FINANCIAL LIBERALIZATION, FOREIGN EQUITY INVESTMENT AND VOLATILITY IN EMERGING STOCK EXCHANGES

A Ph.D. Dissertation

by
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Department of
Management
Bilkent University
Ankara
October 2008

TO MY FAMILY

FINANCIAL LIBERALIZATION, FOREIGN EQUITY INVESTMENT AND VOLATILITY IN EMERGING STOCK EXCHANGES

The Institute of Economics and Social Sciences
of
Bilkent University

by

MEHMET UMUTLU

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I certify that I have read this thesis and have found that it is fully adequate, in scope and in quality, as a thesis for the degree of Doctor of Philosophy in Management.

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ABSTRACT

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In this thesis, the effects of financial liberalization and foreign equity investment on the return volatility of stocks in emerging stock exchanges are investigated. At the aggregate level analyses, it is shown that the degree of financial liberalization has an increasing impact on the aggregated total volatility of stocks. The analysis of the components of the aggregated total volatility indicates that that the degree of financial liberalization impacts the aggregated total volatility through aggregated idiosyncratic and local volatility. In the second part of the aggregate level analyses, the effect of foreign equity investment on the return volatility of stocks is investigated by using foreign equity flow data which is available for İstanbul Stock Exchange. It is found that foreign equity inflow and outflow have asymmetric effects on average stock-return volatility. While an inflow has a decreasing impact on aggregated stock return volatility, an outflow has an increasing impact. At the firm level analysis, the time-series variation in return volatility of stocks that are cross-listed on US exchanges is examined. Unlike previous studies in cross-listing literature, return volatility is analyzed using conditional heteroscedasticity models. It's found that firms' exposure to risks such as local and global market betas remain unchanged after cross-listing. Moreover, no change in the dynamics of the volatility of cross-listed stocks is detected. Furthermore, it's shown that the mean level of conditional variance is not affected by the decision to cross-list. Thus, it is concluded that share holders of cross-listed stocks are not subject to adverse volatility effects.

Keywords: financial liberalization, foreign equity investment, stock-return volatility, ADR listing, emerging stock exchanges.

ÖZET

GELİŞMEKTE OLAN MENKUL KIYMET BORSALARINDA FİNANSAL LİBERALİZASYON, YABANCI HİSSE SENEDİ YATIRIMI VE VOLATİLİTE

Mehmet Umutlu

Doktora, İşletme

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Bu tezde, finansal liberalizasyonun ve yabancı hisse senedi yatırımının gelişmekte olan menkul kıymet borsalarındaki hisse senetlerinin getiri volatilitesi üzerindeki etkileri incelenmiştir. Toplam seviye analizlerinde, finansal liberalizasyon derecesinin ağırlıklandırılmış toplam volatilite üzerinde arttırıcı bir etkiye sahip olduğu gösterilmiştir. Ağırlıklandırılmış toplam volatilitenin bileşenlerinin analizi, finansal liberalizasyon derecesinin ağırlıklandırılmış toplam volatiliteyi toplam firma volatilitesi ve yerel ülke volatilitesi aracılığıyla etkilediğini göstermektedir. Toplam seviye analizlerin ikinci kısmında, yabancı hisse senedi yatırımının hisse senetlerinin getiri volatilitesi üzerindeki etkisi, İstanbul Menkul Kıymetler Borsası için yabancı hisse senedi akışı verisi kullanılarak incelenmiştir. Yabancı kaynak giriş ve çıkışının, ortalama hisse senedi getiri volatilitesi üzerindeki asimetrik etkileri olduğu bulunmuştur. Giriş, ağırlıklandırılmış hisse senedi volatiletisi üzerinde

azaltıcı bir etkiye sahip iken çıkış arttırıcı bir etkiye sahiptir. Şirket seviyesindeki analizde, Amerikan borsalarında eş zamanlı kote olmuş hisse senetlerinin getiri volatilitelerinin zaman serisi değişimleri incelenmiştir. Eş-kotasyon literatüründeki diğer çalışmalardan farklı olarak getiri volatilitesi koşullu varyans modelleri kullanılarak analiz edilmiştir. Şirketlerin lokal ve global piyasa betası gibi risklerinin eş-kotasyondan sonra değişmeden kaldığı bulunmuştur. Üstelik eş zamanlı kote olmuş hisse senetlerinin volatilite dinamiklerinde bir değişim belirlenmemiştir. Ayrıca koşullu varyansın ortalama seviyesinin eş-kotasyon kararından etkilenmediği gösterilmiştir. Böylece, eş zamanlı kote olmuş hisse senetlerinin sahiplerinin ters volatilite etkilerine maruz kalmadıkları sonucuna varılmıştır.

Anahtar Kelimeler**:** finansal liberalizasyon, yabancı hisse senedi yatırımı, hisse senedi getiri volatilitesi, ADR kotasyonu, gelişmekte olan menkul kıymet borsaları

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CHAPTER 1

INTRODUCTION

Increasing equity market liberalizations, the removal of barriers to international capital flows, and high returns in emerging markets in addition to the benefits of international diversification have led foreign investors to trade heavily in emerging markets' stock exchanges in the last few decades. Today, foreign investors in emerging markets play the role of institutional investors in developed markets and hold a significant portion of the traded stocks. Therefore, assessing the impact of foreign investors on local stock exchanges is now an important issue for emerging markets. Foreign investor participation in emerging stock exchanges can have positive and negative effects. On the positive side, it is documented that financial liberalization lowers the cost of capital, which, in turn, leads more projects to be profitable, and thus spurs economic growth. On the negative side, foreign equity investment is blamed for being very sensitive to the changes in local conditions and thus causing excess volatility in local markets. However, there is no consensus among researchers about the effects of foreign investor participation on the return volatility. A clear understanding of this relationship is important, because it has implications for both firms and governments.

Foreign investor participation is handled in different ways in the literature. While a number of studies associate foreign investor participation with financial liberalization or foreign equity flows, another group of studies associate it with ADR listing or cross-listings. At the aggregate level, foreign investors can take place in local stock exchanges after equity market financial liberalization which is a process that opens local stock exchange to foreign investor participation. After equity market liberalization, foreign investors can buy the local stocks and repatriate the capital and profits in the allowance limits of emerging markets. The literature on financial liberalization focuses on the behavior of return volatility of local market indexes in event windows around liberalization date. These studies implicitly assume that liberalization occurs at a single point in time. There are two major drawbacks to these studies. First, financial liberalization is a gradual process rather than an event. Thus, ignoring the ongoing nature of financial liberalization and treating it as a one-time event may lead to erroneous conclusions about the effects of financial liberalization. Second, analyzing the return variance of market index can be misleading, because a change in the variance of a portfolio may be due to changes in the covariances of the stocks forming the portfolio, without an accompanying change in their variances. In another line of studies, foreign equity flows are used to assess the effects of foreign participation in emerging markets (Choe et al., 1999; Froot et al., 2001; Bekaert et al., 2002b; and Wang, 2007). Among these studies, the ones that concentrate on volatility also examine market index; thus, these might contain the problem discussed above.

At the firm level, foreign investors can trade cross-listed stocks on international stock exchanges without directly taking part in the stock exchange which local stocks originally belong to. Therefore a cross-listed stock becomes eligible to foreign investors even if its home stock exchange is not liberalized at all. Thus, cross-listing is a way of liberalization at the firm level since it allows indirect foreign ownership. The research on the behavior of cross-listed stocks analyzes the changes in the cost of capital, return volatility, systematic and unsystematic risk after the listing date. The studies in the cross-listing literature that analyze the volatility and risk characteristics of cross-listed stocks, however, ignore the volatility clustering observed in the stock return data. Thus, they suffer from model misspecification problem.

This thesis investigates the impacts of financial liberalization (both at the aggregate and the firm level) and foreign equity investment on return volatility of stocks in emerging equity markets. The second chapter examines the effect of the degree of financial liberalization of emerging equity markets on the aggregated stock-return volatility in a panel setting with fourteen emerging markets during the period from 1991 to 2005. The results show that the aggregated total volatility is positively related to the degree of financial liberalization. This relationship is persistent under the control of market development, liquidity, country and time effects. Thus, it is concluded that the degree of financial liberalization has an increasing impact on the aggregated total volatility of stocks. Having shown this relationship, our next concern is to investigate in what ways the aggregated total volatility is impacted by the degree of financial liberalization. For this purpose, we decompose the aggregated total volatility in a modified market model framework which reflects the partially segmented partially integrated nature of many emerging markets. Under this model, we derive the global, local, and idiosyncratic volatility components for the aggregated total volatility. In thirteen out of the fourteen emerging markets, idiosyncratic volatility makes the largest and local volatility makes the second largest contribution to total volatility. Therefore, idiosyncratic volatility is the most important component of total volatility nearly in all emerging markets in our study.

The analysis of the relationship between the derived volatility components and the degree of financial liberalization shows that the idiosyncratic and local volatilities are positively associated with the degree of financial liberalization. However, no relationship between the degree of financial liberalization and the global volatility is detected. These results suggest that the degree of financial liberalization impacts the aggregated total volatility through the idiosyncratic volatility and the local volatility, but not through the global volatility.

We perform a set of robustness checks. First, we examine whether our results are affected by the potential overpurging problem that may arise due to the orthogonalization process in the decomposition of aggregated total volatility. We change the order of orthogonalization and derive the new set of volatility components accordingly. With this new set of volatility components, we re-estimate the regression analyses that aim to assess the impact of the degree of financial liberalization on the volatility components. The results are qualitatively the same and are not affected by the potential overpurging problem. Next, we check the robustness of the results obtained for idiosyncratic volatility. Our results for idiosyncratic volatility build on the residuals from the modified market model framework. Therefore the results for idiosyncratic volatility may be model-specific. We use a new model-independent definition of idiosyncratic volatility and repeat our analyses.

We show that the results are not sensitive to the alternative model-independent definition of idiosyncratic volatility.

The third chapter examines the effect of foreign equity flows on the aggregated total volatility and on its components in İstanbul Stock Exchange (İSE) where the aggregate foreign equity flow data is available. The use of foreign equity flow data in representing the foreign investor participation not only allows capturing the effective foreign investor participation preciously but also detecting the asymmetric effects of foreign equity inflow and outflow on the volatility. Thus, this chapter provides additional insight about the influence mechanisms of foreign investor participation at the aggregate level. We find that aggregated total volatility is negatively related to the foreign equity flows, even after controlling for market development, liquidity, and volatility persistency effects. This finding suggests a two-way impact of foreign equity flow on the aggregated total volatility. While a positive net equity flow (inflow) has a decreasing impact on aggregated stock return volatility, a negative net equity flow (outflow) has an increasing impact. We also find that net equity flow shows its effect on the aggregated total volatility through the local and the aggregated idiosyncratic volatility. As in previous essay, we find similar results with the alternative order of orthogonalization in the volatility decomposition process and with the alternative model-independent definition of idiosyncratic volatility.

The fourth chapter deals with a particular form of liberalization at the firm level, namely American Depository Receipt (ADR) issuance. This study analyzes the time-series variation in return volatility of non-US stocks that are cross-listed on US exchanges. Unlike previous studies in cross-listing literature, return volatility is modeled using conditional heteroscedasticity models. We find that firms' exposure to risks such as local and global market betas remain unchanged after cross-listing.

Moreover, we do not identify important changes in the dynamics of the volatility of cross-listed stocks after cross-listing. We further show that the mean level of conditional variance is not affected by the decision to cross-list. Thus our results provide counter evidence to the belief that firm level liberalization drives volatility upward.

The chapter proceeds with the literature survey and then the contributions to the existing literature are presented in the next section.

1.1 Literature Survey

1.1.1 Theoretical Models of Market Segmentation

In integrated markets, stocks in the same risk class should provide the same risk adjusted returns due to no-arbitrage condition. However in segmented markets similar stocks may be priced differently since only national factors affect asset pricing (Bayar and Önder 2001). The recent trend in emerging markets is however to remove the barriers on the foreign portfolio flows. The removal of barriers can take any form such as capital account liberalization and/or decreased barriers in trading of goods and service. In this study our main focus will be on financial liberalization. In most of the cases, local markets are open or partly open to foreign investor participation through financial liberalization but they do not complete their integration with the world markets yet (Bekaert and Harvey 2003). Thus many local markets are neither fully segmented nor fully integrated. Partial segmentation theories are introduced to handle such cases. Some studies try to construct a theoretical framework for the pricing of assets in the presence of partially segmented markets.

Errunza and Losq (1985) provide an equilibrium asset pricing model which is a two-country model of partial segmentation. In this two-country world, investment barriers are asymmetric. For instance country 2 securities are eligible for country1 investors but country 2 investors can't invest in country 1 securities (ineligible securities). Their results show that if ineligible securities become accessible to country 2 investors by cross-listing, its share price increases and required rate of return decreases. The reason is attributed to high volatility of emerging market returns as compared to their covariances with world market returns. Thus, with the removal of investment barriers a more efficient risk sharing environment is established because of the benefits of international diversification.

Similar model of Alexander, Eun and Janakiramanan (1987) show that the firms undergoing cross-listing in the completely segmented markets experience a higher equilibrium market price and a lower expected rate of return in the case that the cross-listed stock has a smaller covariance with the foreign market portfolio than that of the domestic market portfolio. The main idea in these studies can be summarized as the following. In completely segmented markets, the benchmark portfolio in determining the prices of securities is the local market index portfolio. If the high volatility of the local returns is considered (De Santis and İmrohoroğlu 1997; Harvey 1995), it is most probably that local expected return is high. However, in the integrated markets it is reasonable to expect a decrease in the expected returns since the high volatility inducing local factors are eliminated. Given that there is no change in the expectation of the earnings of the firm, the decrease in expected return will lead to a decrease in the cost of capital of firms, which in turn increases the stock prices.

1.1.2 Empirical Literature

1.1.2.1 Event Study Analysis and Financial Liberalization

An extensive body of literature examines the effects of financial liberalization in event windows around liberalization date. Mainly changes in stock price, liquidity and volatility are analyzed. These studies assume that liberalization is effective from the day of implementation. However there may be strong violations to this assumption. First of all, foreigners may have an indirect access to local markets through investing in cross-listed stocks and American Depositary Receipts (ADRs). So markets may be integrated before liberalization. Secondly, there is a possibility that liberalization remains ineffective. Foreigners will be reluctant to take part in local markets if they think that their rights will not be protected properly or structural reforms will not be accompanied. In such cases, a government will not achieve market integration even if it removes the barriers on foreign investment.

The problems about event study approach are not limited with those discussed above. Defining the event date precisely is very important. But this is not an easy task in the case of equity market liberalizations. Performing an event study first obviously necessitates the proper identification of the event date. However, alternative event definitions lead to various event dates for financial liberalization. For instance, regulatory reform date, (Kim and Singal 2000, De Santis and İmrohoroğlu 1997, Chari and Henry 2004, Bekaert and Harvey 1997, Henry 2000a) announcement of the first country fund and announcement of first ADR program (Bekaert and Harvey 2000, Bekaert, Harvey and Lundblad 2003) are all used as liberalization dates in the literature. Since there is not a consensus on dating the liberalization, the results of this kind of studies may show sensitivity to the dating scheme. Moreover it is not realistic to expect that liberalized countries experience sudden and discrete changes in their stock market and real economy just after the liberalization. Liberalization is in fact not a one-time event. It may take time for a market to be fully liberalized and the speed of liberalization depends on the particular conditions of each country. Therefore researchers direct their studies to take into account the gradual nature of financial liberalization.

1.1.2.2 Gradual Nature of Market Integration and Financial Liberalization

One of the earliest studies in this category is that of Bekaert and Harvey (1995). They use a regime switching model to examine the expected returns of a country that is segmented formerly and become integrated later. They find that many emerging markets show a time-varying integration pattern. Thus their study leads to a switch from static segmented-integrated market paradigm to partially segmented-integrated market paradigm. However their study depends on a regime-switching econometric specification and their results' validity is conditional on the proper specification of the econometric model. Edison and Warnock (2002) provide a more direct measure and use the ratio of the market capitalization of IFC's Investable Index to that of Global Index as a proxy for time-varying financial liberalization. This ratio represents the available portion of equity market to foreign investors and changes through time depending on the removal of restrictions on foreign equity investment.

