including ITUB (Brazil, 43 times) for which the ADR volumes are higher than those of home shares. In terms of volume, the two most actively traded ADRs are Nokia (Finland, 18.8 mi) and Vale (Brazil, 17.8 mi) while those in home shares are Corpbanca (Chile, 281.6 mi), Mizuho Financial Group (Japan, 152.2 mi) respectively. In terms of countries, Argentina, Brazil, Mexico, Philippines, South Africa, and Israel show average ADR trading volumes higher than that of home shares, while Indonesia, China/Hong Kong, and Japan top the list of all the remaining countries whose average trading volumes in home shares exceed those in ADRs. Interestingly, the ratio between average trading volume of ADRs and home shares exhibit a clear pattern where developed, mostly European nations have low ratios, while the emerging market securities from Asia and South America, low and no overlap regions bear high ratios.

Next, with respect to return and volatility, we observe that the high and low mean returns and volatility are concentrated among a few countries namely, Belgium, Denmark, Finland, Indonesia, Israel, and Philippines, all with a limited number (<= 2) of ADRs. Besides the low count, the lack of diversification in these country ADR portfolios is a likely factor for those differences (Beakert et al. [2014]). Figure 1 plots annualized means of daily returns against their corresponding standard deviations for our sample of 175 ADRs and their underlying home shares, which seem to indicate, at least visually, similar risk return tradeoffs for ADRs and their corresponding home shares. As we remove the few obvious outliers, the graphs project an almost horizontal (linear with slope zero) relation between risk and return implying those are uncorrelated. Rabinovitch et al. (2003) and Dey and Wang (2012) report differences only in the tail regions between ADRs and their underlying home shares returns in Argentina, Chile, and Chinese H-shares respectively.

3.3. Trading volume expectation model and volume surprise

We empirically test Hypothesis 1 regarding asymmetric volume comovements between ADRs and their underlying home shares by decomposing trading volume, total number of shares traded during a trading day into expected and unanticipated (surprise) components as follows.[6] We use a modified version of Halling et al. (2013) as in the VAR equations 1a-1b below, where v_{it} is the respective ADR and the corresponding home share daily trading volume; v_t, the NYSE and respective home market volumes are control variables; $\hat{v}_{it}$ denotes forecast trading volume for each ADR and its underlying home share; and $V_{i,t}$, VAR forecast error denotes volume surprises.[7] We concur with the existing literature and consider $V_{i,t}$, the unanticipated component of volume or volume surprise whose impact on return spillover and asymmetric volatility as the subject of our ensuing analyses.

$$v_{i,t}^{us} = \alpha_1 + \beta_{11} v_{i,t-1}^{us} + \beta_{12} v_{i,t-1}^{h} + \phi_1 v_t^{us} + V_{i,t}^{us} \quad \text{.... (1a)}$$

$$v_{i,t}^{h} = \alpha_2 + \beta_{21} v_{i,t-1}^{h} + \beta_{22} v_{i,t-1}^{us} + \phi_2 v_t^{h} + V_{i,t}^{h} \quad \text{...... (1b)}$$

Table 3 contains summary statistics of the parameter estimates from models 1a and 1b, and unit roots test (ADF) statistics for the residual, $V_{i,t}$ in equations 1a and 1b for the entire sample and also five subsamples referred to earlier. The VAR parameters are OLS estimates while the corresponding t-statistics are Newey-West corrected for autocorrelation and heteroscedasticity.

Table 3, Panel A, Row 1 (Full sample) containing the summary statistics for the full sample finds mean auto and cross lag correlations as –0.389 (-0.336) and 0.011 (0.063) for ADRs (home shares) respectively. All ADRs and their underlying home shares show consistently significant (at less than 1%) negative 1st order auto correlation;

[6] We also use turnover, dollar trading volume as a measure of volume. The distributional properties of turnover are more similar to those of market value of equity than number of trades.

[7] We recognize that market volume casts asymmetric effects on active and thinly traded stocks. Liquid stocks may suffer a larger impact of market volume changes than their thinly traded counterparts. This asymmetry may spill over to home and/or host markets in a largely unpredictable way since while ADR volumes are customarily low in the US, a majority of ADR issuers are among the most active stocks in their respective home markets.

however, with regards to cross correlation, ADRs and home shares show evidence of sharp differences. Among the ADRs and home shares, the signed mean VAR coefficients indicate lag home security volume positively (negatively) impacts volume for 104 (71) ADRs, whereas lag ADR volume is positive (negative) for 168 (7) home share volumes. These results confirm the findings in Halling et al. (2013) that volume autocorrelations are uniformly negative for all securities while cross correlations are relatively smaller and positive between cross listed securities. Further, this evidence of asymmetric, one sided effect, US to home but not the converse based on the dominance of US market is observed in cross country returns but here we observe a similar dominant ADR (US market) to the corresponding home share volume effect, notwithstanding the fact that relevant information about a security is most likely to be generated at home than in the US (Ferson and Harvey [1993]).

Table 3 Panel A further reports summary statistics related to the five portfolios mentioned earlier along with t-statistics for differences in means of the VAR parameter estimates between emerging and developed markets and among the three time overlap portfolios. Seventy three (34 developed, 39 emerging) ADRs from 25 countries (except Denmark and Israel) show significant (at less than 10%) cross security volume comovements; in contrast, 135 (70 developed, 65 emerging) home securities from 27 countries show significant (at less than 10%) cross market volume comovements. The t-statistics (-1.22 and -1.37) reject differences between emerging and developed markets with respect to auto and cross volume comovements in ADRs; in contrast, with respect to home shares, the t-statistics, -8.65 (2.03) indicate emerging markets exhibit a steeper decline (increase) in auto (cross) volume comovements than those in developed markets.

Similarly, VAR estimates of auto and cross volume comovements exhibit significant differences among all three subsamples time overlap portfolios but only for home shares; for ADRs, significant differences exists in all auto and cross volume comovements except cross (auto) volume comovements between ADRs from high (low) and low (zero) overlap countries. Notably, the home securities from the Australia-Asia region (no overlap), namely Australia (5) and Asia (49) bear the largest number of significant cross correlations followed by Europe with 27 and the Americas with 17 home shares. This inverse relation between the number of significant volume comovements and the extent of overlap in trading time zones between the specific regions of the world and the US is also observed by Moulton and Wei (2009) and Halling et al. (2013).

Table 3, Panel A provides clear evidence of asymmetries in volume comovements between ADRs and home shares in different countries. Variance decomposition results confirm this asymmetric lagged auto and cross covariance effects on trading volumes such that while home share volume shows little impact on ADR volume, home shares volume finds small but relatively a much greater impact due to ADR volume.

Table 3 Panel B confirms significant differences and hence asymmetric serial auto and cross correlation coefficients of volume corresponding to ADRs and home shares within each of the five portfolios, emerging, developed, low, high, and no overlap. Reported t-statistics suggest all auto and cross serial volume correlations between

ADRs and home shares are significant at less than 10 per cent level; the only exception is the auto correlation coefficients for high overlap portfolio, namely South American ADRs (t-stats for serial autocorrelation -0.66) do not contribute to the asymmetry between auto volume comovements.

Finally, almost all ADRs and their underlying home shares exhibit significant positive buoyancy from respective local market volume (not reported in Table 3 for conserving space); only six securities (2 each from Chile and Mexico, 1 each from the Netherlands and Spain) find insignificant local market volume effect. Those four countries belong to South America and Europe with high or low overlap with the US than do countries in Australia and Asia, where there is no time overlap.

The residuals from equations 1a and 1b denote unanticipated volume or volume surprise and how it affects returns spillover and asymmetric volatility is the fundamental issue we investigate in this paper. Hence in Table 3, panel C, we present some diagnostics on the volume residuals. The residuals, $V_{t,t}$ for each ADR and its underlying home security are tested for autocorrelations via ADF ($\chi^2(6)$) and KPSS tests, which soundly reject unit roots for all ADRs and their underlying home shares. Nevertheless, the significant correlations between ADR and home security residual volumes in each of those five portfolios mentioned earlier find continued comovements.

3.4. Sample statistics by momentum trades

Until this point, we have followed the existing literature and split our data based primarily on the basis of country of origin or location of primary listings of the cross listed securities in our sample. These classifications serve as noisy proxies for market inefficiency and the consequent arbitrage opportunities arising thereof but do not uncover any time dependent trading styles involving volume.

We devise a time series classification of the sample based on trade momentum (feedback) days during which positive/negative excess volume is caused jointly by high (low) trading and higher (lower) than expected returns where returns follow a zero mean stochastic process. We operationalize this return volume momentum via a trinary dummy variable that separates the sample trading days into three separate momentum classes based on the joint binary (+/-) empirical distributions of signed volume residuals and returns over time. For each security trading day, we define positive momentum or feedback, M+ days as those characterized by positive volume shocks and positive return; negative momentum or feedback, M- days as negative volume shock with negative return; and zero momentum, M0 days as positive (negative) volume shock with negative (positive) return. Hence, we end up with three portfolios by pooling security trading days by positive M+, negative M-, and zero M0 momentum days.

Panels A and B in Table 4 contain diagnostics statistics on volume residuals and returns related to M+, M-, and M0 trading days portfolios. During our sample period but not every trading day, all ADRs and their underlying home securities experience all three momentum classification days and as such each of the three M+, M-, and M0 trading days portfolios contain our entire sample of 175 securities of both ADRs and their corresponding home securities.

Table 4 Panel A reports the means and standard deviations of volume residuals and returns of ADRs and their underlying home shares for the three trade momentum based portfolios, M+, M-, and M0. Between ADRs and home shares, the mean percentages of M+, M- days computed over the total number of trading days seem relatively close (approximately 25% for each quarter and 50% for M0 denoting two quarters); however, the highly significant t-tests of the differences in the mean percentages between the subsamples, M+, M- suggest extremely low sample variance that may be caused due to large number of observations in each sample and/or volume shocks typically affect all stocks and their effects are minimal over a long period of time. We also notice large differences among momentum classes in terms of means of ADR and home share volume residuals and returns, which indicate asymmetric volume surprises and returns across those momentum classes. These differences in volume surprises and returns across momentum classes point to momentum as a significant factor in the determination of volume impact on return and volatility (Hameed et al. [2011]).