Thus Edison and Warnock's measure allows modeling the financial liberalization continuously. More recently, De Jong and De Roon (2005) provide a theoretical asset pricing framework in which market integration is modeled as a determinant of expected returns. They use the degree of financial liberalization measure of Edison and Warnock (2002) to proxy for time-varying market integration. They find that integration with the world market is associated with a decrease in expected returns. In addition, they show that expected returns are affected by the level of segmentation in the neighbor countries of the same region. They also allow for time varying betas by modeling the betas as a function of segmentation variable. This nonlinear specification provides further evidence about the concrete effects of partial segmentation on expected returns.

1.1.2.3 Market-Index Volatility and Financial Liberalization

The most important line of attack to foreign equity investment is that it is not stable. It is asserted that financial liberalization triggers financial crises in liberalizing country since foreign equity investment is sharply affected by even small shocks in the economy. (Stiglitz 1999, 2000). Thus, high sensitivity of foreign funds to local factors may cause stock prices to be volatile. So, whether foreign investments are beneficial is questioned. Many studies try to clarify this point, however mixed results are obtained.

Bekaert and Harvey (1997) report that after equity market liberalization, most of the countries in their sample experience a reduction in their market-index volatility. Besides the time-series analysis tracking the time variation in the market-index volatility, they also perform a cross-sectional analysis to understand that why there is a variation of volatility across countries. They use variables to proxy for asset concentration, the stage of stock market development, microstructure effects, macroeconomic influences, and political risk. They show that more open economies experience a significantly lower volatility. In their succeeding study (Bekaert and Harvey, 2000), they analyze the impact of market liberalization on the cost of capital, volatility, beta, and the correlation with the world market returns. Different liberalization dates such as regulatory changes, introduction of depository receipts and country funds, and structural breaks in equity capital flows are employed to check the sensitivity of the results to imprecision in dating. They also construct an index to deal with the gradual nature of market integration. Differently from other studies, they use aggregate dividend yields to measure cost of capital changes. They conclude that capital market integration reduces the cost of capital and increases volatility and correlation with the world market return insignificantly. De Santis and İmrohoroğlu (1997) analyze the dynamic behavior of market volatility using time-series analysis. They can not provide evidence that market liberalization increases volatility. Similarly, Kim and Signal (2000) detect an increase in stock return around market opening with no accompanying increase in the conditional volatility of market index returns using financial liberalization dates. Hargis (2002) finds a decrease in market level volatility after liberalization in Latin America countries. However, the results are less clear cut in Asian markets. Volatility in Thailand increases after liberalization whereas Taiwan experiences a reduction. No significant change is detected in Korea and Malaysia. Aggarawal et.al (1999) follows a different route to analyze volatility in emerging markets. Rather than examining whether a certain event causes volatility, they first detect the volatility jumps in market returns and look for the presence of local or global events around period of high volatility.

Their results show that high volatility periods are associated with mainly local factors. Only the global event of October 1987 Crash is found to induce volatility in emerging markets. Thus they conclude that local factors rather than global factors affect volatility. As a summary, it is hard to reach clear cut results about the impact of financial liberalization on the market-index return volatility.

1.1.2.4 Firm Level Analysis

Firm level analyses are comprised of two groups. The first group consists of ADR and cross-listing studies which deal with the firms that are traded simultaneously on other foreign exchanges or over-the-counter markets. The second group of literature is very limited and deals with broader extent of stocks and either analyzes the impacts of liberalization on individual firms on a dating basis or investigates the cross-sectional differences between investible and non-investible firms.

1.1.2.4.1 ADRs and Cross-Listings

Cross-listing is the simultaneous listing of local stocks on international stock exchanges. If a firm cross-lists its stock on the organized or on the over-the-counter markets in the USA, then this kind of cross-listing is named as American Depository Receipt (ADR) listing. ADRs are negotiable certificates that are listed on organized US exchanges or on the over-the-counter markets. An ADR holder obtains the ownership of shares of local firms traded in their local stock exchanges with the dividend and ownership rights. Although investors can achieve the advantages of ADR programs by investing directly in local markets, investing through ADRs brings an additional benefit of eliminating the expense and complexities of investing directly in local markets.

The researches under this category can be subdivided into two groups. The first group of studies mainly analyzes the stock return reaction to cross-listing in the context of market segmentation hypothesis. Some studies like Errunza and Losq (1985) and Alexander, Eun and Janakiramanan (1987) provide a theoretical framework for pricing of assets in the presence of segmented markets. They show that when a firm becomes accessible by foreigners, its cost of capital decreases and share price increases as more efficient risk sharing is established due to the integration with the world market. A considerable amount of empirical research is also conducted to analyze the effects of cross-listings on the returns of underlying assets. Miller (1999) examines the impact of cross-listing on stock price around the announcement of depositary receipt programs. He finds positive abnormal returns around the announcement date. He also reports that highest abnormal returns are experienced for firms that cross-list on the major organized US exchanges rather than the over-the-counter markets. Errunza and Miller (2000) analyze the impact of an initiation of an ADR program on the cost of capital. They use both realized returns and changes in dividend yields to proxy for equilibrium expected returns in their study and find that the initiation of an ADR program decreases the cost of capital for the underlying asset.

Second and a smaller group of studies in the cross-listing literature concentrates on the impact of cross-listings on the risk. One of the earlier studies of volatility around cross-listing date is that of Howe and Madura (1990). They examine whether the systematic and the total risk characteristics of listed firms undergo a differentiation after cross-listing, and they report no such changes in their study.

Jayaraman, Shastri and Tandon (1993) study the impact of ADR listings on the risk and return of the underlying stocks. They work with a sample of European and Asian stocks and find that the variances of cross-listed stocks are higher after listing even they are adjusted for market volatility and October 1987 crash and the possible changes in return generating process. They attribute the increase in the volatility to the increased trading time associated with the cross-listing which allows revelation of more information. Lau, Diltz and Apilado (1994) examine the U.S stocks that are cross-listed internationally. A variance of the stock returns for the estimation period is hypothesized to be equal to variance of the stock returns for the event period and a variance ratio test is conducted against the alternative that variances are not equal. For different estimation and event periods the distribution of F-statistic is symmetrical. So, they conclude that firm volatility is not affected by international listing. Foerster and Karolyi (1999) investigate the stock price performance and changes in risk exposure for ADR initiations for several countries. They find positive abnormal returns after cross-listing and this result is robust when the systematic risks are allowed to vary. That is when the possible changes in the local market beta and world market beta are taken into account, a positive abnormal return is still detected which means that stock price appreciation is not due to the changes in betas. In fact, in the post-listing period local market beta declines and no significant change is detected for the world market beta. But when the authors analyze the countries separately, they obtain mixed results and the results of the overall sample can't be replicated. One of the other important study in this line of research is that of Domowitz et al. (1998). They construct a theoretical model to examine the behavior of cross-listed stocks where inter-market information is costly. Their model suggests that cross-listing may have either increasing or decreasing impact on volatility depending on the transparency of inter-market informational linkages. With freely available price information, favorable conditions in the international markets are tractable by foreign investors. This increases the total number of traders in both markets, which in turn, reduces bid-ask spread, increases market liquidity and thus reduce volatility. If information linkages are imperfect, investors will migrate to the international market. The decrease in the number of traders in the local market reduces liquidity and increases bid-ask spread and volatility. Many studies apply this theoretical model to examine the behavior of local stocks that are cross-listed in several international stock exchanges (Jayakumar 2002, Ejara and Ghosh 2004 and Bayar and Önder 2005). These studies reach mixed results about the impact of cross-listing on the local stock exchanges. Given that each market has its own information linkage characteristics, the mixed results in different stock exchanges are consistent with the implications of the theory.

1.1.2.4.2 Impact of Foreign Investment on Ordinary Firms

This part of the literature is a new area and attracts attention of researchers nowadays. Market segmentation theories predict that financially liberalized firms experience a reduction in the cost of capital and an increase in share price due to the more efficient risk sharing. Therefore, it is expected that firms become more specialized due to the greater risk diversification. Analyzing firms rather than market indeces may show a more direct evidence of the impacts of financial liberalization since liberalization shows its effects through firms in the economy. Therefore, index level studies may represent a poor proxy for variables' true effect. Awareness of these facts triggers the firm level analyses.

Patro and Wald (2005) examine the impact of financial liberalization at the firm level by dating the liberalization. They detect an increase in the stock returns during the liberalization. After the liberalization, firms' mean returns and dividend yields undergo a reduction for most of the firms. They also document an increase in the world market exposure and a decrease in the local market exposure which are consistent with the international asset pricing theories. Moreover, they study the cross-section of return spreads around liberalization and find that cross-listed firms have significantly larger return spreads. Christoffersen et al. (2006) test whether size of firms is relevant for the changes in performance, volatility and return correlation afte liberalization. They show that large firms exhibit large revaluation effects, insignificant change in performance, large declines in volatility, and insignificant change in correlation after liberalization whereas small firms exhibit the opposite. However, the studies of Patro and Wald (2005) and Christoffersen et al. (2006) also suffer from the disadvantages of dating the liberalization. Chari and Henry (2004) distinguish stocks as investible and noninvestible according to the eligibility of purchase by foreigners. They base their study on the following arguments. If liberalization decreases the riskiness of a firm due to more efficient risk sharing, then its stock price should increase. They test this argument by evaluating whether opening of stock market to foreigners leads to stock price revaluations. They show that the price revaluation effect increases with the difference between the firm's local market and global market covariance. Domowitz et.al (1997) focus on the multiple classes of equity which differentiates local investors, foreign investors and institutional investors in Mexico. Any price premium between these multiple shares is attributed to sole ownership restrictions since expected cash flows are identical across multiple shares of a firm. They showed that there are significant price premiums for unrestricted shares. Bailey et.al (1999) extend the study of Domowitz et.al (1997) for 11 countries whose stock markets have otherwise identical shares for local and foreign investors. They also document price premiums for unrestricted shares supporting the results of the earlier work. However they attribute the reason of these premiums to foreign investor demand rather than traditional international asset pricing theories. Bae et.al (2004) brings a different approach to detect the effects of foreign investment on stock-return volatilities. Instead of dating liberalization and observing the differences between pre- and post-liberalization periods, they investigate the cross-sectional variation in firm volatility among firms according to their investibility index. Investibility index is a depiction of the degree of accessibility of a stock by foreigners. They detect a positive relationship between investibility and return volatility under the control of country, industry, firm size and turnover. Highly investible portfolios are found to be subject to higher world market exposure consistent with the view that accessible firms are more integrated with the world market. However, no significant relation between idiosyncratic risk and investibility is found. Thus Bae et.al represent the first firm level analysis taking the liberalization as a gradual process. Mitton (2006) uses firm-specific measures of openness to foreign investors in the spirit of Bae et al. (2004) to examine the impact of stock market liberalization on firm-level operating performance. By identifying the firm-specific dates on which the stocks become eligible to foreigners, he avoids two problems. First, he eliminates the pinpointing problem of country-level liberalization dates. Second, firm-level dating of investability enables him to separate the effects of liberalization from other country-level economic reforms which are concurrent with liberalization. He documents that firms with stocks that are open to foreign investors experience higher growth, greater investment, greater profitability, and lower leverage. He concludes that stock market liberalization offers benefits for the stocks that become investable.

1.2 Contribution to the Existing Literature

We consider the time-varying nature of financial liberalization by using the degree of financial liberalization measure proposed by Edison and Warnock (2003) in Chapter 2. This measure allows us to model equity market liberalization as a quantitative continuous variable. By using this measure, we can observe the changes in the financial opening of emerging stock markets at the monthly frequency. Thus, rather than a binary measure of financial liberalization (liberalized/nonliberalized), we have a more accurate continuous measure of the degree of financial liberalization so that we can detect the changes in the financial opening through time. Hence, the event study methodology (with its all discussed problems) of previous studies will be left to incorporate the time-varying nature of liberalization process. We first investigate the impact of the degree of financial liberalization on the aggregated total volatility of stock returns. We then explore the channels through which the degree of financial liberalization transmits its impact onto the aggregated total volatility. For this purpose, we extend the volatility decomposition of Campbell et al. (2001) in a modified market model framework. After this volatility decomposition, we are able to examine the influence channels of the degree of financial liberalization. To our knowledge, this is the first study to investigate the mechanisms through which the degree of financial liberalization affects total volatility. Furthermore, rather than analyzing the volatility of a market portfolio, as previous studies did, we use the aggregated total volatility of stocks and its components. A possible problem in the previous literature on the volatility of market index is that it is not clear whether a change in the total volatility of a portfolio is due to a change in the variances of the stocks, in the pairwise covariances between stocks, or in both. On the other hand, our aggregated total volatility measure is independent of the correlation of the stocks and therefore is a pure measure of the return volatility of a typical stock in a country.

In Chapter 3, we use foreign equity flow data to search for the relationship between average stock-return volatility and foreign equity investment in İSE where the foreign equity flow data is available. Rather than analyzing the effects of stock exchange openness to foreign investors on stock-return volatility as previous chapter does, this chapter deals with foreign equity investment which is measured by foreign equity flows. By using foreign equity inflow and outflow data, the possible asymmetric effects of incoming and outgoing foreign equity investments on aggregated stock-return volatility are analyzed for the first time in the literature. Thus, this chapter provides further insight about the role of foreign investors in emerging markets.

The fourth chapter which focuses on the volatility effects of firm level liberalization extends previous literature in the following ways. First of all, time-series methods are first used in this study in examining the volatility behavior of cross-listed stocks. Given the observed volatility in return data, neglecting the time variation in return volatility may result in model misspecification. Second, this is the first study to examine the changes in the dynamics of volatility in terms of the coefficients of the conditional volatility equation. Finally, we modify the conditional volatility models by introducing ADR-listing dummies that enter both in the mean and the variance equations. Thus, we are able to investigate the changes in systematic risks and conditional volatility around ADR initiations, simultaneously.

CHAPTER 2

THE DEGREE OF FINANCIAL LIBERALIZATION AND AGGREGATED STOCK-RETURN VOLATILITY IN EMERGING MARKETS

2.1 Introduction

Many emerging markets liberalized their stock markets in the last few decades. With the removal of the restrictions on foreign equity investment, investors are motivated to participate in emerging stock markets to take advantage of high returns in these markets. In addition, investors reduce the risk of their portfolio by international diversification. Therefore, emerging markets attract many investors from all over the world. Equity market liberalization also provides some advantages for emerging markets. Liberalization lowers the cost of capital (Bekaert and Harvey, 2000; Chari and Henry, 2004), which, in turn, leads to investment booms (Henry, 2000a) and thus spurs economic growth (Bekaert et al., 2005). On the other hand, financial liberalization is blamed for causing excess volatility in emerging markets (Bae et al., 2004 and Li et al., 2004). However, this view is not fully supported in the literature. De Santis and İmrohoroğlu (1997), Hargis (2002), Howe and Madura (1990), and

Kim and Signal (2000) find either a reducing impact or no impact of financial liberalization on volatility. Much effort is needed to understand fully the relationship between financial liberalization and volatility. Uncovering the ambiguity in this relationship will have policy implications, especially for government policy makers, about their decisions on financial liberalization.