Table 4 Panel B contains regression coefficients and their corresponding t-statistics from a pooled Poisson regression model that aims to test whether and how the momentum classifications capture some of the cross sectional and time series elements of the panel data. A mix of time varying for example, month and year, and time invariant, for example, emerging vs. developed markets independent variables are chosen to confirm both the time stationary and dynamic information content in the momentum indicators.

The regression model turns out to be a consistent and robust fit for the counts of M+, M-, and M0 days as manifested by the high likelihood ratio estimates and across the board significance levels for the regression coefficients corresponding to all parameters except month that is significant (0.005 z-value 5.82) only for M+ days. The large positive coefficients (0.195, 0.185, and 0.177 all significant at less than 1% level for M+, M-, and M0 days respectively) for similar home market momentum days confirm contemporaneous correlation and transmission of security level shocks across home and US markets. The adjusted R^2 for the model ranges from 17% to 46% for M+, M-, and M0 days.

4. Testing hypotheses on the effect of volume surprise on return spillover

4.1 Effect of volume surprise on return spillover

We estimate the serial return auto and cross correlation coefficients along with those related to volume surprises as in Gagnon and Karolyi (2009) from the bivariate VAR model in equations 2a and 2b below, where , $r_{i,t}^{us}$ and $r_{i,t}^{h}$ denote daily returns while $V_{i,t}^{us}$ and $V_{i,t}^{h}$ denote unexpected volume surprises for the *ith* ADR or home security respectively, at time *t*. The two interaction terms, $r_{i,t}^{us} * V_{i,t}^{us}$ and $r_{i,t}^{h} * V_{i,t}^{h}$ correspond to each ADR and its underlying home security and denote the respective volume induced lag return comovements. We call these volume induced spillover. We also include two relevant control variables, changes in exchange rates and contemporaneous market return (computed from NYSE composite for ADR and the respective home market corresponding to the respective home shares) in each equation in the system.

The exogenous control variables account for broad systematic risks implicit in the respective securities market. The resulting VAR model is as follows.

$$r_{i,t}^{us} = a_1 + b_{11} r_{i,t-1}^{us} + b_{12} r_{i,t-1}^{us} V_{i,t-1}^{us} + b_{13} r_{i,t-1}^{h} + b_{14} r_{i,t-1}^{h} V_{i,t-1}^{h} + c_{15} x_t^{us} + e_{i,t}^{us} \quad \ldots\ (2a)$$

$$r_{i,t}^{h} = a_2 + b_{21} r_{i,t-1}^{h} + b_{22} r_{i,t-1}^{h} V_{i,t-1}^{h} + b_{23} r_{i,t-1}^{us} + b_{24} r_{i,t-1}^{us} V_{i,t-1}^{us} + c_{25} x_t^{h} + e_{i,t}^{h} \quad \ldots\ (2b)$$

The parameter vectors b_{ij} where $i=\{1,2\}$ and $j=\{1..4\}$ in equations 2a-2b signify time dependence and predictability of returns via serial auto and cross correlations while those with lag volume interactions imply volume induced return spillover for each ADR and home security respectively. With respect to the above one lag auto and cross correlations parameter estimates, b_{ij} Blume et al. (1994), Wang (1993), and Campbell et al. (1993) stipulate the following alternate hypotheses:

a) Return lag autocorrelation, $b_{i1} \geq 0$
b) (Volume residual * Return) lag autocorrelation, $b_{i2} > 0$, for information motivated trades; (Volume residual * Return) lag auto correlation, $b_{i2} < 0$, for allocation/hedging motivated trades
c) Return lag cross correlation, $b_{i3} \neq 0$
d) (Volume residual * Return) lag cross correlation, $b_{i4} > 0$ for + volume residual; $b_{i4} < 0$ for - volume residual.

For each ADR and its underlying home share in our sample, we estimate the parameters of the above VAR model and report the cross sectional averages of the parameter estimates along with the corresponding number of significant coefficients in Table 5 Panel A. Parameter estimates for individual securities (not reported to conserve space) indicate significant lagged dependence on returns for a majority of ADRs and their underlying home securities. The mean serial autocorrelation coefficients are -0.113 (-0.194) with 136 (154) ADRs (home shares) significant at less than 10 percent level; the corresponding numbers of securities showing negative and positive lag dependence are 152 (167) and 23 (8) respectively. Our findings of the large scale negative serial autocorrelations in ADRs and home shares confirm similar evidence in Gagnon and Karrolyi (2009) but only for ADRs while refuting the evidence of positive serial autocorrelation in Eun and Sabherwal (2003) and Grammig et al. (2005). The overwhelming evidence of negative serial autocorrelation for both ADRs and their corresponding home shares support return reversals and hence contradict the implications of heterogeneous traders models by Blume et al. (1994) and Wang (1994).

In contrast, serial cross correlation coefficients for ADRs (home shares) are 0.133 (0.217) with 139 (157) securities display significant positive lag cross dependence supporting similar findings in Gagnon and Karolyi (2009) and also He and Yang (2012) for Hong Kong based ADRs. The evidence supports the notion that trading across cross listings are 'predominantly' information based. Interestingly, the cross security lag return effect is noticeably stronger both in terms of magnitude (0.217 vs. 0.133) and number of significant results (157 vs. 139) on home shares returns than on ADRs, the exact opposite of the evidence in Gagnon and Karolyi (2009) and implies ADR returns cast a stronger lead for home security returns than the converse.

The lagged dependence in return, when volume innovation is included, irrespective of whether it is auto or cross dependence, paints a more subdued and nuanced picture with 56 (57) ADRs (home shares) displaying significant volume induced autocorrelation, while 66 (70) ADRs (home securities) exhibit significant volume induced cross correlations. The mean volume induced serial auto (cross) correlation coefficients are positive, 0.003 (0.017) and 0.005 (0.023) for ADRs and home shares respectively. These results, albeit modest stand in stark contrast with those in Gagnon and Karolyi (2009), who find volume induced autocorrelation 'reliably' negative implying hedging/allocation motive for both ADRs and their underlying home securities; in contrast, our evidence of positive auto and cross correlation coefficients tend to indicate on an average, information motive revealed in volume residual. Further, in contrast to the findings in Gagnon and Karolyi (2009), we find the volume induced cross correlation estimates to be more reliable than the volume induced autocorrelation coefficients.

Gagnon and Karolyi (2009) made additional observations regarding the cross correlation hypotheses (c and d above) for their sample of cross listed securities. Specifically, one of their highlighted finding is that the cross security effect is stronger when it originates from home i.e., $|b_{13}| > |b_{23}|$ and similarly, $|b_{14}| > |b_{24}|$. On this point, our results ($|b_{23}| = 0.217 > |b_{13}| = 0.133$ and similarly, $|b_{24}| = 0.023 > |b_{14}| = 0.017$) decisively indicate that in terms of cross security effects ADRs dominate home shares rather than the converse and hence again directly contradicts the findings in Gagnon and Karolyi (2009).

Finally, with regards to the parameters b_{14} and b_{24}, Blume et al. (1994) predict positive (negative) signs denoting continuation (reversal) associated with positive (negative) volume shocks. While Gagnon and Karolyi (2009) do not specifically test that hypothesis, we do additional testing with our sample split between positive and negative excess volume days and based on our estimates below for b_{14} and b_{24}, we detect a mild trend towards but not enough support for the above predictions in Blume et al. (1994).

b_{14}: for V^+ mean 0.045 with 110 (65) positive (negative) estimates; for V^- mean 0.005 with 89 (86) positive (negative) estimates, and

b_{24}: for V^+ mean 0.040 with 117 (58) positive (negative) estimates; for V^-mean 0.003 with 84 (91) positive (negative) estimates.

In summary, we find many of our serial correlation estimates, in particular, the positive volume induced auto and cross correlations denoting return continuation refute the evidence in Gagnon and Karolyi (2009) and support information motives revealed in trades.   Nonetheless, we find our mixed evidence provide cursory support for Blume et al. (1994) and Campbell et al. (1993) who contend trades reveal information and hedging/allocation motives.

In table 5 Panel A, we also report a summary of the estimated parameters pertaining to equations 2a-2b based on an alternative model of estimating volume residuals using a 50 days MA filter as in Gagnon and Karolyi (2009).   Our intention is to determine how much our use of the volume comovement model factors in separating our results, particularly the parameter estimates corresponding to auto and cross security volume from those in Gagnon and Karolyi (2009). Specifically, we compare the volume induced auto and cross correlation parameter estimates, b_{12} (b_{22}) and b_{14} (b_{24}) related to ADRs (home shares) where the volume residuals are based on two distinct expectation models, volume comovement and 50 days moving average.

Our estimates are as follows: b_{12} = 0.003 and b_{22} = 0.005 for ADRs and home shares respectively based on a volume comovement model compared to b_{12} = -0.005 and b_{22} = -0.002 for those identical parameters using a 50 days moving average model as in Gagnon and Karolyi (2009). Evidently, the signs alternate and thus there are strong implications for volume content. By contrast, for parameters b_{14} and b_{24} related to ADRs (home shares), a volume comovement model estimates are 0.017 (0.023) compared to 0.016 (0.011) yielded by an MA filter model; the corresponding number of significant estimates are 66 (70) and 60 (69) for ADRs (home shares). In this case although large differences exist between the two sets of estimates, those are not as stark. We consider both sets of parameter estimates, b_{12} (b_{14}) and b_{22} (b_{24}) corresponding to ADRs (home shares) yielded by a cross security comovement vs. a MA filter model and conclude that while the choice of an expectation model for volume seems critical, perhaps there are other data issues which turn our results diametrically opposite to those in Gagnon and Karolyi (2009). Although, we cannot be definitive without comparing the actual samples, we suspect that the sample selection, whereby a large number of presumably Canadian Ordinary shares (ORDs) are included in the sample in Gagnon and Karolyi (2009) might have contributed to the polar opposite results with respect to volume residual content in cross listed securities.

In table 5 Panels B and C, we report summary statistics on the parameters of equations 2a and 2b for the following subsamples: ADRs and their corresponding home securities from developed and emerging markets and markets with high, low, and no time overlaps with the US. The subsample results indicate only a few scattered significant group mean differences. For example, the group mean parameters associated with lag cross return*volume for ADRs from developed (emerging) markets are 0.021 (0.015), significant at 10% level, while those for home shares are 0.025 (0.020), which are not significantly different. The respective group mean parameters associated with auto and cross lag returns for home shares from developed (emerging) markets are -0.129 (-0.25) and 0.143 (0.283), both significant at 1% level. Similarly, significant differences exist between respective group mean parameters associated with select auto and cross lag returns and lag return*volume for ADRs and their underlying home shares from high overlap, low overlap, and no overlap countries. The lack of significant results on specific country/market indicator variables confirm similar findings by Gagnon and Karolyi (2009).

Finally, Table 5 Panel C reports summary statistics and results on the differences in means tests for each subsample classified as M+, M-, and M0 based on positive, negative, and zero momentum days. Since the data now does not retain the time series continuity, we estimate OLS parameters of two separate single equations 2a and 2b.

The means for the auto and cross volume induced spillover coefficients, b_{12}, b_{22} and b_{14}, b_{24} respectively for each momentum class highlights the observed asymmetry in volume effects. The positive (negative) means for b_{12} indicate information (hedging) motivated trades on positive (negative/zero) momentum days; conversely, the positive (negative) means for b_{22} indicate information (hedging) motivated trades on zero (positive/negative) momentum days; while, low (high) positive means for b_{14} indicate low (high) information motivated trades on negative (zero/positive) momentum days;

and finally, positive (negative) means for b_{24} indicate information (hedging) motivated trades on positive (negative/zero) momentum days. Further, recall that the cross volume induced spillover estimates, b_{14} and b_{24} both turned out positives for positive and negative volume shocks, V^+ and V^- earlier and although the former was significantly higher than the latter, we could not find support for Blume et al. (1994). However, under our momentum definition, the estimates of b_{14} and b_{24} are .030 (.002) and .027 (.001) for M+ (M-), which seem to strengthen but still not support Blume et al. (1994).

To say the least, the above results for the momentum classes are striking. Other than the parameters associated with auto lag return for ADRs and cross lag volume*return for home shares every pairwise comparison between two momentum classes shows significant differences between the parameter estimates, which establishes the role of momentum as a crucial explanation for asymmetries in return spillover estimates. In the next section, using a regression analysis, we identify how momentum ratios, proportions of positive and negative momentum days determine volume induced return spillover parameters.

4.2 Security and Market determinants of volume surprise induced return spillover

We estimate the parameters of the following system of equations,

$$B_{12} = a_0 + a_1X_1 + \cdots + a_nX_n + \varepsilon_1 \qquad \text{(3a)}$$

$$B_{14} = a_0 + a_1X_1 + \cdots + a_nX_n + \varepsilon_1 \qquad \text{(3b)}$$

$$B_{22} = a_0 + a_1X_1 + \cdots + a_nX_n + \varepsilon_1 \qquad \text{(3c)}$$

$$B_{24} = a_0 + a_1X_1 + \cdots + a_nX_n + \varepsilon_1 \qquad \text{(3d)}$$

where the dependent and independent variables are as follows.

B_{ij}= b_{ij} * *pdum* {pdum =1, if b_{ij} > 0 significantly; pdum =-1, if b_{ij} < 0 significantly; pdum =0, if b_{ij} is neither for i= {1, 2} and j = {2, 4}}

X_1= *Log (MVE)* - MVE-ADR and MVE-home security

X_2= *Log (TR)* - Turnover ratio, TR is *Turnover(t)/MVE(t-1)*

X_3= *Log (MR1)* - Momentum ratio1, MR1 is *Nos. of M+ days/Nos. of M- days*

X_4= *Log (MR2)* - Momentum ratio2, MR2 is (*Nos. of (M+ + M-) days/ Nos. of M0 days*

X_5= *Olapd* {-1, if home trading hours partially overlap (<1/2 of trading day) with those in US; +1 if mostly overlaps (>1/2 of trading day); 0, if no overlap}

X_6= *Mktd* {1, if developed; 0, if emerging}

Our primary interest in the above model is to determine the role of the security specific momentum ratios, MR1 and MR2, time series averages of those two momentum ratios on the estimated volume spillover coefficients after controlling for market capitalization and turnover ratio denoting size and liquidity for individual securities (ADR and home), and two market/country specific indicator variables, which are identical for each home security within a home country, region, or continent and also its corresponding ADR. The control variables, size and turnover ratios denote multiple security specific risk including volatility and liquidity while the indicator variables proxy information and market frictions.

Table 6 reports the OLS parameter estimates from the above equations, which find significant positive impact of changes in firm size on the magnitude of volume induced auto and cross correlation parameters, b_{12}, b_{22}, b_{14}, and b_{24} for ADRs and home shares. In contrast, a change in turnover ratio is a significant determinant (0.010 with t-stat 10.03 and 0.019 with t-stat 17.71) only for the auto (cross) security parameter, b_{12} (b_{24}) for ADR (home share); changes in home shares turnover ratios do not affect either auto or cross return correlations. The mostly significant positive impact of changes in firm size and turnover ratios on volume induced return spillover confirm continuation for larger and more liquid securities, both home and abroad contradicting the notion that large and liquid firms are prone to return reversals.

With respect to the ADRs and their underlying home shares parameters associated with momentum ratio, MR1, we find asymmetry between their signed effects on ADR (b_{12}), 0.029 (t-stat 1.64 insignificant) and home share (b_{22}), -0.029 (t-stat -2.38 significant at less than 5% level). With respect to those two parameters associated with momentum ratio, MR2, we find asymmetry between their signed effects on ADR (b_{12}), 0.043 (t-stat 2.11 significant at less than 5% level) and home share (b_{22}), -0.103 (t-stat -7.88 significant at less than 1% level) and also on ADR (b_{14}), -0.111 (t-stat -5.42 significant a less than 1% level) and home share (b_{24}), 0.032 (t-stat 2.18 significant at less than 5% level). Overall, home shares volume induced spillovers, b_{14} (cross correlation for ADRs) and b_{22} (autocorrelation for home shares) exhibit consistent reversals due to positive changes in ADR and home shares momentum ratios respectively, while other estimated effects of momentum ratios on spillover coefficients are inconsistent. For example, considering only the consistent estimates, b_{14} and b_{22}, a one percent increase in ADR (home share) momentum ratios is expected to decrease volume induced cross (auto) correlation coefficient by -0.204 or –0.111 (to -0.029 or –0.103) percent.

On the contrary, the two country/market specific indicator variables, time overlap and emerging vs. developed asymmetrically impact the intercept (alpha) for ADRs and home shares. While the volume induced auto spillover parameter related to ADR, b_{12} is not significant, all other parameters, b_{22}, b_{14}, *and* b_{24}, which include both auto and cross correlation parameters corresponding to home shares are strongly significant. This asymmetry is compounded due to sign changes in the parameter estimates resulting in $b_{14}=-0.018(-0.017+0.002-0.003)$ becoming more negative, while $b_{22}=0.043(-0.043-.081+.167)$ *and* $b_{24} = 0.059(0.123+0.098-0.162)$ turn positive and less positive respectively for securities from a developed nation in Europe, say UK ($X_5=-1$ and $X_6=1$) compared to securities from an emerging market Asian nation, say India ($X_5=0$ and $X_6=0$). In addition, the signs of the slope parameters (betas) associated with the four interaction terms, *log(MVE)*Olapd*, *log(TO)*Olapd, log(TO)*Mktd*; *log(MVE)*Mktd* find asymmetric effect of size and turnover on the volume induced spillover parameters between emerging and developed markets securities and also among securities with primary listing in countries with high, low, or no overlap. For example, note that the only insignificant parameters correspond to b_{22} *and* b_{24} the cross and auto correlation parameters for ADRs home shares.

The parameter estimates associated with the four interaction terms, *log(MR1)*Olapd*, *log(MR2)*Olapd, log(MR1)*Mktd*; *log(MR2)*Mktd* find asymmetry between ADRs in different market clusters and home shares in those clusters; similar asymmetries are observed in those parameter estimates between ADRs and home shares in countries with varied levels of time overlap with the US. Once again, these statistics indicate that the effects of the momentum ratios on the spillover coefficients significantly (with the exception of *log(MR1)*Mktd* that is not significant for 3 out of four spillover coefficients) differ among countries and markets.

The model summary statistics denoted by F-stats 33.07-61.82 and adjusted R^2 8.67%-15.27% for the four dependent variables indicate superior fit. The variance inflation factor (VIF), a measure of multicollinearity, is well below 10.0 for all independent variables except the two indicator variables, *Mktd and Olapd*, and the four interaction variables *log(MVE)*Olapd*, *log(TO)*Olapd,* *log(TO)*Mktd*; *log(MVE)*Mktd*, where as expected, substantial evidence of multicollinearity exists.

We summarize our results on the volume effect on return spillover as follows. First, auto (cross) correlation coefficients are negative (positive) for both ADRs and their home shares denoting reversal (continuation) and implying mixed information and hedging motives revealed in trades. Continuation are more likely on momentum days. Between auto and cross correlation estimates, the latter are much larger in absolute values and hence more impactful than the former. Second, in terms of magnitude, size and liquidity have asymmetric effects on the of volume induced spillover coefficients; however, the impact of size and liquidity is consistently positive for all spillover coefficients for both ADRs and home shares. Momentum content in volume induces positively (negatively) auto (cross) correlations for ADRs but mixed for home shares. Third, the asymmetric effect of size and/or liquidity on the sign and magnitude of the spillover coefficients may also depend on whether the securities are from developed vs. emerging market countries and also whether a country has a low, high, or no overlap in terms of trading time with the USA. These later two may proxy for the speed of transmission of any information signal from the home country to the US or the converse. The significant coefficients of firm size, liquidity, and momentum ratios as determinants of return spillover coefficients denoting continuation or reversal confirm the notions of asymmetry between home shares and ADRs, differences among countries, and time varying risk premiums in Erb et al. (1996).