In most of the previous work, financial liberalization is assumed to occur at a single point in time and is treated as a one-time event. The time-series characteristics of the volatility of the local market indexes are analyzed in the event windows around the liberalization date. However, alternative event dates are used for financial liberalization.[1] Different inferences for different liberalization dates may be drawn in such studies, which may be one reason why mixed results are obtained in the literature. However, recent literature (Bekaert and Harvey, 2002; Bae et al., 2004; Edison and Warnock, 2003) shows that the implementation and speed of financial liberalization varies, depending on the conditions of local markets. Researchers now agree that for many emerging markets, financial liberalization is a process rather than an event and that its intensity and speed changes over time for many emerging markets. Therefore, it is unlikely that liberalization can be characterized by a single date. Another possible problem in the previous literature is the examination of the return variance of a market portfolio to make inferences about average stock return variances. This practice may cause erroneous results, because a change in the variance of a portfolio may be due to changes in the covariances of the stocks forming the portfolio, without an accompanying change in their variances. Thus,

[1] For instance, regulatory reform date (Kim and Singal, 2000; De Santis and İmrohoroğlu, 1997; Chari and Henry 2004; Bekaert and Harvey 1997; and Henry 2000b) announcement of the first country fund, announcement of the first ADR (Lau et al., 1994; Foerster and Karolyi, 1999; and Errunza and Miller, 2000) and endogenous break dates (Bekaert et al., 2002) are some of the alternative event dates used in the literature.

changes in the return variance of a market portfolio may not reflect the changes in the return variance of the stocks forming that market portfolio.

In this study, we address the question of whether the degree of financial liberalization affects the aggregated total volatility of stock returns, by considering the time-varying nature of financial liberalization. The degree of financial liberalization is defined as the stock market openness to foreign investors and shows the accessibility of the stock exchange by foreign investors through time. By using the degree of financial liberalization measure proposed by Edison and Warnock (2003), we not only properly specify the gradual nature of financial liberalization but also eliminate the imprecision problem in dating the liberalization. Our next concern in this study is to determine the channels through which the degree of financial liberalization transmits its impact onto the aggregated total volatility. For this purpose, we extend the volatility decomposition of Campbell et al. (2001) in a modified market model framework. Campbell et al. decompose the aggregated return volatility of stock returns by using a methodology that does not require the estimation of covariance or stock beta terms. In our extended model, the returns of individual stocks are affected by both the local and global portfolio returns, and thus, we consider the partially segmented/integrated nature of many emerging markets.[2] The appealing feature of this model is that it accounts for the conditional effect of one factor, given the other. By value weighting the return volatility of stocks in a country, we show that the aggregated total volatility can be decomposed into local, global and idiosyncratic volatility. After this volatility decomposition, we are able to examine through which components the aggregated total volatility is affected. Interestingly, no other study in the literature investigates the mechanisms through

[2] Bekaert and Harvey (1995), De Jong and De Roon (2005) are examples of studies that follow the partial segmentation/partial integration paradigm.

which the degree of financial liberalization transmits its impact on the aggregated total volatility. Moreover, unlike previous studies that examine the return volatility of a market portfolio, we analyze the aggregated total volatility of stocks. Our aggregated volatility measure is independent of the co-variation in the stock returns and therefore, is a pure measure of the average stock-return volatility in a country.

We find that aggregated total volatility is positively impacted by the degree of financial liberalization, even after controlling for size, liquidity, country and year effects. Moreover, the degree of financial liberalization transmits its impact on the aggregated total volatility through the aggregated idiosyncratic and local volatility, but not through the global volatility. Our findings are robust to the alternative order of orthogonalization of returns in the volatility decomposition process and to the alternative model-independent definition of idiosyncratic volatility.

The rest of the chapter is organized as follows: In section 2, the details of the volatility decomposition are introduced. Section 3 describes the data and the estimation methodology of aggregated total volatility and its components. In section 4, the relationship between aggregated total volatility and the degree of financial liberalization is analyzed; section 5 extends the analysis to include the volatility components. Some robustness checks are presented in section 6, and the final section concludes the chapter.

2.2 Volatility Decomposition in a Modified Market Model

Campbell et al. (2001) propose a new method to decompose the aggregated return volatility that does not require the estimation of covariances or individual beta terms. Ferreira and Gama (2005) use this approach to study the behavior of stock-return volatility from the perspective of a global investor. The results of both Campbell et al. (2001) and Ferreira and Gama (2005) emerge from separate adjusted models that occur at the same time, which may be restrictive.[3] We extend the method of volatility decomposition introduced by Campbell et al. (2001) to a modified market model, where the return of stock *i* belonging to country *l* is taken to be driven by the return of both the global market portfolio and the local market portfolio, in period *t*. This model represents the partially segmented, partially integrated nature of many emerging markets. Decomposing the total volatility in this manner not only enables us to examine the effects of local and global factors simultaneously, but also to account for the conditional effect of one factor, given the other.

The details of the volatility decomposition methodology are as follows. It is assumed that the return on the global market portfolio is equal to the weighted average returns of the local market portfolios, i.e., $\Sigma_l w_{lt} R_{lt} = R_{wt}$ and that the return on the local market portfolio is the weighted average return of individual stocks in a country, that is $\Sigma_i w_{it} R_{ilt} = R_{lt}$. In addition, each local market portfolio contributes to the systematic risk of the global market portfolio, commensurate with its covariance with the global market portfolio. More specifically,

$$\tilde{R}_{lt} = \beta_{wl} \tilde{R}_{wt} + \tilde{\varepsilon}_{lt} . \tag{2.1}$$

The modified market model in an international framework is formulated as

$$\tilde{R}_{ilt} = \beta_{iw} \tilde{R}_{wt} + \beta_{il} \tilde{\varepsilon}_{lt} + \tilde{\varepsilon}_{ilt} \tag{2.2}$$

[3] While market and industry adjusted models are used in Campbell et al. (2001), world and country adjusted models are used in Ferreira and Gama (2005).

where $\beta_{iw} = \mathrm{cov}(\tilde{R}_{wt}, \tilde{R}_{ilt}) / \mathrm{var}(\tilde{R}_{wt})$; $\beta_{il} = \mathrm{cov}(\tilde{\varepsilon}_{lt}, \tilde{R}_{ilt}) / \mathrm{var}(\tilde{\varepsilon}_{lt})$; and $\tilde{R}_{lt} = \sum_{i \in l} w_{it} \tilde{R}_{ilt}$.

Note that

$$\sum_{i \in l} w_{it} \beta_{iw} = \mathrm{cov}(\tilde{R}_{wt}, \sum_{i \in l} w_{it} \tilde{R}_{ilt}) / \mathrm{var}(\tilde{R}_{wt}) = \mathrm{cov}(\tilde{R}_{wt}, \tilde{R}_{lt}) / \mathrm{var}(\tilde{R}_{wt})$$

$$= \mathrm{cov}(\tilde{R}_{wt}, \beta_{wl} \tilde{R}_{wt} + \tilde{\varepsilon}_{lt}) / \mathrm{var}(\tilde{R}_{wt}).$$

$$= \left(\mathrm{cov}(\tilde{R}_{wt}, \beta_{wl} \tilde{R}_{wt}) + \mathrm{cov}(\tilde{R}_{wt}, \tilde{\varepsilon}_{lt}) \right) / \mathrm{var}(\tilde{R}_{wt})$$

$$= \left(\beta_{wl} \, \mathrm{cov}(\tilde{R}_{wt}, \tilde{R}_{wt}) \right) / \mathrm{var}(\tilde{R}_{wt}) = \beta_{wl}.$$

where $\mathrm{cov}(\tilde{R}_{wt}, \tilde{\varepsilon}_{lt})$ is zero, since $\tilde{R}_{wt}$ and $\tilde{\varepsilon}_{lt}$ are orthogonal by construction.

Similarly,

$$\sum_{i \in l} w_{it} \beta_{il} = \mathrm{cov}(\tilde{\varepsilon}_{lt}, \sum_{i \in l} w_{it} \tilde{R}_{ilt}) / \mathrm{var}(\tilde{\varepsilon}_{lt}) = \mathrm{cov}(\tilde{\varepsilon}_{lt}, \tilde{R}_{lt}) / \mathrm{var}(\tilde{\varepsilon}_{lt})$$

$$= \mathrm{cov}(\tilde{\varepsilon}_{lt}, \beta_{wl} \tilde{R}_{wt} + \tilde{\varepsilon}_{lt}) / \mathrm{var}(\tilde{\varepsilon}_{lt})$$

$$= \left(\mathrm{cov}(\tilde{\varepsilon}_{lt}, \beta_{wl} \tilde{R}_{wt}) + \mathrm{cov}(\tilde{\varepsilon}_{lt}, \tilde{\varepsilon}_{lt}) \right) / \mathrm{var}(\tilde{\varepsilon}_{lt})$$

$$= \mathrm{cov}(\tilde{\varepsilon}_{lt}, \tilde{\varepsilon}_{lt}) / \mathrm{var}(\tilde{\varepsilon}_{lt}) = 1$$

where $\mathrm{cov}(\tilde{\varepsilon}_{lt}, \beta_{wl} \tilde{R}_{wt})$ is zero, since $\tilde{R}_{wt}$ and $\tilde{\varepsilon}_{lt}$ are orthogonal by construction.

In volatility decomposition, covariance and stock beta-free components are aimed to be reached so that estimation of these parameters, which may not be constant and precise over time, is eliminated. For this purpose, a variant of the market-adjusted model is used, as suggested by Campbell et al. (2001), as the following:

$$\tilde{R}_{ilt} = \tilde{R}_{wt} + \tilde{\varepsilon}_{lt} + \varepsilon_{ilt} . \tag{2.3}$$

Here, the return on stock *i* of country *l* is modeled to be the sum of the return on the global market portfolio, a country specific shock, and a firm-specific residual.

Equating (2.2) to (2.3) produces the following equality that shows in which channel the two equations are connected

$$\varepsilon_{ilt} = (\beta_{iw} - 1)\tilde{R}_{wt} + (\beta_{il} - 1)\tilde{\varepsilon}_{lt} + \tilde{\varepsilon}_{ilt} . \tag{2.4}$$

Taking the variance of (2.3) yields

$$\operatorname{var}(\tilde{R}_{ilt}) = \operatorname{var}(\tilde{R}_{wt}) + \operatorname{var}(\tilde{\varepsilon}_{lt}) + \operatorname{var}(\varepsilon_{ilt}) + 2\operatorname{cov}(\tilde{R}_{wt}, \varepsilon_{ilt}) + 2\operatorname{cov}(\tilde{\varepsilon}_{lt}, \varepsilon_{ilt}) . \tag{2.5}$$

Inserting (2.4) into (2.5) for covariance terms only yields

$$\begin{aligned} \operatorname{var}(\tilde{R}_{ilt}) = {} & \operatorname{var}(\tilde{R}_{wt}) + \operatorname{var}(\tilde{\varepsilon}_{lt}) + \operatorname{var}(\varepsilon_{ilt}) + 2\operatorname{cov}(\tilde{R}_{wt}, (\beta_{iw} - 1)\tilde{R}_{wt} + (\beta_{il} - 1)\tilde{\varepsilon}_{lt} + \tilde{\varepsilon}_{ilt}) \\ & + 2\operatorname{cov}(\tilde{\varepsilon}_{lt}, (\beta_{iw} - 1)\tilde{R}_{wt} + (\beta_{il} - 1)\tilde{\varepsilon}_{lt} + \tilde{\varepsilon}_{ilt}) . \end{aligned} \tag{2.6}$$

Rearranging (2.6),

$$\operatorname{var}(\tilde{R}_{ilt}) = \operatorname{var}(\tilde{R}_{wt}) + \operatorname{var}(\tilde{\varepsilon}_{lt}) + \operatorname{var}(\varepsilon_{ilt}) + 2(\beta_{iw} - 1)\operatorname{var}(\tilde{R}_{wt}) + 2(\beta_{il} - 1)\operatorname{var}(\tilde{\varepsilon}_{lt}) . \tag{2.7}$$

Taking the weighted averages of (2.7) over *i* and substituting β_{wl} for $\sum_{i \in l} w_{it}\beta_{iw}$ and 1 for $\sum_{i \in l} w_{it}\beta_{il}$, drop the last term and yield the following

$$\sum_{i\in l} w_{it}\ \mathrm{var}(\tilde{R}_{ilt}) = \mathrm{var}(\tilde{R}_{wt}) + \mathrm{var}(\tilde{\varepsilon}_{lt}) + \sum_{i\in l} w_{it}\ \mathrm{var}(\varepsilon_{ilt}) + 2\,\mathrm{var}(\tilde{R}_{wt})\left(\sum_{i\in l} w_{it}\beta_{iw} - 1\right)$$

$$+2\,\mathrm{var}(\tilde{\varepsilon}_{lt})\left(\sum_{i\in l} w_{it}\beta_{il} - 1\right)$$

$$= (2\beta_{wl} - 1)\,\mathrm{var}(\tilde{R}_{wt}) + \mathrm{var}(\tilde{\varepsilon}_{lt}) + \sum_{i\in l} w_{it}\ \mathrm{var}(\varepsilon_{ilt})$$

$$\sigma^2_{a_{lt}} = \sigma^2_{w_{lt}} + \sigma^2_{\varepsilon_{lt}} + \sigma^2_{\varepsilon_{ilt}} \tag{2.8}$$

where $\sigma^2_{a_{lt}} = \sum_{i\in l} w_{it}\ \mathrm{var}(\tilde{R}_{ilt})$, $\sigma^2_{w_{lt}} = (2\beta_{wl} - 1)\,\mathrm{var}(\tilde{R}_{wt})$, $\sigma^2_{\varepsilon_{lt}} = \mathrm{var}(\tilde{\varepsilon}_{lt})$, and $\sigma^2_{\varepsilon_{ilt}} = \sum_{i\in l} w_{it}\ \mathrm{var}(\varepsilon_{ilt})$.

The aggregated return volatility of stocks in a country is a representation of the return volatility of a typical firm in the particular country. Equation (2.8) shows that the total volatility of a typical firm in a country is composed of global, local, and aggregated idiosyncratic volatility. The volatility components in equation (2.8) do not contain covariance and stock beta terms. The only beta term in this equation, β_{wl}, is the beta of the local market portfolio with respect to the global market portfolio. Fama and Macbeth (1973) mention that estimated portfolio betas are much more precise estimates of the true betas than the beta estimates of individual securities. Thus, the estimation problems of the components of the aggregated total volatility in a country are minimized.

Next, we proceed in the same manner to reach the volatility components for a typical firm in the global market portfolio. Taking the weighted averages of (2.8) over *l* yields the following:

$$\sum_{l} w_{lt} \sum_{i\in l} w_{it}\ \mathrm{var}(\tilde{R}_{ilt}) = \mathrm{var}(\tilde{R}_{wt}) + \sum_{l} w_{lt}\ \mathrm{var}(\tilde{\varepsilon}_{lt}) + \sum_{l} w_{lt} \sum_{i\in l} w_{it}\ \mathrm{var}(\varepsilon_{ilt})$$

$$\sigma^2_{aw_{lt}} = \sigma^2_{g_{lt}} + \sigma^2_{lt} + \sigma^2_{\varepsilon_{lt}} \tag{2.9}$$

where $\sigma^2_{aw_{lt}} = \sum_l w_{lt} \sum_{i \in l} w_{it} \operatorname{var}(\tilde{R}_{ilt})$, $\sigma^2_{g_{lt}} = \operatorname{var}(\tilde{R}_{wt})$, $\sigma^2_{lt} = \sum_l w_{lt} \operatorname{var}(\tilde{\varepsilon}_{lt})$, and $\sigma^2_{\varepsilon_{lt}} = \sum_l w_{lt} \sum_{i \in l} w_{it} \operatorname{var}(\varepsilon_{ilt})$.

Thus, volatility components that do not contain individual stock beta, portfolio beta, and covariance terms are obtained for an average firm in the global market portfolio. In assessing the impact of the degree of financial liberalization, we are primarily interested in aggregated volatilities of individual stocks rather than the volatility of a local market portfolio. The reason is that country index volatility is composed of both individual stock return variances and the pairwise covariances of stock returns. Therefore, studies analyzing the return volatility of country indices do not fully explain the behavior of average stock return volatility. The aggregated volatility used in this study clearly demonstrates the effects of external factors on the return volatility of an average stock.

Although the volatility components expressed in equation (2.9) are beta and covariance-free, and thus, estimation problems of these parameters are eliminated, it is difficult, if not impossible, to estimate the volatilities of all stocks in the global index. Moreover, we are mainly interested in the effects of the degree of financial liberalization on the average return volatility of stocks in this study. Therefore, we confine our empirical implementation to the estimation of equation (2.8), which provides information about an average stock return volatility in a country.