5. Testing hypotheses on volatility: Volume effect on spillover asymmetric volatility

Volatility is not observable and hence we choose a model for estimating volatility. We compute volatility of each ADR and its corresponding home share as the absolute values of the respective errors from the following equations (modified version of equations 2a and 2b) and test volume effects on asymmetric volatility in Section 5.1 below. The control variables, US and respective home market returns and rate of change in exchange (US to home) rates account for broad market related risks inherent in securities returns.

$$r_{i,t}^{us} = a_1 + b_{11} r_{i,t-1}^{us} + b_{12} r_{i,t-1}^{h} + c_{13} x_t^{us} + e_{i,t}^{us} \quad \ldots.. \text{(4a)}$$

$$r_{i,t}^{h} = a_2 + b_{21} r_{i,t-1}^{h} + b_{22} r_{i,t-1}^{us} + c_{23} x_t^{h} + e_{i,t}^{h} \quad \ldots\ldots. \text{(4b)}$$

$$\sigma_{i,t}^{A} = \left| e_{i,t}^{us} \right| \quad \ldots\ldots. \text{(4c)}$$

$$\sigma_{i,t}^{H} = \left| e_{i,t}^{H} \right| \quad \ldots\ldots \text{(4d)}$$

5.1 Asymmetric volatility and volume effect

In this section, we use a variation of the model in Abramov et al. (2006) and estimate the parameters of equations 5a and 5b below for each ADR and its underlying home share, where V_t is volume surprise, e_t is excess return (the error terms in equations 4a-4b) and volatility, $\sigma(t)$ is denoted by the absolute value of e_t, the return error (we ignore the *i* subscript denoting the *ith* security in our description).

$$\sigma_t^A = a_A + \sum_{i=1}^{6} b_{1i}\sigma_{t-i}^A + c_{11}e_{t-1}^A + c_{12}V_{t-1}^A e_{t-1}^A + \sum_{j=1}^{6} g_{1j}\sigma_{t-j}^H + c_{13}e_{t-1}^H + c_{14}V_{t-1}^H e_{t-1}^H + \varepsilon_{1t} \quad \text{...(5a)}$$

$$\sigma_t^H = a_H + \sum_{i=1}^{6} b_{2i}\sigma_{t-i}^H + c_{21}e_{t-1}^H + c_{22}V_{t-1}^H e_{t-1}^H + \sum_{j=1}^{6} g_{2j}\sigma_{t-j}^A + c_{23}e_{t-1}^A + c_{24}V_{t-1}^A e_{t-1}^A + \varepsilon_{2t} \quad \text{...(5b)}$$

Note that the parameter vectors b_i and g_i in equations 5a and 5b signify volatility auto and cross lag correlations; c_{i1} and c_{i3} denote asymmetric volatility coefficients whereas c_{i2} and c_{i4} indicate coefficients measuring impact of unanticipated volume times excess return on volatility. The notion of auto (cross) asymmetric volatility is predicated on a negative sign for c_{i1} (c_{i3}) that indicates trades reveal valuable information and hence as information risk reduces, volatility reduces too leading to an inverse relation between volatility and lag unexpected return (Jones et al. [1994], Chan and Fong [2000]). On the contrary, based on the empirical predictions of Wang (1993, 1994) and the evidence in Abramov et al. (2006), a negative c_{i2} (c_{i4}) indicates information trading as driving auto (cross) asymmetric volatility wherein, volatility increases (decreases) when unexpected volume times unexpected return decreases (increases); on the other hand, a positive c_{i2} (c_{i4}) indicates allocation/hedging trades as driving auto (cross) volatility wherein, volatility increases (decreases) when unexpected volume times unexpected return increases (decreases). Note that in this context, we consider volume surprise is mutually exclusive either information or allocation/hedging motivated. We test the null hypotheses, $c_{ij} = 0$ for all $i=\{1,2\}$ denoting the US and home markets and $j=\{1,2,3,4\}$ denoting auto and cross parameters respectively, which are based on the empirical implications in Wang (1993, 1994) and Campbell et al. (1993) and tested by Abramov et al. (2006) in the context of single listed US domestic securities, as we extend those to cross listed securities.

Table 7 contains means of estimated asymmetric volatility parameters, $\mu(c_{ij})$ for the entire sample and several relevant subsamples. Panel A contains means of estimated parameters along with the numbers of positive, negative, and significant parameters. The full sample means of the asymmetric volatility parameters for ADRs (home shares), c_{11} (c_{21}), c_{12} (c_{22}), c_{13} (c_{23}), *and* c_{14} (c_{24}) are 0.007 (-0.024), -0.005 (0.000), -0.013 (0.008), and -0.003 (-0.006) respectively while the number of positive/negative coefficients associated with parameters c_{ij} are 104/71 (47/128), 75/100 (90/85), 54/121 (97/78), and 87/88 (75/100) indicate a tepid and mixed evidence of across the board asymmetric volatility.[8] Although our results exhibiting the relatively high number of positively coefficients along with a low proportion of significant coefficients mark a clear departure from documented evidence of asymmetric volatility in equities, it is worth pointing out that the two positive coefficients indicating a direct relation between excess return and volatility are both related to ADRs; five of those eight coefficients are indeed negative and thus validate asymmetric volatility, while one, volume times excess return for home shares finds the coefficient to be approximately zero with 90 (85) positive(negative) coefficients and the lowest number (39) of significant estimates.

We turn to the subsample statistics to obtain a better understanding of the deviations from asymmetric volatility, the inverse relation between excess return and volatility. The statistics corresponding to the developed and emerging market

[8] We are surprised by the large number of positive coefficients indicating an increasing relation between excess return and volatility. In order to ensure that those results are indeed due to our model, specifically cross security inputs including the volume measure based on cross security volume comovements, we run equations 5a and 5b as single equation model without cross security excess returns and volume. The results unequivocally confirm asymmetric volatility, an inverse relation between excess return and volatility.

subsamples show only two differences, one as home shares cross effect on ADR volatility (c_{13}) and another as auto excess return effect on home shares volatility (c_{21}); however, in both these instances, the signed coefficients are negative and hence the difference does not help to resolve the sign effects of excess return on volatility. We observe many more significant differences in the volatility parameter estimates among high, low, and no overlap regions. Nevertheless, some of the differences are only marginally significant and the statistics fail to offer any systemic and conclusive evidence regarding the excess return volatility relation.

Finally, in Panel D, we report means and counts of positive, negative, and significant estimates related to the asymmetric volatility parameters corresponding to the momentum classifications, M+, M-, and M0 sample days. The detailed statistics on the means and counts of positive, negative, and significant parameter estimates clearly show that for every single parameter, one of the momentum classification yields a mean positive estimate along with a disproportionately high number of securities with positive estimates. The mostly significant t-statistics confirm pairwise differences between mean parameter estimates for the momentum classifications, M+, M-, and M0. Only two parameters, c_{14} and c_{22} denoting cross excess return times volume surprise for ADRs and cross excess return for home shares do not show any difference among the estimates for the three momentum classifications

Overall, we find the evidence on asymmetric volatility mixed for our sample of ADRs and their underlying home shares. While ADRs find most (3 out of 4) parameters including both cross security parameters indicating an inverse relation between excess return and volatility, only two home shares parameters related to one of each, auto and cross security parameters show support for asymmetric volatility. Subsample analyses with emerging and developed markets and further the trading time overlap markets do not shed any more light on the contrary evidence. In contrast, sampling by momentum days yield huge rewards since parameter estimates M+, M-, and M0 days show large and significant differences. In particular, the estimates pinpoint the sources of positive parameter estimates mostly alternate between positive (M+) and negative (M-) momentum days; all but one parameter estimates for M0, no momentum days are negative implying asymmetric volatility singularly emerging from trading days when high (low) volume surprises are matched with low (high) excess returns.

5.2 Determinants of asymmetric volatility parameters

Tables 8A and 8B contain the OLS parameter estimates for ADRs and home shares respectively corresponding to a regression model similar to equations 3a-3d to identify the determinants of asymmetric volatility parameters c_{ij}, for $i = \{1, 2\}$ and $j=\{1,2,3,4\}$ from equations 5a/5b above. The independent regressor variables are firm size, turnover ratio, momentum ratios, two indicator variables denoting overlap and market type (developed vs. emerging), and multiple interaction variables between the continuous and indicator variables.

Table 8A finds significant positive impact of changes in firm size on the magnitude of asymmetric volatility parameters, for both ADRs and home shares. In contrast, a change in turnover ratio is a significant determinant (-0.006 with t-stat -9.38 and 0.005

with t-stat 7.56) for the auto security parameters, c_{11} *and* c_{12} for ADRs but only so for the corresponding home security excess return (-0.002 with t-stat -4.23) but not the excess return times volume parameters, c_{13} *and* c_{14}. Table 8B reports similar OLS parameter estimates for home shares and finds significantly positive impact of firm size on auto excess return times volume and cross security excess returns (0.001 and 0.004 with corresponding t-statistics of 2.35 and 7.28) but only a negative significant (-0.001, t-statistics -2.40) auto excess return effect on volatility. Regarding turnover ratio, again the effects are asymmetric between auto and cross securities effects on ADR and home securities such that while both auto security effects are negative (-0.007 and -0.003 with corresponding t-statistics of -13.97 and -6.68) only cross security ADRs' excess return effect on volatility is significantly negative (-0.010 with t-stat -15.61). The mix of positive and negative significant impact of changes in firm size and turnover ratios on asymmetric volatility parameters confirm a non-monotonic impact of firm size and liquidity on asymmetric volatility observed in ADRs and their underlying home shares.

All ADR related OLS parameters associated with momentum ratios, MR1 and MR2 are significant at less than 10% level. The signed coefficients related to MR1with respect to the ADR auto, cross returns, c_{11}, c_{13} (-0.117, -0.024) are negative while auto, cross return times volume, c_{12} , c_{14} (0.037, 0.021) are positive. With respect to those parameters associated with momentum ratio, MR2, ADRs' 0.059, 0.113, 0.039 are positive, while c_{14} (-0.039) is negative.

Unlike those for ADRs, the OLS parameters associated with momentum ratios, MR1 and MR2 with respect to home share parameters, c_{21}, $c_{23,}$ c_{22}, c_{24} show mixed levels of significance. The signed coefficients related to MR1with respect to the home shares auto and cross excess returns, c_{21}, c_{23} (-0.016, -0.203 with t-stats -1.67 and -16.82) are negative while cross excess return times volume, c_{24} (0.043, t-stat 4.18) is positive. With respect to the OLS parameters associated with momentum ratio, MR2, for home shares, the auto excess return times volume (0.021, t-stat 2.46) and the cross excess return (0.10, t-stat 7.17) are significant; others are not. Overall, both ADRs and their underlying home shares exhibit mixed and nuanced effects of momentum ratios on asymmetric volatility parameters. The mixed positive and negative effects of changes in momentum ratios on the asymmetric volatility parameters turn the net effect to be dependent on the time varying trade momentum.

On the contrary, the two country/market specific indicator variables, time overlap and emerging vs. developed asymmetrically impact the intercept (alpha) for ADRs and home shares asymmetric volatility parameters. For example, as reported in Table 8A, the OLS estimates -0.030 and -0.023 (t-stats –4.12 and –1.79) corresponding to overlap and market respectively are inversely related to asymmetric volatility parameter c_{12} while in Table 8B, those parameter estimates are 0.009 and 0.029 (t-stats 2.08 and 4.51) for the asymmetric volatility parameter c_{22}. These asymmetries are further compounded due to the signs of the slope parameters (betas) associated with the four interaction terms, *log(MVE)*Olapd*, *log(TO)*Olapd, log(TO)*Mktd*; *log(MVE)*Mktd* find asymmetric effect of size and turnover on the volume induced spillover parameters between emerging and developed markets securities and also among securities with primary listing in countries with high, low, or no overlap. For example, recall that for the ADR auto excess return parameter, c_{11} all the interaction variables related to size and turnover ratio are insignificant, while for the cross excess return parameter for ADRs, c_{13} the interaction variables related to momentum ratios are mostly insignificant. The dichotomy suggests while size and turnover ratios cast similar effects on the relation between ADR excess return and volatility for securities in emerging and developed markets and also in different overlap regions, the impact of momentum ratios are different among ADRs from those markets and regions; in contrast, while size and turnover ratios have different impact on the cross security excess return parameter for securities in different markets and regions, momentum is not. Nevertheless, home shares parameters do not show such redundancies except in scattered instances. The model summary statistics denoted by F-stats 17.69-102.45 and adjusted R^2 4.7%-23.1% for the four dependent variables in Table 8A and similar statistics denoted by F-stats 15.71-80.04 and adjusted R^2 4.2%-19.0% in Table 8B indicate moderate fit.

We summarize our results on the determinants of asymmetric volatility parameters as follows. First, size and liquidity denoted by market value of equity and turnover ratio respectively cast asymmetric effects on asymmetric volatility parameters. While size effects are positive for ADRs, those are mostly positive for home shares; on the other hand, liquidity effects are all negative for home shares but mostly negative for ADRs. Momentum ratios thrust significant and asymmetric effects on asymmetric volatility for ADRs and home shares. Further, those asymmetric effects of size, liquidity, and momentum on the sign and magnitude of the coefficients denoting the relation between excess return and volatility continue over emerging and developed markets and over different overlap regions.

6. Conclusion

We empirically investigate the effect of trading volume on return comovements and asymmetric volatility in the case of 175 ADRs and their underlying securities listed in 27 developed and emerging market countries. Our results show that a) cross security lag volume determines security volume, albeit asymmetrically in multi market trading; b) a lag interaction term residual volume*return casts asymmetric impact on return for ADRs and their underlying home securities; c) the relation between excess return and volatility is asymmetric between ADRs and home shares and so is the relation between residual volume*excess return and volatility. The asymmetric return comovements between ADRs and their underlying home shares and those between auto and cross securities may be explained by trade momentum. Similarly, momentum also factors in determining the asymmetric relation between excess return, be it volume induced or not and volatility. Momentum, size and liquidity are determinants of volume induced return comovements and the relation between excess return and volatility for securities from developed vs. emerging markets or from countries with low, high, or no time overlap.

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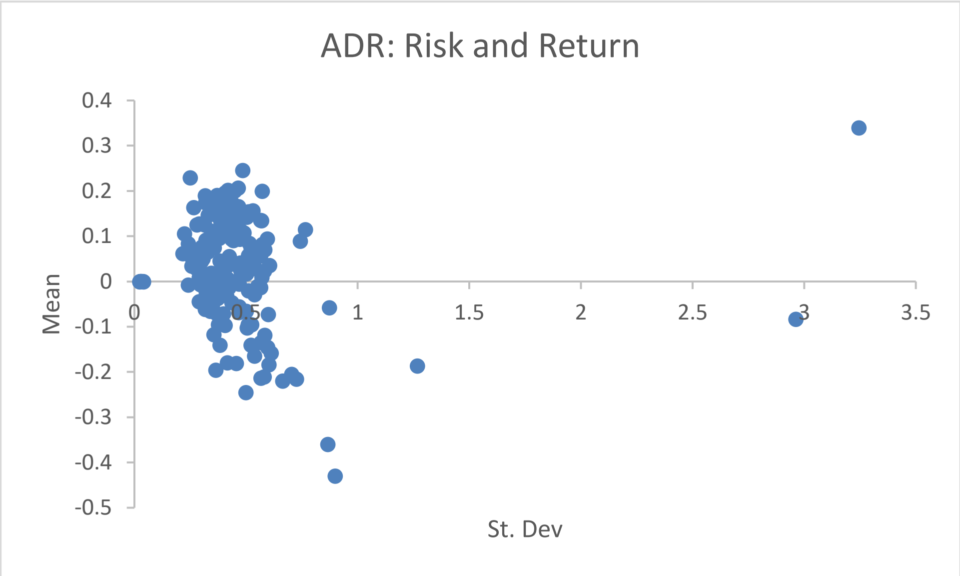
Table 1: Sample breakdown into countries included in MSCI ACWI index, which is composed of 23 developed and 23 emerging markets indexes as below.

	Total	MSCI	Sample
Nos. of non-US issuers (countries) listed on NYSE Market as of Dec 2012	525 (46)		
Nos. of ADRs (countries with >=1 ADR) listed on NYSE as of Dec 2012	259 (33)		
ADRs (Countries) included in Developed Markets		81 (16)	82 (17)
Australia		6	6
Belgium		2	2
Denmark		1	1
Finland		1	1
France		7	6
Germany (1 preferred)		4	3
Ireland		3	3
Israel		2	2
Italy		4	4
Japan		15	17
Netherlands (3 NY Registry Shares)		5	5
Norway		1	1
Portugal		1	1
Spain		3	3
Switzerland (1 NY Registry Shares)		5	4
UK		23	21
Luxembourg* (Primary listings in Netherlands and Italy)			2
ADRs (Countries) included in Emerging markets		148 (16)	93 (11)
Brazil (1 preferred)		25	24
Chile (1 preferred)		12	9
China		60	14
Colombia		2	0
Greece		1	0
India		8	6
Indonesia		1	1
Mexico (1 Global Share)		14	10
Peru		2	0
Philippines		1	1
Russia		2	0
South Africa		7	6
South Korea		8	7
Taiwan		5	7
Turkey		1	0
Argentina*			8

Table 2: The top and bottom panels contain descriptive statistics on daily trading volume and returns respectively corresponding to the full sample and selected matched equally weighted portfolios of ADRs and their underlying home securities. The portfolios are constructed as follows. For each portfolio, we begin with the earliest eligible listed security and thereafter adding new eligible securities as those are listed. Daily trading volume (in millions) for the sample ADRs listed on NYSE and their underlying shares listed on the respective home country stock exchanges is denoted by $v_t^i = \ln(N_t^i)$ on the *tth* day while the annualized daily returns are computed as $r_t^i = \ln(P_t^i / P_{t-1}^i)$ where P_t^i denotes closing price of security *i* on the *tth* day, for those ADRs and their underlying home shares. Two sets of t-tests for differences between means are reported. The row t-tests test differences between subsample means; the right most column reports t-tests for differences between ADR and home shares means. *, #, ^ indicate less than 1, 5, and 10 percent level of significance respectively.

	ADR Mean-mi	**Volume St. Dev.**	**ADR Skewness**	**Volume Kurtosis**	**Home Mean-mi**	**Volume St. Dev.**	**Home Skewness**	**Volume Kurtosis**	**t-test**
All- Sample	4.85	2.76	1.38	7.88	16.07	8.06	1.36	9.37	-57.1*
Developed	2.49	2.05	4.67	53.03	11.01	5.50	1.26	7.89	-103.2*
Emerging	8.20	5.40	1.71	12.49	22.93	17.14	5.84	113.69	-58.21*
t-test Dev vs Emer	-70.21*				-47.04*				
Overlap=1	11.10	10.19	4.30	63.69	6.38	7.0	4.86	51.93	26.9*
Overlap=-1	2.73	2.21	5.0	58.60	10.97	5.28	1.44	9.28	-102.3*
Overlap=0	5.61	4.18	2.51	19.20	29.76	21.24	2.75	18.91	-79.3*
t-test 1 vs -1	57.0*				-37.03*				
t-test -1 vs 0	-43.22*				-60.90*				
t-test 1 vs 0	35.43*				-73.69*				
	ADR Mean	**Return St. Dev**	**ADR Skewness**	**Return Kurtosis**	**Home Mean**	**Return St. Dev**	**Home Skewness**	**Return Kurtosis**	**t-test**
All- Sample	0.019%	0.014	-0.20	11.28	0.024%	0.01	-0.47	8.36	-0.16
Developed	0.032%	0.014	-0.32	9.49	0.030%	0.011	-0.201	8.09	0.18
Emerging	0.001%	0.017	0.221	13.47	0.02%	0.013	0.124	16.61	-0.63
t-test Dev vs. Emer	0.962				0.287				
Overlap=1	-0.01%	0.021	-0.391	16.77	0.029%	0.016	-0.57	21.43	-1.04
Overlap=-1	0.029%	0.015	-0.305	9.08	0.023%	0.012	-0.275	7.47	0.23
Overlap=0	0.014%	0.017	0.098	9.61	0.017%	0.013	-0.397	8.66	-0.08
t-test 1 vs -1	-1.092				0.197				
t-test -1 vs 0	0.471				0.252				
t-test 1 vs 0	-0.634				0.402				

Figure 1. Scatterplot of risk return of 175 ADRs and their underlying home shares.