2.3 Data and Methodology

Our main data sources in this study are the Standard & Poor's Emerging Markets Database (EMDB) and Datastream. Our data comprise returns of stocks that are listed in the SP/IFC (Standard & Poor's/International Finance Corporation) Global Index of the emerging markets in our study. The SP/IFC Global (IFCG) Index aims to represent 70-80% coverage of the total market capitalization of local stock exchanges. Index-constituent firms are chosen from the most liquid stocks, and therefore, the composition of the index is subject to change over time. All SP/IFCG Index firms of the particular emerging markets form our sample. A country is included in the study if it has a variation in the degree of financial liberalization during the research period. Some countries such as Argentina, Chile, Hungary, Poland, South Africa and Turkey adopted intense financial liberalization. Either these countries liberalized their stock exchanges fully one at a time or they became fully open to foreign investors in a few years after the initial liberalization. Some other countries such as the Philippines, Sri Lanka, Peru and Jordan partly open their stock exchanges to foreigners at the first time of the liberalization, but do not exhibit a notable change in the intensity of capital controls, thereafter.[4] We do not include these countries in our study, since we focus on the effects of time-varying financial liberalization. Additionally, we exclude the countries that have data for less than eight years. After these screens, Brazil, China, Colombia, the Czech Republic, India, Indonesia, Korea, Malaysia, Mexico, Pakistan, Russia, Taiwan, Thailand and Zimbabwe remain for analysis.

The research period extends from 1991 to 2005. For each year in the sample period, yearly return variances of firms listed in the SP/IFC Global Index of the EMDB are computed by using the monthly adjusted closing prices. In calculating the weighted averages of return variances, the weights are based on the market capitalizations of the indexed firms, which are also extracted from the EMDB. The

[4] For a graphical representation of the foreign ownership restrictions through time for emerging markets, see Edison and Warnock (2003).

return variance of global index, σ_{wt}^2 of equation (2.8), is computed by using the closing prices of the global index drawn from Datastream. The closing prices of the local index, which is the SP/IFCG Index of the emerging markets, come from EMDB.

For the degree of financial liberalization, we use the measure of Edison and Warnock (2003). This measure is defined as the ratio of market capitalizations of a country's SP/IFC Investible (SP/IFCI) Index to its SP/IFCG Index, both of which are tracked by EMDB. For each emerging market, the SP/IFC computes a Global Index that aims to proxy the whole market. SP/IFC also computes an Investible Index that shows the accessible portion of the market to foreign investors. The ratio of the market capitalization of SP/IFCI Index to that of SP/IFCG Index gives a quantitative measure of the openness of the market to foreigners. This ratio (*Finlib* hereafter) lies between zero (the inaccessible case) and one (the fully accessible case). Making use of this variable brings some unique advantages to our study. *Finlib* allows us to model the equity market liberalization as a quantitative continuous variable and to observe the changes in the financial openings of the emerging markets through time. Thus, rather than a binary measure of financial liberalization (liberalized/non-liberalized), we have a more accurate continuous measure of the degree of financial liberalization. Hence, the previously discussed dating of the liberalization problem is eliminated by incorporating the time-varying nature of the liberalization process.

It is important to note that *Finlib* measure may signal foreign investor participation but is not a direct measure for effective foreign investor participation. By definition, *Finlib* represents the allowance limits for foreign investor participation. Thus it does not necessarily capture the effective foreign investor participation. For instance, if equity market liberalization is not binding and foreign investors do not invest in the local stocks up to the allowed limits after the relaxation of the restrictions, then *Finlib* will be an overestimation of the effective foreign investor participation. Therefore the results of this study should be interpreted as the effects of the degree of financial liberalization (or equivalently the degree of openness to foreign investors) rather than the effects of effective foreign investor participation.

Another detail about this measure is the way the stocks are screened by Standard and Poor's during the index construction process. Standard and Poor's applies size and liquidity screens to stocks that can be investable by foreigners for S&P/IFCI index eligibility. Size screen requires a stock to have a market capitalization of US$ 100 million to be included in the investable index. Liquidity screen necessitates a minimum of US$ 50 million trading activity in the prior year for inclusion in S&P/IFCI index. The composition of S&P/IFCI index is rebalanced once a year. A stock that is already in the S&P/IFCI index is dropped from the index if its total trading volume for the previous year is less than US$ 35 million, or if its adjusted market capitalization falls below US$ 75 million as of September of that year. Thus a stock that is investable by foreigners may not be included in the investable index. This makes the use of *Finlib* measure questionable. However, similar index inclusion criteria also exist for S&P/IFCG index. Therefore, it is most likely that a stock that fails to be included in the investable index due to the size and liquidity screens also fails to be included in global index. Thus, the ratio of the market capitalizations of the investable and global index is not expected to be altered much by the screens.

In the empirical part of our study, we analyze the impact of the degree of financial liberalization on the aggregated total volatility and its components under the control of some volatility determinants.[5] We introduced the turnover variable, *TO*, to control for liquidity effects. *TO* is defined as the total value of shares traded during the period divided by the average market capitalization for the period, calculated in local currency. Average market capitalization is calculated as the average of the end-of period values for the current period and the previous period. In order to account for the effect of the stock market development on the volatility, we use the variable *Size*, which is defined as the ratio of market capitalization of the stock market to the country's GDP. The data for the control variables are taken from EMDB, except for GDP data. GDPs are obtained from the World Bank.

2.3.1. Estimation of Volatility and Volatility Components

The aggregated total volatility and its components are estimated in the following manner. Let s refer to months over which returns are calculated and t refer to the year in which the volatility estimates are constructed. The yearly volatility of a stock in country l is computed as

$$\mathrm{var}(\tilde{R}_{ilt}) = \sum_{s\in t} (R_{ils} - \mu_{il})^2 \tag{2.10}$$

where μ_{il} is the mean return of stock i in country l over the sample.

The weighted average of return volatilities of all stocks in the SP/IFCG Index of country l in year t forms the aggregated total volatility measure for that year.

[5] See Bekaert and Harvey (2000) for a set of explanatory variables for volatility at the aggregate level.

$$\sum_{i\in l} w_{it} \operatorname{var}(\tilde{R}_{ilt}) = \sum_{i\in l} w_{it} \left(\sum_{s\in t} (R_{ils} - \mu_{ilt})^2\right). \tag{2.11}$$

The weight for each firm is the ratio of its market capitalization to the stock exchange market capitalization of country l in year t. The volatility estimations are based on the dollar returns and are plotted for each market in Figure 2.1. Nearly all emerging countries in this study experience high volatility in their stock markets during the years 1997, 1998 and 1999. This is not surprising, because the Asian Crisis broke out in East Asia in 1997, and it spread to many countries in 1998. The Asian Crisis is considered to have triggered the Russian Ruble Crisis that hit Russia, the Baltic States, and some other countries in 1998 and 1999. Besides these common volatile periods for many markets, our aggregated total volatility measure also detects the country specific volatile times. For instance, the high volatility observed in 1994 and 1995 in Mexico corresponds to the Mexican Tequila Crisis. The Monetary Crisis of China in 1994 is also apparent in Figure 2.1. Similarly, the burst of the Internet bubble in Taiwan in 2001, the economic crisis of Brazil in 2002, the Kargil War between India and Pakistan in 1999, and the government crisis of Zimbabwe in 2003 are all detected as volatile periods in the country plots of Figure 2.1, which suggests that the aggregated volatility measure accurately captures the average volatility in a country.

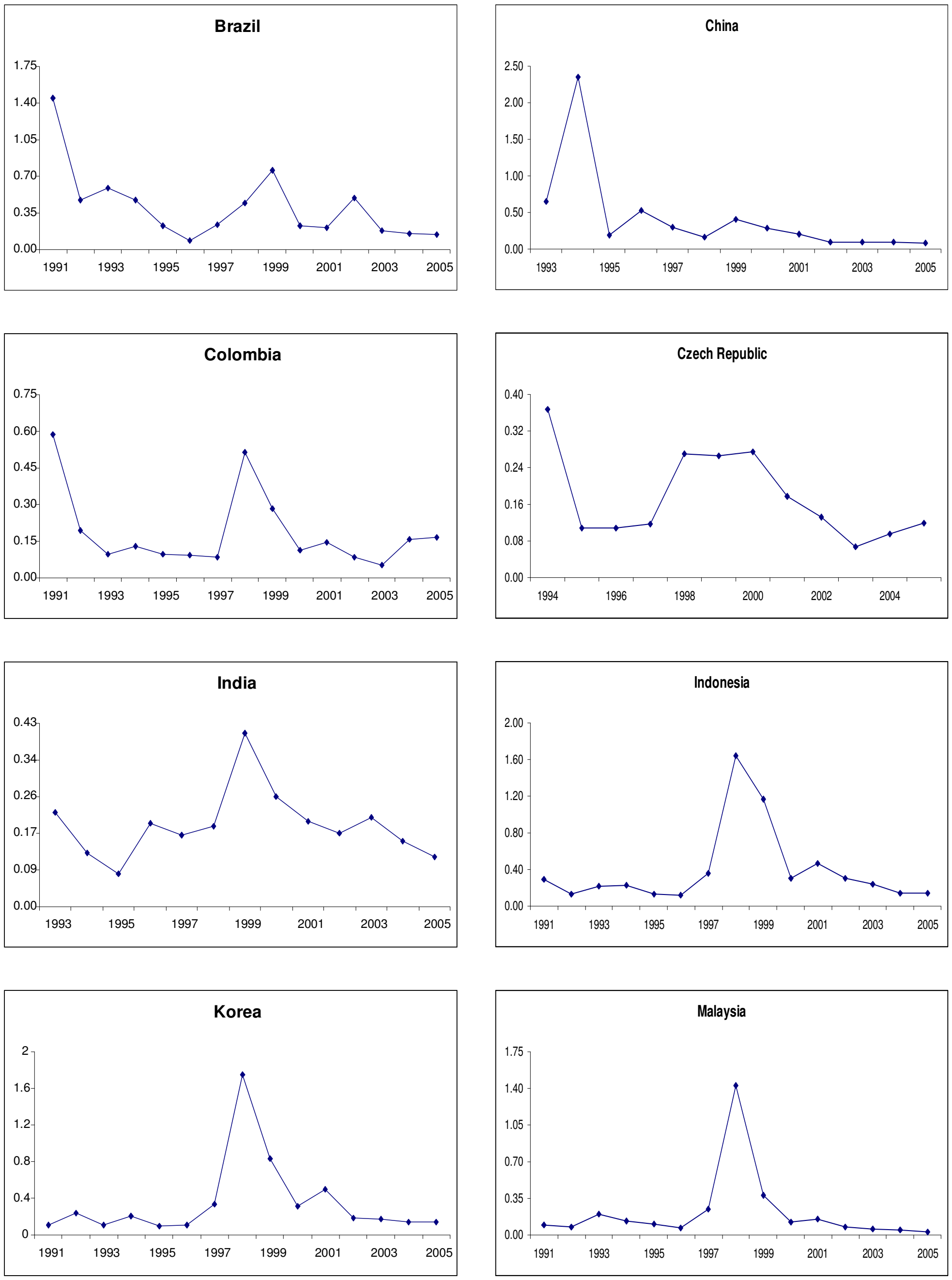

Figure 2.1 Aggregated Total Volatility through Time across Emerging Markets

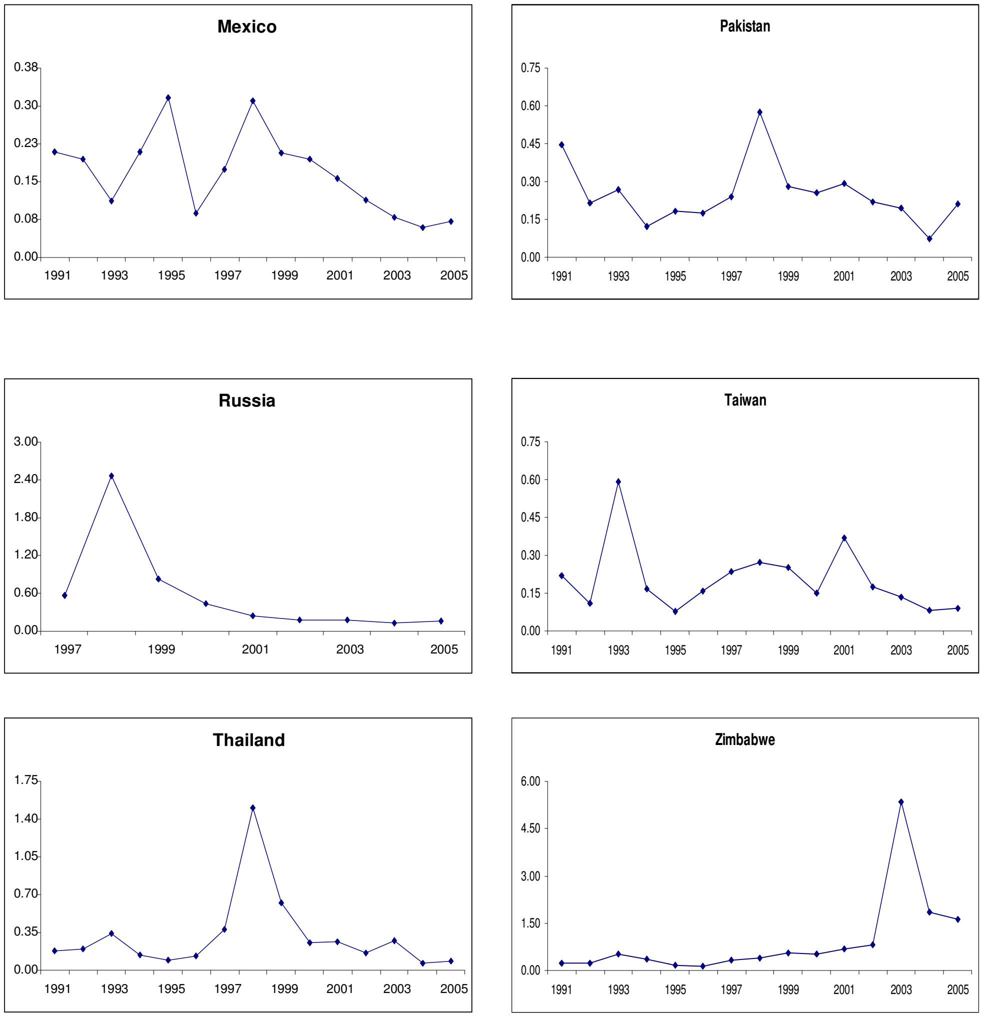

Figure 2.1 (continued).

Next, we estimate the components of the aggregated total volatility that are expressed in equation (2.8). For instance, the global volatility, which is denoted as *Global*, within period t is computed as follows:

$$Global = \hat{\sigma}^2_{wt} = (2\hat{\beta}_{wl} - 1)\left(\sum\nolimits_{s \in t} (R_{ws} - \mu_{wt})^2\right) \qquad (2.12)$$

where $\hat{\beta}_{wl}$ is the estimated regression coefficient of equation (2.1), and μ_{wt} is the mean of the global index return.

Local volatility, the variance of local index return that is isolated from the global index return, is computed by summing up the squares of the country-specific residuals of equation (2.1) within period *t*. More explicitly, it is computed as

$$Local = \hat{\sigma}^2_{\varepsilon_{lt}} = \sum\nolimits_{s \in t} \hat{\varepsilon}^2_s \, . \tag{2.13}$$

For estimating the idiosyncratic volatility component, first, we sum up the squares of the firm-specific residuals of equation (2.3) for each firm within period *t*:

$$\hat{\mathrm{var}}_{\varepsilon_{ilt}} = \sum\nolimits_{s \in t} \hat{\varepsilon}^2_{ils} \, . \tag{2.14}$$

Then we aggregate equation (2.14) over firms in a market to reach value-weighted idiosyncratic volatility estimates, as follows:

$$Idiosyncratic = \hat{\sigma}^2_{\varepsilon_{lt}} = \sum\nolimits_{i \in l} w_{it} \; \hat{\mathrm{var}}(\varepsilon_{ilt}) \, . \tag{2.15}$$

2.3.2 Descriptive Statistics

The descriptive information for several volatility measures, the degree of financial liberalization measure and the control variables are provided in Table 2.1. The time-series means of each variable are presented for each county in the body of the table. The bottom rows show the preliminary statistics for the overall sample. Out of the emerging countries in this study, Brazil, the Czech Republic, Indonesia, Malaysia, and Mexico have the most liberal stock exchanges, with an average degree of financial liberalization of more than 70%. China, Korea, Pakistan, and Russia are at a moderate level of liberalization, with an average degree of financial liberalization of between 50% and 70%. Colombia, India, Taiwan, Thailand, and Zimbabwe have less than 50% of average liberalization and are relatively more close to foreign investor participation.