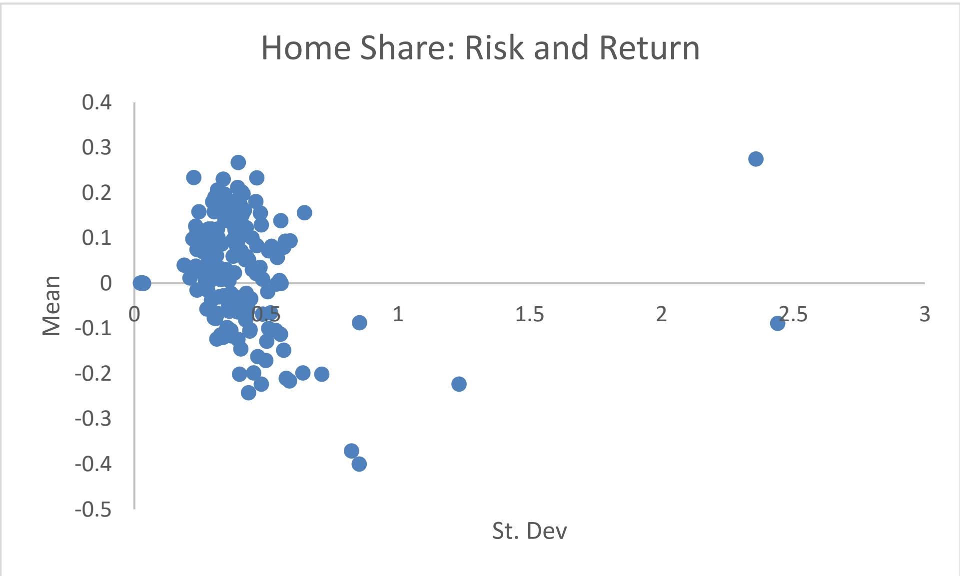


Table 3: Summaries of estimated parameters and residuals of the following bivariate VAR model for ADR and home security volumes. Panel A contains the following VAR model parameter estimates while Panel B provides means, standard deviation, and other diagnostics on the VAR residuals.

$$v_{i,t}^{us} = \alpha_1 + \beta_{11} v_{i,t-1}^{us} + \beta_{12} v_{i,t-1}^{h} + \phi_1 v_t^{us} + V_{i,t}^{us} \quad \ldots\text{(1a)}$$

$$v_{i,t}^{h} = \alpha_2 + \beta_{21} v_{i,t-1}^{h} + \beta_{22} v_{i,t-1}^{us} + \phi_2 v_t^{h} + V_{i,t}^{h} \quad \ldots\ldots\text{(1b)}$$

A	**Mean β11**	**Mean β12**	**%Var (US)**	**%Var (Home)**	**Mean β21**	**Mean β22**	**%Var (US)**	**%Var (Home)**
Full sample	-0.389 0, 175, 175	0.011 104, 71, 67			-0.336 0, 175, 175	0.063 168, 7, 170		
Developed	-0.385	0.016	0.999	0.001	-0.292	0.054	0.058	0.942
Emerging	-0.393	0.007	0.999	0.001	-0.374	0.071	0.102	0.898
t-test: Dev vs Emer	-1.22	-1.37			-8.65*	2.03**		
Overlap=1	-0.405	0.020	0.998	0.002	-0.398	0.041	0.140	0.860
Overlap=-1	-0.378	0.026	0.999	0.001	-0.297	0.059	0.072	0.928
Overlap=0	-0.389	-0.013	0.999	0.001	-0.328	0.095	0.045	0.955
t-test 1 vs -1	-3.53*	-0.86			-8.11*	-1.94**		
t-test -1 vs 0	1.44	-7.55*			2.82*	-3.22*		
t-test 1 vs 0	-2.07*	4.84*			-6.44*	-5.28*		
B	**Developed t-test**	**Emerging t-test**		**Olap=1 t-test**	**Olap=-1 t-test**	**Olap=0 t-test**		
Nos. of Obs.	82	93		51	65	59		
β11 vs. β21	-11.94*	-2.57**		-0.66	-8.19*	-7.49*		
β12 vs. β22	-4.66*	-6.80*		-2.00***	-3.14*	-10.77*		
C	**ADR Vol Residual Mean**	**ADR Vol Residual Std. Dev**	**ADF**	**Home Vol Residual Mean**	**Home Vol Residual Std. Dev**	**ADF**	**t-test: diff. in means**	**$\rho(V^{US},V^{H})$**
Developed	-0.23%	0.206	-34.73*	-0.326%	0.131	-36.0*	0.27	0.269*
Emerging	-0.353%	0.264	-27.61*	-0.406%	0.226	-34.17*	0.089	0.30*
t-test Dev vs Emer	0.27			0.21				
Overlap=1	-0.527%	0.325	-26.34*	-0.333%	0.354	-28.20*	-0.30	0.393*
Overlap=-1	-0.259%	0.219	-27.33*	-0.305%	0.143	-27.58*	0.12	0.191*
Overlap=0	-0.246%	0.274	-28.57*	-0.328%	0.211	-33.18*	0.15	0.217*
t-test 1 vs -1	-0.49			-0.04				
t-test -1 vs 0	-0.029			0.027				
t-test 1 vs 0	-0.49			-0.027				

Table 4: Diagnostics on volume residuals and returns for positive, negative, and zero momentum days. Panel A1 contains diagnostics on daily trading volume residuals (in millions), V_t^i on the *tth* day for each momentum subsample, M+, M-, and M0 of days in our sample ADRs listed on NYSE and their underlying shares listed on the respective home country stock exchanges from the following set of VAR equations.

$$v_{i,t}^{us} = \alpha_1 + \beta_{11} v_{i,t-1}^{us} + \beta_{12} v_{i,t-1}^{h} + \phi_1 v_t^{us} + V_{i,t}^{us} \quad .... (1a)$$

$$v_{i,t}^{h} = \alpha_2 + \beta_{21} v_{i,t-1}^{h} + \beta_{22} v_{i,t-1}^{us} + \phi_2 v_t^{h} + V_{i,t}^{h} \quad ...... (1b)$$

Panel A2 includes those on annualized daily returns computed as $r_t^i = \ln(P_t^i / P_{t-1}^i)$ where P_t^i denotes closing price of security *i* on the *tth* day, for those ADRs and their underlying home shares. Panel B reports parameter estimates and the corresponding z-stats for a Poisson regression model separately for M+, M-, and M0 days. M+, M-, and M0 days are defined as follows. For each security trading day, we define positive momentum or feedback, M+ days as those characterized by positive volume shocks and positive return; negative momentum or feedback, M- days as negative volume shock with negative return; and zero momentum, M0 days as positive (negative) volume shock with negative (positive) return. *, #, ^ indicate less than 1, 5, and 10 percent level of significance respectively.

A1	**ADR** **# of days (%)**	**Home Shares** **# of days (%)**	**ADR Volume residual** **Mean**	**ADR Volume Residual** **St. Dev.**	**Home Volume residual** **Mean**	**Home Volume residual** **St. Dev.**
M+	0.240	0.235	0.138	0.157	0.10	0.10
M-	0.248	0.244	-0.137	0.155	-0.99	0.103
M0	0.512	0.521	0.0025	0.222	-0.0022	0.165
t-test + vs -	-6.90*	-6.0*	139.03*		162.38*	
t-test - vs 0	176.61*	85.09*	-59.63*		-59.91*	
t-test + vs 0	-198.67*	90.50*	56.73*		60.32*	

A2			**ADR Return** **Mean**	**ADR Return** **St. Dev.**	**Home Return** **Mean**	**Home Return** **St. Dev**
M+			0.559%	0.73%	0.439%	0.517%
M-			-0.405%	0.508%	-0.422%	0.487%
M0			-0.119%	0.92%	0.209%	0.745%
t-test + vs -			86.96*		106.02*	
t-test - vs 0			-23.02*		-42.89*	
t-test + vs 0			47.88*		39.89*	

B	**M+** **Estimates**	**M+** **Z-values**	**M-** **Estimates**	**M-** **Z-values**	**M0** **Estimates**	**M0** **Z-values**
Intercept	-43.237	-41.48*	-46.041	-44.53*	-28.344	-36.64*
Year	0.021	41.34*	0.023	44.46*	0.014	37.1*
Month	0.005	5.82*	0.001	0.86	0.000	0.35
Overlap	0.377	67.80*	0.365	66.83*	0.203	50.69*
Emer/Dev	0.245	27.77*	0.224	25.95*	0.126	19.92*
Momentum	0.195	221.0*	0.185	220.61*	0.177	356.65*
Home						
Adj. R^2		17.3%		17.6%		45.8%
LRatio		60607*		60434*		151048*

Table 5: Cross sectional (country groups) summaries of select estimated parameters of the following bivariate VAR model for ADR and home security returns, r_t. The select parameters are the coefficients corresponding to auto and cross lag correlation and auto and cross lag return*volume residual for each security. The following statistics related to the parameter estimates are reported: Sample mean followed by the Nos. of positive, negative, and significant estimates. In panel B, the subsamples include developed and emerging market countries as classified via MSCI respective index constituents. In panel C, the subsamples denote securities with primary listing in Asia and Australia denote C1 with no overlap with US trading day; Europe and South Africa denote C2 with partial overlap with US trading day; and C3 denotes Americas with extensive (more than 2/3rd) overlap with US trading days. In panel D, time series classification yield three subsamples based on daily volume and return dynamics- M+, positive momentum denote those trading days where both excess trading volume and return are positive; M-, negative momentum occurs on those days when excess trading volume and returns are negative; M0, zero momentum days denote trading days when there is no clear positive or negative momentum i.e., excess volume times return is negative.

$$r_{i,t}^{us} = a_1 + b_{11}r_{i,t-1}^{us} + b_{12}r_{i,t-1}^{us}V_{i,t-1}^{us} + b_{13}r_{i,t-1}^{h} + b_{14}r_{i,t-1}^{h}V_{i,t-1}^{h} + b_{15}x_t^{us} + e_{i,t}^{us} \quad ..... \text{(2a)}$$

$$r_{i,t}^{h} = a_2 + b_{21}r_{i,t-1}^{h} + b_{22}r_{i,t-1}^{h}V_{i,t-1}^{h} + b_{23}r_{i,t-1}^{us} + b_{24}r_{i,t-1}^{us}V_{i,t-1}^{us} + b_{25}x_t^{h} + e_{i,t}^{h} \quad .... \text{(2b)}$$