Table 2.1
Descriptive Statistics

	Aggregated Total Volatility	Local	Idiosyncratic	Global	Finlib	TO	Size
Brazil	0.4093	0.1464	0.2622	0.0445	0.8426	0.4131	0.3104
China	0.4171	0.1764	0.1978	-0.0025	0.6718	1.4800	0.2470
Colombia	0.2133	0.1026	0.1150	-0.0020	0.2433	0.0868	0.1511
Czech R.	0.1751	0.0574	0.0925	0.0060	0.7462	0.5151	0.2222
India	0.1893	0.0644	0.1219	0.0069	0.3776	1.2318	0.3636
Indonesia	0.3918	0.1660	0.1982	0.0273	0.7151	0.4268	0.2326
Korea	0.3482	0.1013	0.1924	0.0071	0.6319	2.0936	0.5041
Malaysia	0.2144	0.0846	0.1031	0.0152	0.8254	0.4170	1.7419
Mexico	0.1662	0.0647	0.0781	0.0218	0.8976	0.3353	0.2815
Pakistan	0.2774	0.1420	0.1361	-0.0036	0.6735	1.2946	0.1246
Russia	0.5766	0.2144	0.2447	0.0632	0.5942	0.3060	0.3902
Taiwan	0.2050	0.0789	0.0971	0.0171	0.4240	2.5122	0.9358
Thailand	0.3135	0.1185	0.1552	0.0277	0.4356	0.8344	0.5457
Zimbabwe	0.3685	0.1415	0.2414	-0.0158	0.2289	0.1070	0.3045
Mean	0.2992	0.1157	0.1577	0.0155	0.6075	0.8976	0.4831
Std. Dev.	0.3520	0.1474	0.1693	0.0232	0.3048	0.9596	0.5114
Minimum	0.0306	0.0080	0.0214	-0.0340	0.0000	0.0002	0.0485
Maximum	2.4652	1.1456	1.5028	0.1175	1.0000	4.7546	3.2936

Notes: Time-series averages of variables are reported for each country in the body of the table. The descriptive statistics of the whole sample are reported in the bottom rows. Aggregated Total Volatility is the weighted average of return volatilities of stocks in the S&P/IFCG Index of the particular country. *Global* is defined as $(2\hat{\beta}_{wl}-1)\hat{\sigma}^2_{wt}$ where $\hat{\beta}_{wl}$ is the beta of the country index return with respect to the global index return, and $\hat{\sigma}^2_{wt}$ is the return variance of the global index. *Local* is the residual variance of the following regression equation: $\tilde{R}_{lt}=\beta_{wl}\tilde{R}_{wt}+\tilde{\varepsilon}_{lt}$. *Idiosyncratic* is the aggregated residuals variance, where residuals are obtained by the model, $\tilde{R}_{ilt}=\tilde{R}_{wt}+\tilde{\varepsilon}_{lt}+\varepsilon_{ilt}$. *Finlib* is the measure of the degree of financial liberalization and is defined as the ratio of the market capitalization of the SP/IFCI Index to that of the SP/IFCG Index. *Size* is the total market capitalization of the stock market to the GDP, and it reflects the level of market development in terms of size. *TO* is the total value of shares traded in the market during the period, divided by the average market capitalization for the period turnover ratio of the stock market in terms of value traded, and it accounts for the liquidity effects.

The mean level of volatility components for the overall sample in Table 2.1 shows that *Idiosyncratic* represents the largest share of total volatility, with a mean level of 0.1577. *Local* makes the second largest contribution, with a mean level of 0.1157. The smallest contribution to the total volatility comes from Global Volatility, with a 0.0155 mean level. At the country level, Pakistan is the only exception that has a greater local volatility than idiosyncratic volatility. Figure 2.2 depicts the relative shares of volatility components as a percentage of total volatility through time. This graphical analysis again reveals that *Idiosyncratic* is the most important component of the total volatility for the emerging markets in this study. A note that deserves attention in Figure 2 is the behavior of local volatility during the prevalent crises in 1994, 1997 and 1998. The relative share of local volatility increases during these times. Such an increase in local volatility is reasonable, because the crises increase the systematic risk in a country.

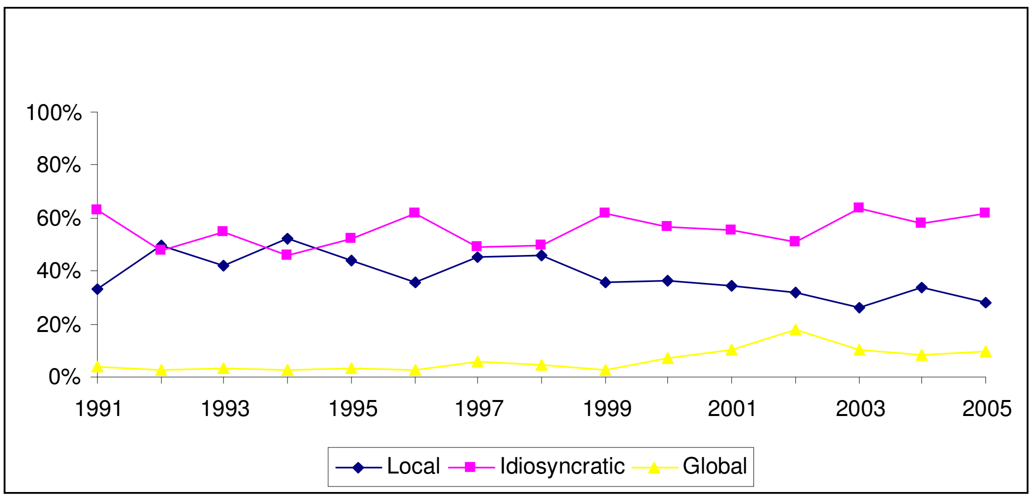

Figure 2.2 Relative Shares of Volatility Components in the Aggregated Total Volatility.

Another issue is to check how well the proposed volatility components represent the aggregated total volatility. For this purpose, we compare the aggregated total volatility to the summation of the volatility components. Note that the aggregated total volatility and its components are computed independently, and thus, we have two series for aggregated total volatility: the first series is obtained by the direct computation of equation (2.11), whereas the second series is obtained indirectly by summing up the computed volatility components. Location-difference tests are performed to determine if the direct measure of volatility is systematically different from the indirect measure. As we work with variances, deviations from normality may arise. We account for this issue by performing a nonparametric test in addition to the parametric paired sample t-test. A non-parametric Wilcoxon Mann-Whitney test is employed to test the null hypothesis that the aggregated volatility is identically distributed with respect to the median for both series for each country. We test the hypothesis that the mean of the paired differences of the two samples is zero with a parametric paired sample t-test. The results of these tests, along with the Pearson correlation coefficient between the series, are presented in Table 2.2. Both the non-parametric and parametric tests show that the null hypotheses cannot be rejected. Additionally, the correlation coefficient of a magnitude greater than 0.90 for each country depicts a strong association between the series. These results suggest that the aggregated total volatility is satisfactorily decomposed into its constituents.

Table 2.2
Comparison of Direct and Indirect Measures of Aggregated Total Volatility

	Mean of direct measure	Mean of indirect measure	Paired t statistics	Median of direct measure	Median of indirect measure	Wilcoxon-Mann Whitney statistics	Correlation coefficient
Brazil	0.41	0.45	-1.08	0.24	0.24	0.12	0.98
			(0.30)			(0.90)	
China	0.42	0.37	0.94	0.20	0.19	0.00	0.99
			(0.37)			(0.99)	
Colombia	0.19	0.19	0.06	0.13	0.14	0.08	0.99
			(0.95)			(0.93)	
Czech R.	0.18	0.16	2.43	0.13	0.13	0.26	0.97
			(0.03)			(0.80)	
India	0.19	0.19	-0.78	0.19	0.19	0.10	0.98
			(0.45)			(0.92)	
Indonesia	0.39	0.39	0.02	0.24	0.23	0.46	0.99
			(0.98)			(0.65)	
Korea	0.35	0.30	1.91	0.18	0.17	0.21	0.99
			(0.08)			(0.84)	
Malaysia	0.21	0.20	0.48	0.11	0.11	0.41	0.99
			(0.64)			(0.68)	
Mexico	0.17	0.16	0.22	0.18	0.16	0.04	0.94
			(0.83)			(0.97)	
Pakistan	0.25	0.25	-0.01	0.22	0.24	0.04	0.98
			(0.99)			(0.97)	
Russia	0.58	0.52	0.62	0.24	0.35	0.18	0.99
			(0.55)			(0.86)	
Taiwan	0.20	0.19	0.82	0.16	0.16	0.12	0.93
			(0.42)			(0.90)	
Thailand	0.31	0.30	0.54	0.20	0.25	0.25	0.99
			(0.60)			(0.80)	
Zimbabwe	0.91	0.98	-1.20	0.51	0.50	0.08	0.99
			(0.25)			(0.93)	

A non-parametric Wilcoxon Mann-Whitney test is employed to test the null hypothesis that the aggregated total volatility is identically distributed with respect to the median for both series. The two-sample paired t-test is used to test the null hypothesis that the mean of the paired differences of the two samples is zero. p values are in parentheses.

2.4 Aggregated Total Volatility and the Degree of Financial Liberalization

In this section, we examine whether the degree of financial liberalization has an impact on the aggregated total volatility of stocks, $\sum_{i\in I} w_{it}\ \mathrm{var}(\tilde{R}_{it}) = \sigma^2_{alt}$. $\log \hat{\sigma}^2_{alt}$ is regressed on the degree of financial liberalization under the control of fixed country and year effects in a panel setting:

$$\log \hat{\sigma}_{alt}^2 = \alpha + \beta_1 Finlib_{lt} + country_l + year_t + \eta_{lt}. \tag{2.16}$$

$\log \hat{\sigma}_{alt}^2$ is the logarithm of the aggregated total volatility. In order to have a dependent variable that is approximately normal in distribution, the logarithmic transformation of aggregated total volatility is used. $Finlib_{lt}$ is the ratio of the market capitalization of the SP/IFCI Index to that of the SP/IFCG Index. $Finlib_{lt}$ represents the degree of financial liberalization of country l in time t and is the focus of interest in this study. $country_l$ is a country-specific dummy variable and controls for unobserved country effects that may drive volatility. $year_t$ is a year-specific dummy variable. Given that the research period covers some major crises (such as the 1994 Mexican peso and Chinese Monetary crisis, the 1997-1998 Asian crisis, the 1998 Russian Ruble crisis, the 2002 South American Economic Crisis, and the 2002 burst of the Internet bubble in Taiwan) and that the volatility in a country is likely to be affected during these times, we include time dummies in the model in order to account for fixed year effects.

The relationship between the aggregated total volatility and the degree of financial liberalization is also analyzed under a different set of volatility determinants. As Bekaert and Harvey (2000) suggest, volatility may exhibit different patterns as the stock market becomes more developed and mature. With this in mind, we include the *Size* control variable measured by the total market capitalization of the stock market to the GDP, aiming to reflect the level of market development. Moreover, we account for the effects of liquidity measured by the turnover ratio, *TO*, in terms of value traded. The extended panel regression is of the following form:

$$\log \hat{\sigma}^2_{alt} = \alpha + \beta_1 Finlib_{lt} + \beta_2 Size_{lt} + \beta_3 TO_{lt} + country_l + year_t + \upsilon_{lt} . \qquad (2.17)$$

Table 2.3 presents the estimation results of the regressions specified above, along with some other specifications that include the control variables in different combinations. In all specifications, country and year dummies are included; t-statistics are provided in parentheses. When *Finlib* enters the regression equation alone, a highly significant positive effect of *Finlib* on aggregated total volatility is observed. The inclusion of *TO* and *Size* variables in the regressions both separately and simultaneously does not diminish the strong relation between *Finlib* and aggregated total volatility. In each specification, a persistent significant positive effect of *Finlib* is documented. These findings reveal that the degree of financial liberalization increases the aggregated total volatility.

Table 2.3
Aggregated Total Volatility and the Degree of Financial Liberalization

Finlib	0.8265***	0.7721***	0.8220***	0.7711***
	(3.6851)	(3.4170)	(3.6304)	(3.3845)
TO		0.1063		0.1060
		(1.5512)		(1.5368)
Size			0.02583	0.0067
			(0.1733)	(0.0447)
Country fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Ad. R^2	0.5589	0.5629	0.5560	0.5600

Notes: The following baseline panel regression model is estimated:

$$\log \hat{\sigma}^2_{a_{lt}} = \alpha + \beta_1 Finlib_{lt} + \beta_2 Size_{lt} + \beta_3 TO_{lt} + country_l + year_t + \upsilon_{lt} .$$

The results of some other regression models in which the control variables are entered with several combinations are also presented. $\sigma^2_{a_{lt}}$ is the weighted average of monthly return volatilities of stocks in the S&P/IFCG Index of the relevant emerging countries. *Finlib* is the measure of the degree of financial liberalization and is defined as the ratio of the market capitalization of the SP/IFCI Index to that of the SP/IFCG Index. *Size* is the proportion of the total market capitalization of the stock market to the GDP, and it reflects the level of market development. *TO* is the total value of shares traded in the market during the period divided by the average market capitalization for the period and accounts for the liquidity effects. *country* and *year* are country-specific and year-specific dummy variables, respectively. The t-statistics are given in parentheses. *, **, and *** represent 10%, 5%, and 1% significance levels, respectively.

2.5 Volatility Components and the Degree of Financial Liberalization

We further try to discover through which channels the degree of financial liberalization affects aggregated total volatility. We examine the three volatility components that are expressed in Equation (2.8) in order to determine which components are responsible for the observed relation between *Finlib* and aggregated total volatility. For this purpose, we regress each of the three volatility components on *Finlib*. Idiosyncratic volatility is the strongest candidate for a channel of influence. Firstly, it is the most important component of the aggregated total volatility. Secondly, as a stock market becomes more open to foreign investors, aggregated idiosyncratic volatility may increase due to the informed trading of foreign investors who are generally sophisticated institutional investors. Recent literature documents a relationship between institutional ownership and aggregated idiosyncratic volatility in developed markets (Xu and Malkei, 2003). A similar relationship between foreign ownership and aggregated idiosyncratic volatility may hold in emerging markets. Foreign investors may heavily trade in the stocks that they have special information on, as institutional investors do in developed markets. Thus, as more foreign investors participate in emerging stock markets with an increasing degree of financial liberalization, it is likely that aggregated idiosyncratic volatility increases. To investigate the possible relationship between the degree of financial liberalization and aggregated idiosyncratic volatility, we run the following regression equation:

$$\log Idiosyncratic_{lt} = \alpha_l + \alpha_1 Finlib_{lt} + \alpha_2 Size_{lt} + \alpha_3 TO_{lt} + country_l + year_t + \xi_{lt}. \quad (2.18)$$

The results of the regression equation (2.18) along with some other specifications are presented in Panel A of Table 2.4. As expected, aggregated idiosyncratic volatility is positively related to the degree of financial liberalization. This relationship is persistent after controlling for size, liquidity, country and year effects. The regression results also show that *TO* has a positive impact on aggregated idiosyncratic volatility.