	ADR			ADR	Home			Home
	Mean b_{11};	Mean b_{12};	Mean b_{13};	Mean b_{14};	Mean b_{21};	Mean b_{22};	Mean b_{23};	Mean b_{24};
Expected signs of parameters	$b_{i1} \geq 0$	$b_{i2} > 0$ $b_{i2} < 0$	$b_{i3} \neq 0$	$b_{i4} > 0$ $b_{i4} < 0$	$b_{i1} \geq 0$	$b_{i2} > 0$ $b_{i2} < 0$	$b_{i3} \neq 0$	$b_{i4} > 0$ $b_{i4} < 0$
	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$
A. Sample								
Full Sample	-0.112 23, 152, 136	0.003 90, 85, 56	0.133 156, 19, 139	0.017 109, 66, 66	-0.194 8, 167, 154	0.005 97, 78, 57	0.217 168, 7, 157	0.023 110, 65, 70
Full Sample MA filter-GK (2009)	-0.082 28, 147, 129	-0.005 73, 102, 51	0.100 151, 24, 139	0.016 115, 60, 60	-0.203 7, 168, 158	-0.002 83, 92, 64	0.274 173, 2, 168	0.011 99, 76, 69
B. Market								
μ (Dev) μ (Emer) Significance.	-0.10 11, 71, 63 -0.122** 12, 81, 73	0.006 43, 39, 17 0.002** 47, 46, 39	0.105 70, 12, 63 0.157** 86, 7, 76	0.021 56, 26, 35 0.015** 53, 40, 31	-0.129 6, 76, 66 -0.25* 2, 91, 88	-0.003 42, 40, 29 0.012*** 55, 38, 28	0.143 77, 5, 67 0.283* 91, 2, 90	0.025 54, 28, 38 0.020 56, 37, 32
C. Overlap								
μ(C1) / μ(C2) t-stat for diff. in means	-.131/-.099 2.15*	.018/.005 -1.38	.125/.105 1.12	.029/.023 -0.57	-.258/-.142 4.01*	.008/.001 -0.73	.305/.160 -4.56*	.037/.021 -1.41
μ(C2) / μ(C3) t-stat for diff. in means	-.099/-.117 0.51	.005/-.016 -2.13*	.105/.176 2.97*	.023/-.003 -2.40*	-.142/-.184 -1.68***	.001/.005 0.41	.160/.189 1.12	.021/.008 -1.09
μ(C1) / μ(C3) t-stat for diff. in means	-.131/-.117 -0.76	.018/-.016 -3.17*	.125/.176 2.15**	.029/-.003 3.43*	-.258/-.184 2.64*	.008/.005 -0.37	.305/.189 -3.89*	.037/.008 -2.62*
D. Momentum								
μ_{M+} / μ_{M-} t-stat: $\mu_{M+} > \mu_M$	-.07/-.091 1.54	.010/-.007 2.0**	.130/.052 4.74*	.030/.002 2.14**	-.090/-.141 3.08*	.026/.001 1.64***	.175/.114 3.71*	.027/.001 2.95*
μ_{M-} / μ_{M0} t-stat: $\mu_{M-} > \mu_{M0}$	-.091/-.082 -.077	-.007/.001 -1.03	.052/.094 3.31*	.002/.023 2.30**	-.141/-.133 0.60	.001/-.001 0.36	.114/.172 -4.26*	.001/.028 -3.51*
μ_{M+} / μ_{M0} t-stat: $\mu_{M+} > \mu_M$	-.07/-.82 0.94	.010/.001 1.05	.130/.094 2.22**	.030/.023 0.49	-.090/-.133 2.60*	.026/-.001 1.92***	.175/.172 0.20	.027/.028 -0.16

Table 6: Regression (OLS) Estimates and the corresponding t-stats of Volume Induced Return Spillover Parameters. The regression model along with its dependent and independent variables are as below. *, ** denote significance at .01 and .05 levels respectively.

$$Y_i = a_0 + a_1 X_1 + \cdots + a_n X_n + \varepsilon_1$$

Y_{ij}=B_{ij}= Abs(b_{ij})*κ

Where, b_{ij} denote the estimated parameters from VAR equations 2a and 2b for i={1,2} and j={2,4} and κ={1, if b_{ij} > 0 and significant <10%; -1, if b_{ij} < 0 and significant <10%; 0, if b_{ij} is not significant}

X_1= Log (MVE);

X_2= Log (Turnover ratio, Dollar volume(t)/MVE(t-1)

X_3= Log (Mratio1=Nos. of M+ / Nos. of M-);

X_4= Log (Mratio2=Nos. of M+ + M- / Nos. of M0);

X_5= Olapd {1, if overlap; -1, if partial overlap; 0, if no overlap}

X_6= Mktd {1, if developed market; 0, if emerging market}

	ADR	ADR	Home	Home
	Y = B_{12}	**Y = B_{14}**	**Y= B_{22}**	**Y = B_{24}**
C	0.084(8.36)*	-0.017(-2.34)**	-0.043(-7.25)*	0.123(13.64)*
LOG (MVE)-ADR	0.002(2.17)**			0.005(4.69)*
LOG (MVE)-Home		0.002(4.72)*	0.005(10.44)*	
LOG ($TO/10^6$)-ADR	0.010(10.03)*			0.019(17.71)*
LOG ($TO/10^6$)-Home		0.000(0.05)	0.001(1.24)	
Log (Mratio 1)-ADR	0.029(1.64)	-0.204(-12.13)*		
Log (Mratio 1)-Home			-0.029(2.38)**	-0.117(-7.63)*
Log (Mratio 2)- ADR	0.043(2.11)**	-0.111(-5.42)*		
Log (Mratio 2)- Home			-0.103(-7.88)*	0.032(2.18)**
Olapd	-0.002(-0.23)	0.046(6.07)*	0.081(12.68)*	-0.098(-9.94)*
Mktdum	-0.009(-0.50)	0.088(7.76)*	0.167(16.57)*	-0.162(-8.97)*
Olapd * LOG (MVE)	-0.004(-4.67)*	-0.002(-3.41)*	-0.005(-9.04)*	0.003(3.21)*
Mktd * LOG (MVE)	-0.004(-3.02)*	-0.003(-4.16)	-0.010(-12.56)*	0.004(2.61)**
Olapd * LOG($TO/10^6$)	-0.006(-6.74)*	0.001(1.50)	0.001(1.49)	-0.010(-9.91)*
Mktd * LOG($TO/10^6$)	-0.005(-3.12)*	0.003(2.40)**	0.002(1.83)***	-0.018(-10.05)*
Olapd * LOG(Mratio1)	-0.040(-2.25)**	0.132(7.72)*	-0.0002(-0.01)	0.055(2.80)**
Mktd * LOG (Mratio1)	-0.048(-1.64)	0.342(12.97)*	0.018(0.66)	0.004(0.12)
Olapd * LOG(Mratio2)	0.059(2.68)**	0.174(7.84)*	0.164(11.41)*	0.013(0.74)
Mktd * LOG(Mratio2)	-0.079(-2.26)**	0.141(4.00)*	0.210(9.36)*	-0.084(-3.30)*
Nos. of observations	175	175	175	175
F-stat	33.07	34.87	39.14	61.82
Adjusted R^2	8.67%	9.12%	10.15%	15.27%

Table 7: Summaries of select estimated parameters of the following bivariate VAR model for ADR and home security volatility, σ_t. The select parameters are the coefficients corresponding to auto and cross lag correlation and auto and cross lag return*volume residual for each security. The following statistics related to the parameter estimates are reported: Sample mean followed by the Nos. of positive, negative, and significant estimates. In panel B, the subsamples include developed and emerging market countries as classified via MSCI respective index constituents. In panel C, the subsamples denote securities with primary listing in Asia and Australia denote C1 with no overlap with US trading day; Europe and South Africa denote C2 with partial overlap with US trading day; and C3 denotes Americas with extensive (more than 2/3rd) overlap with US trading days. In panel D, time series classification yield three subsamples based on daily volume and return dynamics- M+, positive momentum denote those trading days where both excess trading volume and return are positive; M-, negative momentum occurs on those days when excess trading volume and returns are negative; M0, zero momentum days denote trading days when there is no clear positive or negative momentum i.e., excess volume times return is negative.

$$\sigma_t^A = a_A + \sum_{i=1}^{6} b_{1i}\sigma_{t-i}^A + c_{11}e_{t-1}^A + c_{12}V_{t-1}^A e_{t-1}^A + \sum_{j=1}^{6} g_{1j}\sigma_{t-j}^H + c_{13}e_{t-1}^H + c_{14}V_{t-1}^H e_{t-1}^H + \varepsilon_{1t} \quad (5a)$$

$$\sigma_t^H = a_H + \sum_{i=1}^{6} b_{2i}\sigma_{t-i}^H + c_{21}e_{t-1}^H + c_{22}V_{t-1}^H e_{t-1}^H + \sum_{j=1}^{6} g_{2j}\sigma_{t-j}^A + c_{23}e_{t-1}^A + c_{24}V_{t-1}^A e_{t-1}^A + \varepsilon_{2t} \quad (5b)$$

	ADR			ADR	Home			Home
	Mean c_{11};	Mean c_{12};	Mean c_{13};	Mean c_{14};	Mean c_{21};	Mean c_{22};	Mean c_{23};	Mean c_{24};
Expected signs	$c_{11} \geq 0$	$c_{12} < 0$	$c_{13} \neq 0$	$c_{i4} < 0$	$c_{21} \geq 0$	$c_{22} < 0$	$c_{23} \neq 0$	$c_{24} < 0$
	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$	Mean #+, #-, #$
A. Sample								
Full Sample	0.007 104, 71, 52	-0.005 75, 100, 53	-0.013 54, 121, 58	-0.003 87, 88, 42	-0.024 47, 128, 84	0.000 90, 85, 39	0.008 97, 78, 53	-0.006 75, 100, 47
B. Market								
μ (Dev)	0.010 49, 33, 24	-0.005 36, 46, 24	-0.021 18, 64, 33	0.002 43, 39, 18	-0.035* 14, 68, 47	0.004 47, 35, 19	0.012* 49, 33, 25	-0.007 36, 46, 19
μ (Emer)	0.005 55, 38, 28	-0.006 36, 57, 25	-0.005 39, 54, 29	-0.007 44, 49, 24	-0.014** 33, 60, 37	-0.004 43, 50, 20	0.004 48, 45, 28	-0.004 39, 54, 28
t-stat: Mean diff	0.96	0.03	2.48**	1.34	-3.38*	1.15	1.36	-0.58
C. Overlap								
μ(+1)	-0.004 24, 27, 15	0.003 28, 23, 13	0.0002 23, 28, 15	-0.001 26, 25, 12	-0.006 19, 32, 18	-0.005 25, 26, 9	-0.009 21, 30, 13	0.006 25, 26, 13
μ(-1)	0.009 38, 27, 15	-0.007 25, 40, 19	-0.024 12, 53, 27	0.005 36, 29, 14	-0.036 10, 55, 41	0.006 35, 30, 14	0.011 38, 27, 19	-0.004 34, 31, 15
μ(0)	0.016 42, 17, 19	-0.008 22, 37, 21	-0.013 19, 40, 16	-0.013 25, 34, 16	-0.025 18, 41, 25	-0.003 30, 29, 16	0.019 38, 21, 21	-0.018 16, 43, 19
t-stat:								
μ(+1) v. (-1)	-1.76***	1.22	2.68**	-0.74	3.57*	-1.41	-2.58**	1.52
μ(0) v. (-1)	1.14	-0.10	2.14**	-2.00**	1.68***	-1.06	1.18	-2.03**
μ(+1) v. (0)	-2.78**	1.71***	1.46	1.69***	2.17**	-0.22	-3.41*	4.13*
D. Momentum								
μ(M+)	-0.028 64, 111, 53	-0.004 87, 88, 42	0.041 118, 57, 52	0.010 97, 78, 36	-0.034 51, 124, 48	0.011 106, 69, 41	0.042 137, 38, 60	-0.001 89, 96, 44
μ(M-)	0.041 143, 32, 75	0.005 97, 78, 39	-0.018 56, 119, 40	-0.006 81, 94, 41	0.027 124, 51, 64	-0.001 87, 88, 46	-0.009 72, 103, 58	0.008 104, 71, 36
μ(M0)	-0.004 76, 99, 53	-0.012 67, 108, 59	-0.018 60, 115, 60	-0.008 78, 97, 44	-0.005 78, 97, 65	0.001 85, 90, 45	-0.026 47, 128, 78	-0.015 68, 107, 70
t-stat:								
μ(M+) v. μ(M-)	-8.17*	-1.20	7.56*	1.58	-8.58*	1.38	7.65*	-1.28
μ(M-) v. μ(M0)	7.85*	2.61**	0.15	0.29	-4.45*	1.28	10.19*	1.90***
μ(M+) v. μ(M0)	-3.37*	0.96	7.64*	1.62	4.70*	-0.26	3.10*	3.87*

Table 8A: Regression (OLS) Estimates and the corresponding t-stats of asymmetric volatility parameters for ADRs. The regression model along with its dependent and independent variables are as below. *, ** denote significance at .01 and .05 levels respectively.

$$Y_i = a_0 + a_1 X_1 + \cdots + a_n X_n + \varepsilon_1$$

$Y_{ij}=B_{ij}=$ Abs(b_{ij})*κ

Where, b_{ij} denote the estimated parameters from VAR equations 2a and 2b for i={1,2} and j={2,4} and κ={1, if $b_{ij} > 0$ and significant <10%; -1, if $b_{ij} < 0$ and significant <10%; 0, if b_{ij} is not significant}

X_1= Log (MVE);

X_2= Log (Turnover ratio, Dollar volume(t)/MVE(t-1)

X_3= Log (Mratio1=Nos. of M+ / Nos. of M-);

X_4= Log (Mratio2=Nos. of M+ + M- / Nos. of M0);

X_5= Olapd {1, if overlap; -1, if partial overlap; 0, if no overlap}

X_6= Mktd {1, if developed market; 0, if emerging market}

	ADR	ADR	ADR	ADR
	Y = C_{11}	**Y = C_{12}**	**Y= C_{13}**	**Y = C_{14}**
C	-0.034(-5.61)*	0.045(6.11)*	-0.051(-11.25)*	
LOG (MVE)-ADR	0.001(2.33)**	0.002(3.39)*		
LOG (MVE)-Home			0.004(12.26)*	0.001(1.99)***
LOG ($TO/10^6$)-ADR	-0.006(-9.38)*	0.005(7.56)*		
LOG ($TO/10^6$)-Home			-0.002(-4.23)*	-0.000(-0.59)
Log (Mratio 1)-ADR	-0.117(-10.84)*	0.037(2.87)*		
Log (Mratio 1)-Home			-0.024(-2.48)**	0.021(1.86)***
Log (Mratio 2)- ADR	0.059(4.76)*	0.113(7.57)*		
Log (Mratio 2)- Home			0.039(3.92)*	-0.039(-3.76)*
Olapd	-0.006(-0.95)	-0.030(-4.12)*	-0.049(-10.00)*	0.020(3.33)*
Mktdum	0.020(1.85)***	-0.023(-1.79)***	0.099(12.78)*	0.028(3.06)*
Olapd * LOG (MVE)	0.000(0.64)	0.000(0.06)	0.003(7.56)*	-0.002(-3.48)*
Mktd * LOG (MVE)	-0.001(-1.43)	_0.002(-2.05)**	-0.008(-12.69)*	0.000(-0.42)
Olapd * LOG($TO/10^6$)	0.000(-0.74)	-0.003(-4.55)*	-0.005(-10.27)*	0.001(0.92)
Mktd * LOG($TO/10^6$)	0.002(1.58)	-0.004(-3.54)*	-0.002(-2.42)**	0.005(5.15)*
Olapd * LOG(Mratio1)	0.000(-0.01)	-0.049(-3.75)*	-0.019(-1.48)	-0.044(-2.91)*
Mktd * LOG (Mratio1)	0.110(6.21)*	-0.070(-3.32)*	0.023(1.07)	-0.122(-4.86)*
Olapd * LOG(Mratio2)	-0.097(-7.22)*	0.004(0.23)	0.059(5.28)*	0.028(2.13)**
Mktd * LOG(Mratio2)	-0.133(-6.24)*	-0.130(-5.07)*	-0.008(-0.46)	0.056(2.70)**
Nos. of observations	175	175	175	175
F-stat	32.55	18.23	102.45	17.69
Adjusted R^2	8.5%	4.9%	23.1%	4.7%

Table 8B: Regression (OLS) Estimates and the corresponding t-stats of asymmetric volatility parameters for home shares. The regression model along with its dependent and independent variables are as below. *, ** denote significance at .01 and .05 levels respectively.

$$Y_i = a_0 + a_1 X_1 + \cdots + a_n X_n + \varepsilon_1$$

Y_{ij}=B_{ij}= Abs(b_{ij})*κ

Where, b_{ij} denote the estimated parameters from VAR equations 2a and 2b for i={1,2} and j={2,4} and κ={1, if $b_{ij} > 0$ and significant <10%; -1, if $b_{ij} < 0$ and significant <10%; 0, if b_{ij} is not significant}

X_1= Log (MVE);

X_2= Log (Turnover ratio, Dollar volume(t)/MVE(t-1)

X_3= Log (Mratio1=Nos. of M+ / Nos. of M-);

X_4= Log (Mratio2=Nos. of M+ + M- / Nos. of M0);

X_5= Olapd {1, if overlap; -1, if partial overlap; 0, if no overlap}

X_6= Mktd {1, if developed market; 0, if emerging market}

	Home	Home	Home	Home
	Y = C_{21}	Y = C_{22}	Y= C_{23}	Y =C_{24}
C	-0.002(-0.38)	-0.008(-2.07)**	-0.095(-13.84)*	0.003(0.60)
LOG (MVE)-ADR			0.004(7.28)*	0.000(0.14)
LOG (MVE)-Home	-0.001(-2.40)**	0.001(2.35)**		
LOG ($TO/10^6$)-ADR			-0.010(-15.61)*	-0.001(-1.44)
LOG ($TO/10^6$)-Home	-0.007(-13.97)*	-0.003(-6.68)*		
Log (Mratio 1)-ADR			-0.203(-16.82)*	0.043(4.18)*
Log (Mratio 1)-Home	-0.016(-1.67)***	-0.004(-0.54)		
Log (Mratio 2)- ADR			0.100(7.17)*	-0.001(-0.07)
Log (Mratio 2)- Home	-0.011(-1.04)	0.021(2.46)**		
Olapd	-0.054(-10.52)*	0.009(2.08)**	0.078(11.64)*	-0.012(-2.09)***
Mktdum	0.031(3.90)*	0.029(4.51)*	0.139(11.44)*	0.012(1.16)
Olapd * LOG (MVE)	0.005(10.85)*	-0.001(-2.89)*	-0.005(-8.99)*	0.001(2.85)*
Mktd * LOG (MVE)	0.002(2.30)**	-0.001(-2.37)**	-0.009(-8.85)*	0.001(1.33)
Olapd * LOG($TO/10^6$)	0.001(1.25)	0.001(1.83)***	0.004(5.78)*	0.000(0.60)
Mktd * LOG($TO/10^6$)	0.008(9.02)*	0.004(6.02)*	0.009(7.56)*	0.003(2.78)**
Olapd * LOG(Mratio1)	0.139(10.73)*	-0.066(-6.28)*	0.177(14.56)*	-0.066(-6.44)*
Mktd * LOG (Mratio1)	0.187(8.60)*	-0.013(-0.73)	0.291(14.72)*	-0.015(-0.88)
Olapd * LOG(Mratio2)	0.103(9.02)*	0.009(0.92)	-0.090(-6.03)*	0.050(3.97)*
Mktd * LOG(Mratio2)	0.060(3.36)*	-0.007(-0.51)	-0.093(-3.89)*	0.015(0.73)
Nos. of observations	175	175	175	175
F-stat	80.04	17.29	55.09	15.71
Adjusted R^2	19.0%	4.67%	13.8%	4.2%