Local volatility may be the second channel of influence. Aggarwal et al. (1999) provide evidence that local factors are the important sources of volatility in emerging markets. In line with their results, we previously showed that local volatility makes the second largest contribution to total volatility. Therefore, local volatility is a probable channel through which the effect of the degree of financial liberalization arises. Therefore, we examine the relationship between log*Local* and *Finlib* in several specifications. The results are presented in Panel B of Table 2.4. We detected a strong positive impact of *Finlib* on *Local*.

Finally, we check whether the global volatility contributes to the observed relationship between aggregated total volatility and the degree of financial liberalization. We regress *Global* only on *Finlib*, country, and year dummies and omit the other control variables used before.[6] The reason is that these are local market-specific variables, and they are not relevant to the global volatility. Some other global factors, such as changes in the oil prices may induce global volatility, but the determinants of global volatility are beyond the scope of this study. We focus on the relationship between *Global* and *Finlib*. The results in Panel C suggest that even when *Finlib* enters into the regression equation alone, it cannot explain *Global.*

[6] Unlike previous regressions, we report the results of the regression where the logarithmic transformation of the dependent variable is not performed. The reason is that $Global, (2\beta_{wl} - 1)\,\mathrm{var}(\tilde{R}_{wt})$, makes a negative contribution to total volatility whenever the countries have a $\hat{\beta}_{wl}$ value of less than 0.5. By excluding these countries (China, Colombia, Pakistan and Zimbabwe), we perform the regression analysis with the logarithmic transformation of global volatility. The results, which are not reported here, show that *Finlib* has no explanatory power on log*Global*.

Thus, we conclude that the degree of financial liberalization affects aggregated volatility through idiosyncratic and local volatilities, but not through global volatility.

Table 2.4
Volatility Components and the Degree of Financial Liberalization

Panel A: Dependent variable is log*Idiosyncratic*				
Finlib	0.6167***	0.5521**	0.6013***	0.5418**
	(2.8041)	(2.5010)	(2.7109)	(2.4360)
TO		0.1264*		0.1237*
		(1.8880)		(1.8372)
Size			0.0904	0.0681
			(0.6193)	(0.4681)
Country fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Ad. R^2	0.5307	0.5385	0.5287	0.5361
Panel B: Dependent variable is log*Local*				
Finlib	0.8611***	0.8221***	0.8691***	0.8314***
	(2.8996)	(2.7322)	(2.8991)	(2.7412)
TO		0.0762		0.0786
		(0.8353)		(0.8558)
Size			-0.0471	-0.0613
			(-0.2387)	(-0.3094)
Country fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Ad. R^2	0.4663	0.4652	0.4629	0.4620
Panel C: Dependent variable is *Global*				
Finlib	0.0065			
	(1.3856)			
Country fixed effects	yes			
Year fixed effects	yes			
Ad. R^2	0.7863			

Notes: In Panel A, the results of the panel regressions of the aggregated idiosyncratic volatility on the previously defined control variables are presented. *Idiosyncratic* is the aggregated residuals variance where residuals are obtained by the model, $\tilde{R}_{ilt} = \tilde{R}_{wt} + \tilde{\varepsilon}_{lt} + \varepsilon_{ilt}$, taking the global factors as the base. In Panel B, the dependent variable is *Local*, and it is the residual variance of the following regression equation: $\tilde{R}_{lt} = \beta_{wl}\tilde{R}_{wt} + \tilde{\varepsilon}_{lt}$. In Panel C, *Global* is used as the dependent variable and is defined as $(2\beta_{wl} - 1)\sigma^2_{wt}$ where $\hat{\beta}_{wl}$ is the beta of the country index return with respect to the global index return, and $\hat{\sigma}^2_{wt}$ is the return variance of the global index. The t-statistics are given in parentheses. *, **, and *** represent 10%, 5%, and 1% significance levels, respectively.

2.6 Robustness Checks

2.6.1 Alternative Order of Orthogonalization

The volatility components previously used as the dependent variables are derived from the modified market model, which uses the orthogonalized returns. In the volatility decomposition method, global market portfolio return is taken to be the base, and the local market portfolio return is orthogonalized with respect to the global market portfolio return. Clayton and Mackinnon (2003) point out an overpurging problem in such an orthogonalization process. In our case, this problem means that if stock return volatility is driven to some extent by factors that are common to local and global effects, then the effects of these common factors are attributed only to global factors, and the effects of the local factors are overpurged. In order to handle this potential problem, we change the order of the orthogonalization process and take the local index return as the base, this time. New versions of volatility components are obtained with this order of orthogonalization, giving more emphasis to local factors. In the Appendix, it is shown that the global and local volatilities turn out to be $\text{var}(\tilde{\varepsilon}_{wt})$ and $\text{var}(\tilde{R}_{lt})$, respectively.[7] Although the equation of idiosyncratic volatility remains the same, it is obvious that it differs in value from the former one, because the residuals are model specific. In our empirical implementations, we also use this set of volatility components as dependent variables in the regression analyses. Thus, we can assess whether our results are affected by the potential overpurging problem.

[7] The full details of the volatility decomposition in this setting can be found in the Appendix.

Table 2.5
Volatility Components and the Degree of Financial Liberalization under the Alternative Order of Orthogonalization

Panel A: Dependent variable is log $\hat{\sigma}^2_{\zeta_{lt}}$				
Finlib	0.6845***	0.6259***	0.6838***	0.6284***
	(3.3532)	(3.0529)	(3.3171)	(3.0399)
TO		0.1147*		0.1154*
		(1.8455)		(1.8431)
Size			0.0044	-0.0164
			(0.0327)	(-0.1215)
Country fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Ad. R^2	0.5890	0.5954	0.5862	0.5928
Panel B: Dependent variable is log $\hat{\sigma}^2_{lt}$				
Finlib	1.0239***	0.9837***	1.0385***	0.9989***
	(3.6541)	(3.4663)	(3.6733)	(3.4944)
TO		0.0786		0.0825
		(0.9138)		(0.9536)
Size			-0.0857	-0.1007
			(-0.4607)	(-0.5388)
Country fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Ad. R^2	0.4773	0.4767	0.4746	0.4742
Panel C: Dependent variable is, $\hat{\sigma}^2_{\varepsilon w_{lt}}$				
Finlib	-0.0013			
	(-0.8327)			
Country fixed effects	yes			
Year fixed effects	yes			
Ad. R^2	0.7985			

Notes: In Panel A, the results of the panel regressions of $\hat{\sigma}^2_{\zeta_{lt}}$ on the previously defined control variables are presented. $\hat{\sigma}^2_{\zeta_{lt}}$ is the aggregated idiosyncratic volatility of stocks in a month. Idiosyncratic volatility is the residuals variance where residuals are obtained by the model, $\tilde{R}_{ilt} = \tilde{R}_{lt} + \tilde{\varepsilon}_{wt} + \zeta_{ilt}$, taking the local factors as the base. In Panel B, $\hat{\sigma}^2_{lt}$ is the dependent variable, and it is the return variance of the local index. In Panel C, $\hat{\sigma}^2_{\varepsilon w_{lt}}$ is used as the dependent variable, and it is the residual variance of the following regression equation: $\tilde{R}_{wt} = \beta_{lw}\tilde{R}_{lt} + \tilde{\varepsilon}_{wt}$. The t-statistics are given in parentheses. *, **, and *** represent 10%, 5%, and 1% significance levels, respectively.

Table 2.5 provides the results of the regression of the dependent variables, which are constructed under the alternative order of orthogonalization, on the *Finlib* and the control variables. Again, in each panel, a different dependent variable (*Idiosyncratic*, *Local*, and *Global*) is examined. Under this order of orthogonalization, *Finlib* preserves its positive significant impact on log*Idiosyncratic* and log*Local*. This impact is not affected by the inclusion of the control variables. On the other hand, a significant relationship between *Global* and *Finlib* is not detected. These findings are qualitatively the same as the ones of the previous section. Therefore, the effect of *Finlib* on the volatility is independent of the order of orthogonalization. Thus, the potential overpurging problem does not seriously affect our results.

2.6.2 Model Independent Definition of Aggregated Idiosyncratic Volatility

Our aggregated idiosyncratic volatility measure is derived from the modified market model, and therefore, our results may be subject to the criticism that the conclusions drawn are model dependent. In order to asses the robustness of the results for aggregated idiosyncratic volatility in Tables 2.4 and 2.5, we use the model-independent measure of aggregate idiosyncratic volatility proposed by Bali et al. (2008). They base their argument on the mean-variance portfolio theory and the concept of gain from portfolio diversification. They define a non-diversified portfolio in which the correlations among the stocks equal one. Such a portfolio contains both the systematic risk and idiosyncratic risk of individual stocks. On the other hand, they consider a fully diversified portfolio, such as the stock market index. Because the idiosyncratic risk is eliminated in a fully diversified portfolio, the total risk of this portfolio is due to the systematic risk of the stocks in the portfolio. They define the new measure of average idiosyncratic volatility as the difference between the variance of the non-diversified portfolio and the variance of the fully diversified portfolio. In their study, it is shown that the variance of the non-diversified portfolio equals

$$\sigma_{pt}^2 = \left(\sum_i w_{it}\sigma_{it}\right)^2 \tag{2.19}$$

where σ_{it} is the standard deviation of the return of stock *i*, and w_{it} is the weight of stock *i* in the portfolio. The variance of the fully diversified portfolio is taken to be the market variance, $\text{var}(R_{mt})$. The new measure of model-independent idiosyncratic risk is then

$$\sigma_{\varepsilon t}^2 = \left(\sum_i w_{it}\sigma_{it}\right)^2 - \text{var}(R_{mt})\,. \tag{2.20}$$

We use this new measure to determine whether our results are sensitive to the definition of idiosyncratic volatility. We construct a portfolio composed of the stocks in the IFCG Index of the emerging markets as the non-diversified portfolio, assuming that the correlation between stock returns is equal to one. We use the IFCG Index as the fully diversified portfolio. We repeat our tests with the alternative definition of idiosyncratic volatility, and the results are presented in Table 2.6. We still observe a sharp positive significant effect of *Finlib* on log*Idiosyncratic*. This effect persists under the control of explanatory variables. Thus, our finding of a positive significant relationship between *Idiosyncratic* and *Finlib* is replicated with a model-independent measure of idiosyncratic volatility.

Table 2.6
Alternative Definition of Aggregated Idiosyncratic Volatility and the Degree of Financial Liberalization

Finlib	0.9336***	0.9103***	0.9388***	0.9162***
	(3.4131)	(3.2799)	(3.3994)	(3.5325)
TO		0.0457		0.0472
		(0.5429)		(0.5571)
Size			-0.0304	-0.0390
			(-0.1674)	(-0.2130)
Country fixed effects	yes	yes	yes	yes
Year fixed effects	yes	yes	yes	yes
Ad. R^2	0.4122	0.4095	0.4084	0.4057

Notes: $\hat{\sigma}^2_{\varepsilon_{lt}}$ is the dependent variable in the panel regressions. $\hat{\sigma}^2_{\varepsilon_{lt}}$ is the weighted average of firm-specific return volatilities of stocks in a country. $\hat{\sigma}^2_{\varepsilon_{lt}}$ is calculated by the difference between the variance of the non-diversified portfolio and the variance of the diversified portfolio, as suggested by Bali et al. (2008). The t-statistics are given in parentheses. *, **, and *** represent 10%, 5%, and 1% significance levels, respectively.

2.7 Conclusion

The results of this study show that aggregated total volatility is positively related to the degree of financial liberalization, even after controlling for market development, liquidity, country and time effects. Hence, the degree of financial liberalization has an increasing impact on aggregated total volatility. Furthermore, the components of the aggregated total volatility of stocks are studied under a modified market model. Under this framework, the volatility components are classified as idiosyncratic, local, and global volatility. These volatility components are then regressed on the degree of financial liberalization in order to understand the channels of influence on aggregated total volatility. We found that the degree of financial liberalization transmits its impact on the aggregated total volatility through the aggregated idiosyncratic and local volatility. Similar results are obtained with the alternative order of orthogonalization in the volatility decomposition process and with the alternative model-independent definition of idiosyncratic volatility. Moreover, our results are not affected by the correlations between the stock returns in a portfolio, because the aggregated return volatility used in this study is a pure measure of the average return volatility of stocks in a country.

CHAPTER 3

FOREIGN EQUITY FLOWS AND AGGREGATED STOCK-RETURN VOLATILITY IN İSTANBUL STOCK EXCHANGE

3.1 Introduction

In the previous chapter, we use the degree of financial liberalization measure in order to analyze the effects of openness of stock markets to foreign investors on the return volatility of stocks. Although this new measure is an important improvement over using the financial liberalization dates in identifying the regulatory restrictions on foreign investment in equity markets, it has some restrictions as discussed previously. It is very strong in representing the time-varying nature of financial liberalization but weak in modeling the effective foreign equity investment. Maybe the best measure for effective foreign equity investment is the equity flows of foreigners. However, equity flow data for foreigners is not available for most of the emerging markets. İstanbul Stock Exchange (İSE) is one of the exceptions in emerging equity markets that provide foreign equity inflow and outflow data at the monthly frequency since 1996. In this chapter, we use the volatility decomposition methodology and the definitions of volatility developed in Chapter 2 to examine the relationship between average stock-return volatility and foreign equity flows in İSE. By using foreign equity inflow and outflow data, not only the effective foreign equity investment can be measured but also the possible asymmetric effects of incoming and outgoing foreign equity investments can be analyzed.

İSE is an interesting stock exchange for investigating the effects of foreign equity investment due to its distinguishing characteristics.[8] A policy that allows for foreign institutional and individual investments in securities listed on the ISE is put in use since 1989. There are no restrictions on foreign portfolio investors trading in the Turkish securities markets. Decree No. 32 passed in August 1989, removes all restrictions on the repatriation of capital and profits for overseas institutional and individual investment in securities listed on the Istanbul Stock Exchange. Hence, İSE is fully open to foreign investors. Decree No. 32 also allows Turkish citizens to buy foreign securities. As a consequence of this regulation, foreign investors actively take part in İSE. As of October 2007, foreign investors hold 59% of the total number of stocks; and their market capitalization exceeds 72% of the total market capitalization.

Previous studies use foreign equity flows to assess the effects of foreign participation in emerging markets mostly with uniquely available data sets. Choe et al. (1999) and Froot et al. (2001) investigate the relationship between equity flows and stock returns and document evidence in the favor of the positive feed back trading which means that an increase (decrease) in today's returns lead to an increase (decrease) in future returns. Bekaert et al. (2002) study the interrelationship between

[8] Detailed information about the regulatory rules on foreign investors can be found at the web site of İSE: www.imkb.gov.tr/yabanci.htm

capital flows, returns, dividend yields and world interest rates in 20 emerging markets and show that shocks in equity flows initially increase returns. Although this effect is diminished over time, a permanent effect is found to remain. Edison and Warnock (2004) analyze the US investors' emerging market equity portfolios at the security level. They find that US equity portfolios are directed to firms that are large, have fewer restrictions on foreign ownership, or are cross-listed on US exchanges. Wang (2007) concentrates on the relationship between foreign equity trading and market volatility. However, this study might contain the problem inherent in examining the market volatility. Changes in the return variance of a market portfolio may not necessarily reflect the changes in the return variance of stocks forming that market portfolio as discussed in Section 2.1. Different from previous studies, Li et al. (2004) demonstrate a relationship between return variation and stock market openness. Although they capture the time-varying nature of liberalization, because the openness measure enables the detection of the degree of financial liberalization through time, this measure does not explain whether the documented relationship is a result of the transactions of incoming or outgoing foreign equity investments.

In this study, we use the foreign equity flow data to examine the impact of foreign equity investment on the stock-return volatility in İSE. We first investigate the impact of foreign equity flow on the aggregated total volatility of stock returns in İSE and then explore the channels through which the foreign equity flow transmits its impact onto the aggregated total volatility in the spirit of the previous chapter. The net equity flow variable, which bases on the difference between the net equity inflow and outflow, brings the additional advantage of observing the asymmetric effects of incoming and outgoing funds on volatility besides capturing effective foreign investor participation.

3.2 Foreign Investors in İSE

Foreign investors trade heavily in İSE with an increasingly important role.[9] Figure 3.1 summarizes the shares of foreign investors in portfolio value and turnover ratio. As of December 2006, the market capitalization of foreign holdings reaches 68% of the market capitalization of the free floated shares. The portfolio value of foreign investors exhibits an increasing trend since 2003. This ratio was 67% in 2005, 61% in 2004 and 51% in 2003. In other words, foreign investors are increasing their share in market capitalization consistently and hold nearly two-third of the traded stocks in the last two years. Despite their dominant contribution to the market capitalization, foreign investors' contribution to the turnover in terms of value traded is limited. While their share in turnover is 9% in 2003, it jumped to 21% in 2005 and reached to 19% with a slight decrease in 2006. Although the shares of foreign investors in turnover in the last two years are the highest levels of the last ten years, the majority of turnover in the market is still due to the transactions of domestic investors. By 2006, domestic investors contribute 81% of total turnover and therefore they are the main providers of liquidity.

Foreign portfolio value and turnover are provided in Table 3.1 in absolute terms along with equity flow data. The table demonstrates that during the period of 1999-2002 the size of foreign equity portfolio and the turnover decreased. Negative growth prospects after a devastating earthquake in the most industrialized region of Turkey and financial crises in 2001 and 2002 may be responsible for the leave of foreign investors. Foreign investors started to increase their participation in 2003 and reach

[9] The information in this section is mainly compiled from the annual reports of The Association of Capital Market Intermediary Institutions of Turkey. For a more comprehensive survey on investor profile in İSE, reader is referred to the several annual reports which can be found in the website of the institution: http://www.tspakb.org.tr

maximum levels in the value of the equity portfolio in 2006 and in the trading activity in 2005.

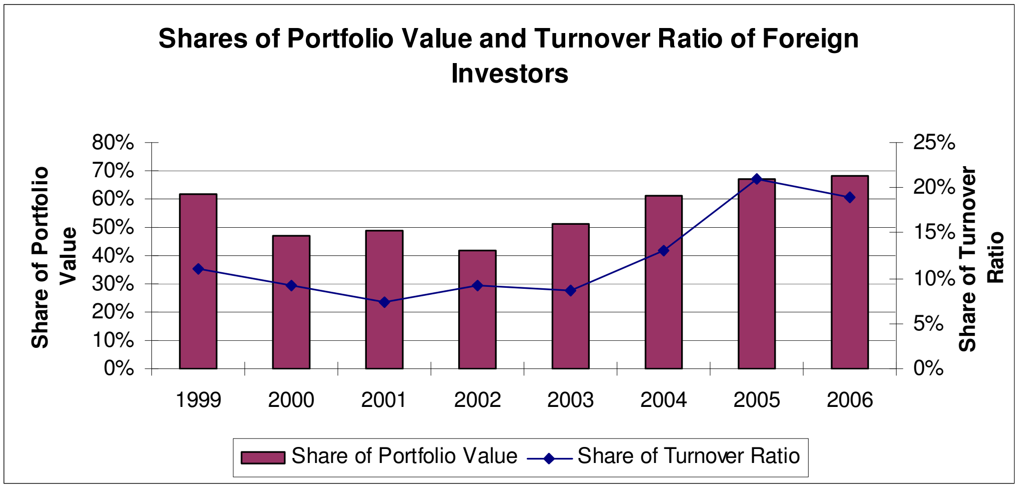

Figure 3.1 Shares of Portfolio Value and Turnover Ratio of Foreign Investors
Source: The Association of Capital Market Intermediary Institutions of Turkey

In Table 3.1, it is also observed that the size of the foreign equity portfolio increased more than US$ 32 billion since 2002. Foreign investors hold a portfolio of size US$ 3,450 at the end of 2002 which is the value of their portfolio at the beginning of 2003. During 2003, they purchase stocks amounting to US$ 82 million in the public offerings and US$ 1,010 million in the secondary market. Thus net equity inflow in 2003 is US$ 1,092 million. If the market prices remain at the same level during 2003, value of the foreign portfolio would worth US$ 4,542 million (= 3,450 + 1,092). However, the table shows that the value at the end of 2003 is US$ 8,954 million. So, it is inferred that the value of the foreign portfolio appreciated by US$ 4,412 million (= 8,954 – 4,542). Similar calculations for the remaining years reveal that the increase of US$ 32 billion in the size of the foreign equity portfolio since 2002 stems from US$ 21 billion appreciation of the portfolio value and US$ 11 billion inflow of equity. Therefore, the main increase in the size of the foreign portfolio is due to the appreciation in the value of the portfolio.

Table 3.1
Foreign Equity Investment Data (mil. $)

	Value of the Equity Portfolio	Turnover	Public Offering Purchase	Secondary Market Net Purchase/Sale	Net Equity Inflow/Outflow	Portfolio Value Appr./Depr.
1999	15,358	17,879	10	1,024	1,034	10,624
2000	7,404	33,410	2,677	-3,134	-457	-7,497
2001	5,635	12,139	10	509	519	-2,288
2002	3,450	12,869	64	-15	49	-2,234
2003	8,954	17,334	82	1,010	1,092	4,412
2004	16,141	37,368	950	1,430	2,380	4,807
2005	33,812	83,275	1,477	3,989	5,466	12,205
2006	35,083	88,519	600	1,144	1,744	-473

Source: The Association of Capital Market Intermediary Institutions of Turkey

Net Equity Inflow/Outflow column shows that foreign investors are net buyers of Turkish stocks in the last six years. Inflow of equity concentrates in the last four years with a total amount of US$ 10.7 billion. In the last column of Table 3.1, it is observed that between 2000 and 2002, the loss in the value of foreign portfolio is US$ 12 billion. On the other hand, foreign investors experience a gain amounting to US$ 21 billion between 2003 and 2005. In 2006, the value of the foreign portfolio falls slightly.

Average holding period of foreign investors is another characteristic of foreign investor participation and it gives an idea about the investment horizon of foreigners in İSE. The Association of Capital Market Intermediary Institutions of Turkey calculates the average holding period in the following way. First, *Average Portfolio Size* of foreigners is computed by taking the equal weighted average of end-of-the month portfolio values in a year. Then *Annual Turnover* is divided by *Average Portfolio Size* in order to see how many times in a year the foreign portfolio is rebalanced. The resulting ratio is called the *Turnover Ratio*. A portfolio is rebalanced (*Turnover Ratio* / 2) times in a year. *Average Holding Period* is calculated by dividing the total investment period to the number of rebalancing in a year. For example, assume that a portfolio of US$ 100 is constructed at the beginning of a year. Later on, this portfolio is sold at US$ 100 and the proceeds are invested to construct another portfolio. At the end of the year, this portfolio is sold again at US$ 100. The annual turnover is US$ 400 and the average portfolio size is US$ 100. Therefore, the turnover rate is 4. The portfolio is rebalanced twice a year which means that average holding period is 180 days (=360/2). Average holding periods of foreign investors are provided in Table 3.2. It is seen that the holding periods of foreign investors are on average 250-300 days between 1999 and 2001. After 2001, average holding period reduces regularly and in 2005 it falls to 196 days. Average holding period again increases to 250-300 day range in 2006.

Table 3.2
Investment Horizons of Foreigners

	Average Portfolio Size	Turnover (Value Traded)	Turnover Rate	Average Holding Period (Day)
1999	6,927	17,879	2.58	283
2000	11,440	33,410	2.92	250
2001	4,849	12,139	2.50	292
2002	4,265	12,869	3.02	242
2003	5,069	17,334	3.42	213
2004	10,603	37,368	3.52	207
2005	22,354	83,275	3.73	196
2006	33,815	88,519	2.62	279

Source: The Association of Capital Market Intermediary Institutions of Turkey

As a summary, foreign investors hold a significant portion of the traded stocks in İSE. However, they hold their portfolio relatively long and thus provide limited liquidity to the market. They experience important increases in their portfolio value in the last few years which are mainly due to the appreciation in the value of their portfolio. The recent increasing trend in foreign investor participation suggests that foreign investors will probably keep their important role in İSE in the future as well.

3.3 Data and Methodology

Our main data sources in this study are the Standard & Poor's Emerging Markets Database (EMDB), Datastream, and İSE. Our data comprise returns of stocks that are listed in the S&P/IFC (Standard & Poor's/International Finance Corporation) Global index of Turkey over the period January 1997 to June 2006. During each month in the research period, monthly return variances of firms listed in the S&P/IFC Global Index of the EMDB are computed by using the daily adjusted closing prices. All IFCG Index firms of Turkey form our sample. The closing prices of the local index (İSE-100) and global index come from EMDB and Datastream, respectively. Our main focus of interest in this section is the foreign participation in emerging stock exchanges. We obtain the foreign investor participation data in terms monthly purchases and sells by foreigners from the İSE. We define a monthly flow variable, *Netflow*, as the difference between the values of foreign purchases and sells, normalized by the total equity market capitalization. In the regressions that aim to assess the impact of net foreign flows on the aggregated volatility and its components, previously defined *Size* and *TO* variables are controlled for. We follow the same sequence of methodology in Section 2.3 in determining the Aggregated total volatility, decomposing the volatility components and estimating them for Turkey. More specifically, volatility measures for Turkey are estimated as described in equations from (2.10) to (2.15).

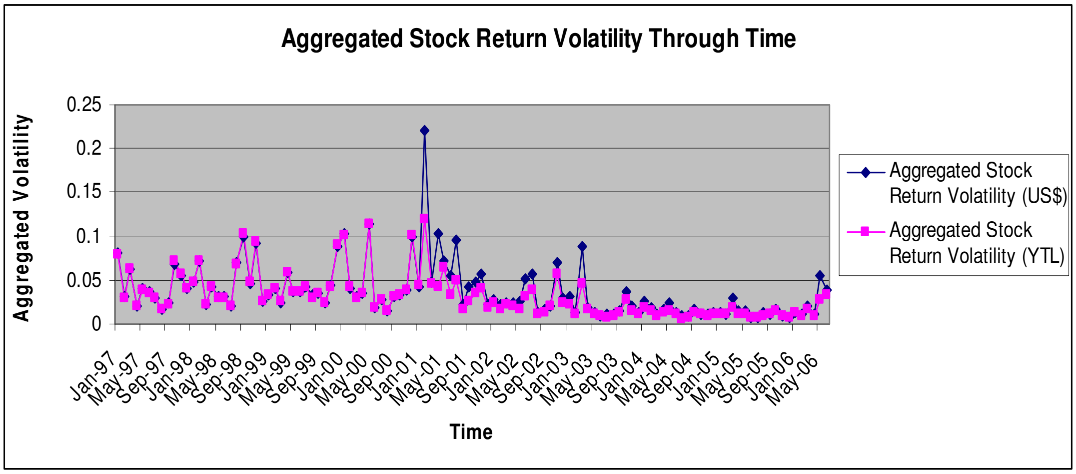

Figure 3.2. Aggregated Stock ReturnVolatility through Time. Weighted average of stock return volatility computed both in dollars and in local currency (YTL).

Figure 3.2 shows the time variation of aggregated return volatility where returns are calculated both in dollars and in local currency (YTL). The volatile times appearing on the graph correspond to major financial crises (one in 1999 and one in 2001) and exchange-rate turbulence in 2006.

Figure 3.3 shows the time variation of volatility components as a percentage of total volatility through time. It is observed that total volatility is dominated by the idiosyncratic volatility and especially by the local volatility. As stated previously, Turkey experienced a few crises in the last decade. The impact of these crises on the overall economy was severe. The crises show their effect as an increase in the aggregated total volatility, but most importantly, the fraction of the total volatility that is represented by the local market volatility increased during these times. Because the crises systematically affect all the firms, it is reasonable to observe such an increase in the share of the local volatility during the crisis periods, in Figure 3.3. On the other hand, the contribution of the global volatility to total volatility is limited. However, Figure 3.3 shows that it increased its share slightly, after 2001.

This increase in global volatility is consistent with the increased foreign participation in the İSE during the last five years. As the foreign investors more heavily trade in the İSE, it is expected that the İSE will become more integrated with the global market and that the volatility, due to the global factors, will increase.

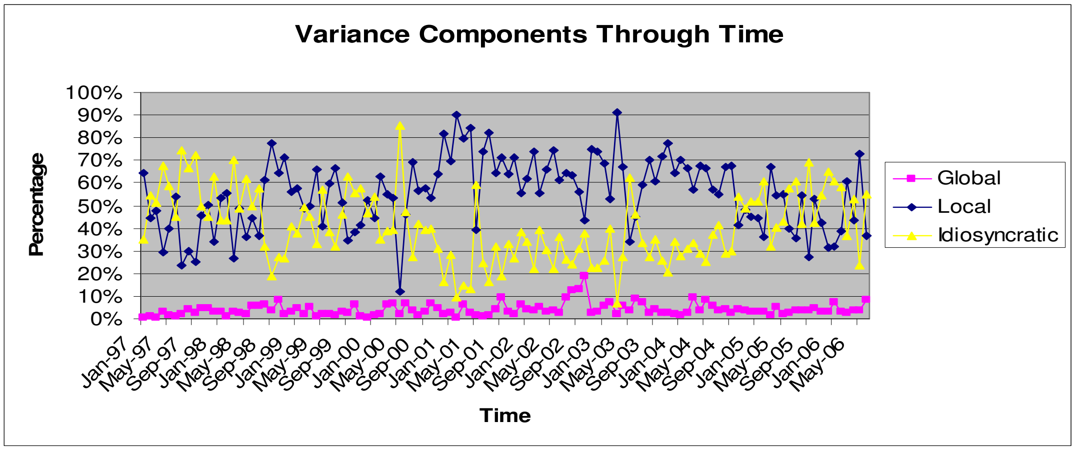

Figure 3.3. Proportion of Volatility Components. Time variation of volatility components as a percentage of total volatility through time.

Some descriptive information for the volatility measures, net flow data, and control variables are provided in Table 3.3. A high variation of *Netflow* during the research period is observed. The mean of the ratio of net equity flow to market capitalization is 0.0017, while the standard deviation is 0.0120, which is more than ten times the mean. Inspection of the mean levels of the volatility components reveal that the maximum contribution to the total volatility is made by the *Local*. *Idiosyncratic* makes the second largest contribution. *Global* is a very small portion of the total volatility.

Table 3.3
Descriptive Statistics

	Mean	Std. Dev.	Median
Aggregated Total Volatility, σ_{at}^2	0.0387	0.0324	0.0293
Global	0.0013	0.0011	0.0010
Local	0.0236	0.0273	0.0164
Idiosyncratic	0.0144	0.0132	0.0115
Netflow	0.0017	0.0120	0.0027
Size	0.2925	0.1121	0.2707
TO	0.1417	0.0531	0.1344

Aggregated Total Volatility is the weighted average of monthly return volatilities of stocks in the S&P/IFCG Index of Turkey. *Global* is defined as $(2\hat{\beta}_{wl}-1)\hat{\sigma}_{wt}^2$ where $\hat{\beta}_{wl}$ is the beta of the country index return with respect to the global index return, and $\hat{\sigma}_{wt}^2$ is the monthly return variance of the global index. *Local* is the monthly residual variance of the following regression equation: $\tilde{R}_{lt}=\beta_{wl}\tilde{R}_{wt}+\tilde{\varepsilon}_{lt}$. *Idiosyncratic* is the aggregated residuals variance, where residuals are obtained by the model, $\tilde{R}_{ilt}=\tilde{R}_{wt}+\tilde{\varepsilon}_{lt}+\varepsilon_{ilt}$. *Netflow* is the difference between the values of the total purchases and the sells of foreigners normalized by the total market capitalization of the market. *Size* is the total market capitalization of the stock market to the GDP, and it reflects the level of market development in terms of size. *TO* is the turnover ratio of the stock market in terms of value traded and accounts for the liquidity effects.

3.4 Aggregated Total Volatility and Net Flow

In this part, we empirically test the hypothesis that the net equity flow does not affect the aggregated total volatility of stocks. The weighted average of return volatilities of stocks in the Global Index of Turkey, $\sum_{i\in l} w_i \operatorname{var}(\tilde{R}_{it})=\sigma_{at}^2$, is regressed on the *Netflow*, which is defined as the difference between the equity inflow and the outflow divided by the equity market capitalization. The relationship between the aggregated total volatility and the *Netflow* is analyzed under the control of some volatility determinants. More specifically, the following regression equation is estimated:

$$\hat{\sigma}_{at}^2=\alpha_l+\beta_1 Netflow_t+\beta_2 Size_t+\beta_3 TO_t+\eta_t\,. \tag{3.1}$$

We are mainly interested in the coefficient of *Netflow*. We use the Generalized Method of Moments (GMM) to estimate the model. GMM does not make any distributional assumptions, such as normality, and this issue is especially important in our study, as we deal with volatilities. Moreover, GMM allows series to be conditionally heteroscedastic and autocorrelated. Volatility may exhibit different patterns as the stock market becomes more developed and mature. With this in mind, we include the *Size* control variable measured by the total market capitalization of the stock market to the GDP, aiming to reflect the level of market development. Moreover, we account for the effects of liquidity measured by the turnover ratio, *TO*, of the stock market in examining the average stock return volatility.

Furthermore, the lagged value of the aggregated total volatility is included as an explanatory variable in order to account for a possible persistence in volatility. We estimate this dynamic model again in a GMM framework by using the one-period lags of the other explanatory variables as the instrumental variables. The extended regression model is of the following form:

$$\hat{\sigma}_{at}^2 = \alpha + \beta_1 Netflow_t + \beta_2 Size_t + \beta_3 TO_t + \beta_4 \hat{\sigma}_{at-1}^2 + \upsilon_t \, . \tag{3.2}$$

Table 3.4 presents the estimation results of the regression of aggregated total volatility on the *Netflow*, along with some control variables. Panel A of the table provides the results of the regression model (3.1) and some other models in which the control variables enter into the regression equation in different combinations.

Table 3.4
Aggregated Total Volatility and the Net Flow

Panel A: Lagged dependent variable is not included as an explanatory variable				
Netflow	-0.8596***	-0.8345***	-0.8415***	-0.8224***
	(-4.4556)	(-4.0327)	(-4.3447)	(-3.8819)
Size		0.0158		0.0126
		(0.5346)		(0.4198)
TO			0.0623	0.0593
			(1.4906)	(1.3697)
C	0.0402***	0.0355***	0.0313***	0.0280***
	(10.0960)	(4.2128)	(5.1401)	(2.9802)
Ad. R^2	0.0933	0.0881	0.0957	0.0894
Panel B: Lagged dependent variable is included as an explanatory variable				
Netflow	-0.9508***	-0.9114***	-1.0257***	-0.9393***
	(-3.8186)	(-3.6550)	(-4.2235)	(-3.7974)
Size		0.0221		0.0264
		(0.7148)		(0.8566)
TO			0.0643*	0.0625
			(1.6936)	(1.5439)
$\sigma^2_{a,t-1}$	0.0030	-0.0747	-0.0192	-0.1219
	(0.0174)	(-0.3491)	(-0.1047)	(-0.5557)
C	0.0377***	0.0349***	0.0285***	0.0253**
	(4.7791)	(4.0064)	(2.9563)	(2.5143)
Ad. R^2	0.0877	0.0520	0.0710	0.0147

In Panel A, the following baseline regression model is estimated by GMM: $\hat{\sigma}^2_{at} = \alpha_l + \beta_1 Netflow_t + \beta_2 Size_t + \beta_3 TO_t + \upsilon_t$.
The results of some other regression models in which the control variables enter with several combinations are also presented. $\hat{\sigma}^2_{at}$ is the weighted average of monthly return volatilities of stocks in the S&P/IFCG Index of Turkey. *Netflow* is the difference between the values of the total purchases and sells of foreigners normalized by the total market capitalization of the market. *Size* is the proportion of total market capitalization of the stock market to the GDP, and it reflects the level of market development in terms of size. *TO* is the turnover ratio of the stock market in terms of value traded and accounts for the liquidity effects. In Panel B, one period lagged dependent variable is added as an explanatory variable to control for volatility persistency, and dynamic regressions are performed. The t-statistics are given in parentheses. *, **, and *** represent 10%, 5%, and 1% significance levels, respectively.

In the first column of Panel A of Table 3.4, a highly significant negative effect of *Netflow* on aggregated total volatility is observed. The negative coefficient for the *Netflow* provides important insights for the impact of equity flows on the volatility. When the *Netflow* is positive in value, i.e., foreign investors are net buyers of local stocks (and thus, foreign funds inflow), there is a negative relationship between inflows and volatility. In other words, net equity inflows reduce volatility. On the other hand, when the *Netflow* is negative in value, i.e., foreign investors are net sellers of local stocks (and thus, foreign funds outflow), there is positive relationship between outflows and volatility, because the multiplication of the negative coefficient with the negative *Netflow* variable results in a positive impact on volatility. This means that net equity outflows increase volatility. This result is persistent when the control variables are included as explanatory variables in different combinations.

In Panel B of Table 3.4, the regression results of the models including the lagged dependent variable are presented. Under these specifications, *Netflow* preserves its negative significant effect on the aggregated total volatility again, and its impact is not affected by the inclusion of the control variables. These findings reveal that when foreign equity funds inflow, aggregated volatility decreases; when the foreign equity funds outflow, aggregated volatility increases.

3.5 Further Analysis on Volatility Components

After analyzing the total volatility of stocks, our next concern is to examine in which channels the net flow affects aggregated total volatility. Equation (2.8) shows that the average total volatility of stocks in a country is composed of systematic components, such as global and local volatility and by the unsystematic component, idiosyncratic volatility. In an attempt to determine whether net flow affects aggregated total volatility through the volatility components, we regress each of these three components on the *Netflow*. In order to study the possible effect of net flow on aggregated idiosyncratic volatility, we run the following regression equation:

$$Idiosyncratic_t = \alpha_I + \alpha_1 Netflow_t + \alpha_2 Size_t + \alpha_3 TO_t + \alpha_4 Idiosyncratic_{t-1} + \xi_t . \qquad (3.3)$$

The results of the regression equation (3.3) and some other specifications are presented in Panel A of Table 3.5. Indeed, we observe a strong negative impact of *Netflow* on *Idiosyncratic* for all specifications. As in the case for aggregated total volatility, this impact is robust to the inclusion of the control variables. Unlike aggregated total volatility, aggregated idiosyncratic volatility is positively affected by *Size*. As the level of market development increases, the aggregated idiosyncratic volatility also increases. This result is consistent with the studies of Campbell et al. (2001) and Xu and Malkiel (2003) in which the aggregated idiosyncratic volatility is shown to have an increasing trend in developed markets.

The second channel of impact may be due to the local factors. In Figure 3.3, it is observed that the main source of aggregated total volatility is local volatility, in Turkey. As a dominant constituent of the total volatility, local volatility is a likely channel through which the effect of net flow emerges. Therefore, we examine the relationship between the *Local* and the *Netflow* in several specifications. The results are presented in Panel B of Table 3.5. As expected, a strong negative impact of *Netflow* on the *Local* is detected.

Finally, we check whether the global volatility contributes to the observed relationship between aggregated total volatility and net flow. We regress the *Global* only on the *Netflow*. The results in Panel C suggest that even when the *Netflow* enters into the regression equation alone, it cannot explain the *Global.* Thus, we conclude that net flow affects aggregated volatility through idiosyncratic and local volatilities.

Table 3.5
Volatility Components and the Net Flow

Panel A: Dependent Variable is Aggregated Idiosyncratic Volatility, *Idiosyncratic*				
Netflow	-0.3843***	-0.3348***	-0.3337***	-0.4972***
	(-2.8863)	(-3.4205)	(-3.4236)	(-3.6136)
Size		0.0312**	0.0309**	0.0453**
		(2.2255)	(2.2063)	(2.0647)
TO			0.0055	-0.0093
			(0.2955)	(-0.4128)
$Idiosyncratic_{t-1}$				-0.4124
				(-1.6080)
C	0.0150***	0.0058	0.0051	0.0090**
	(9.5562)	(1.6481)	(1.2334)	(2.0668)
Ad. R^2	0.1137	0.1751	0.1681	-0.0642
Panel B: Dependent Variable is Local Volatility, *Local*				
Netflow	-0.5630***	-0.5872***	-0.5751***	-0.6158***
	(-3.2039)	(-3.1589)	(-3.1668)	(-2.7310)
Size		-0.0153	-0.0185	-0.0154
		(-0.7105)	(-0.8971)	(-0.8310)
TO			0.0592**	0.0566**
			(2.1211)	(2.6145)
$Local_{t-1}$				0.0598
				(0.2970)
C	0.0246***	0.0291***	0.0216***	0.0164*
	(6.7498)	(4.5901)	(3.1334)	(1.6992)
Ad. R^2	0.0526	0.0480	0.0527	0.0534
Panel C: Dependent Variable is Global Volatility, *Global*				
Netflow	-0.0301	-0.0054		
	(-1.1797)	(-0.0643)		
$Global_{t-1}$		1.4580		
		(0.8639)		
C	0.0042***	-0.0018		
	(5.0748)	(-0.2452)		
Ad. R^2	-0.0040	-0.3461		

In Panel A, the results of the regressions of the aggregated idiosyncratic volatility on the previously defined control variables are presented. Regression models are estimated by GMM. *Idiosyncratic* is the aggregated residuals variance where residuals are obtained by the model, $\tilde{R}_{ilt} = \tilde{R}_{wt} + \tilde{\varepsilon}_{lt} + \varepsilon_{ilt}$, taking the global factors as the base. In Panel B, the dependent variable is *Local*, and it is the monthly residual variance of the following regression equation: $\tilde{R}_{lt} = \beta_{wl}\tilde{R}_{wt} + \tilde{\varepsilon}_{lt}$. In Panel C, *Global* is used as the dependent variable and is defined as $(2\hat{\beta}_{wl} - 1)\hat{\sigma}^2_{wt}$ where $\hat{\beta}_{wl}$ is the beta of country index return with respect to global index return, and $\hat{\sigma}^2_{wt}$ is the monthly return variance of the global index. The t-statistics are given in parentheses. *, **, and *** represent 10%, 5%, and 1% significance levels, respectively.

3.6 Robustness Checks

Our volatility decomposition methodology builds on the orthogonalized returns of the local and global indices. As discussed in Section 2.5, such an orthogonalization process may cause an overpurging problem. To check whether our results suffer from the overpurging problem, the order of the orthogonalization process is reversed and a new set of volatility components is derived. We use the new volatility components as the dependent variables in our regression equations that examine the influence channels of *Netflow* on the aggregated total volatility.

Table 3.6 provides the results of the regression of the dependent variables, which are constructed under the alternative order of orthogonalization, on the *Netflow* and the control variables. Again, in each panel, a different dependent variable (*Idiosyncratic*, *Local*, and *Global*) is examined. Under this order of orthogonalization, *Netflow* preserves its negative significant impact on the *Idiosyncratic* and *Local*. This impact is not affected by the inclusion of the control variables. On the other hand, a significant relationship between the *Global* and *Netflow* is not detected, which is also the case for the former order of orthogonalization. These findings are qualitatively the same as the ones of the previous section. Therefore, the effect of the *Netflow* on the volatility is independent of the order of orthogonalization. Thus, the potential overpurging problem does not seriously affect our results.

Table 3.6
Volatility Components and the Net Flow under the Alternative Order of Orthogonalization

Panel A: Dependent Variable is Aggregated Idiosyncratic Volatility, $\hat{\sigma}^2_{\zeta_{it}}$				
Netflow	-0.4441***	-0.3932***	-0.3925	-0.5921***
	(-3.0028)	(-3.5656)	(-3.5802)	(-3.8622)
Size		0.0321**	0.0319**	0.0479*
		(2.0682)	(2.0557)	(1.9699)
TO			0.0034	-0.0071
			(0.1734)	(-0.2968)
$\hat{\sigma}^2_{\zeta_{it-1}}$				-0.4090
				(-1.6221)
C	0.0172***	0.0076*	0.0072	0.0106**
	(9.9527)	(1.9366)	(1.5774)	(2.3981)
Ad. R^2	0.1333	0.1891	0.1819	-0.0716
Panel B: Dependent Variable is Local Volatility, $\hat{\sigma}^2_{lt}$				
Netflow	-0.6109***	-0.6420***	-0.6307***	-0.6428***
	(-3.7018)	(-3.7948)	(-3.7783)	(-3.1881)
Size		-0.0196	-0.0226	-0.0194
		(-0.9540)	(-1.1329)	(-1.1678)
TO			0.0553*	0.0489**
			(1.9632)	(2.2600)
$\hat{\sigma}^2_{lt-1}$				0.1144
				(0.6062)
C	0.0247***	0.0304***	0.0235***	0.0168*
	(6.7480)	(4.9189)	(3.4029)	(1.8478)
Ad. R^2	0.0638	0.0618	0.0650	0.0774
Panel C: Dependent Variable is Global Volatility, $\hat{\sigma}^2_{\varepsilon_{wt}}$				
Netflow	-0.0302***	-0.0148		
	(-3.8131)	(-1.1178)		
$\hat{\sigma}^2_{\varepsilon_{wt-1}}$		0.7573**		
		(2.3281)		
C	0.0015***	0.0004		
	(9.3994)	(0.8206)		
Ad. R^2	0.0826	0.2565		

In Panel A, the results of the regressions of $\hat{\sigma}^2_{\zeta_{it}}$ on the previously defined control variables are presented. Regression models are estimated by GMM. $\hat{\sigma}^2_{\zeta_{it}}$ is the aggregated idiosyncratic volatility of stocks in a month. Idiosyncratic volatility is the residuals variance where residuals are obtained by the model, $\tilde{R}_{ilt} = \tilde{R}_{lt} + \tilde{\varepsilon}_{wt} + \zeta_{ilt}$, taking the local factors as the base. In Panel B, $\hat{\sigma}^2_{lt}$ is the dependent variable, and it is the monthly return variance of the local index. In Panel C, $\hat{\sigma}^2_{\varepsilon_{wt}}$ is used as the dependent variable, and it is the monthly residual variance of the following regression equation: $\tilde{R}_{wt} = \beta_{lw}\tilde{R}_{lt} + \tilde{\varepsilon}_{wt}$. The t-statistics are given in parentheses. *, **, and *** represent 10%, 5%, and 1% significance levels, respectively.

Next, we use the model independent measure of idiosyncratic volatility of Bali et al. (2008) to see whether our results for aggregated idiosyncratic volatility are sensitive to the definition of idiosyncratic volatility. We form a value-weighted portfolio composed of the stocks in the IFCG index of Turkey as the non-diversified portfolio, and we use the ISE 100 index as the fully diversified portfolio. We repeat our tests with the alternative definition of idiosyncratic volatility, and the results are presented in Table 3.7. We still observe a sharp negative significant effect of *Netflow* on the *Idiosyncratic*. This effect persists under the control of explanatory variables. Thus, our finding of a negative significant relationship between *Idiosyncratic* and *Netflow* is replicated with a model-independent measure of idiosyncratic volatility.

Table 3.7
Alternative Definition of Aggregated Idiosyncratic Volatility and the Net Flow

Netflow	-0.2276	-0.1949**	-0.1957**	-0.3841***
	(-2.3671)	(-2.4763)	(-2.4814)	(-2.6582)
Size		0.0206*	0.0208*	0.0304*
		(1.9048)	(1.9333)	(1.7496)
TO			-0.0040	-0.0211
			(-0.2351)	(-0.6657)
$\hat{\sigma}^2_{\varepsilon_{it-1}}$				-0.5598
				(-1.2168)
C	0.0116***	0.0055*	0.0060	0.0107
	(8.7631)	(1.8020)	(1.4706)	1.4311
Ad. R^2	0.0736	0.1234	0.1159	-0.52226

The regression models, where $\hat{\sigma}^2_{\varepsilon_{it}}$ is the dependent variable, are estimated by GMM. $\hat{\sigma}^2_{\varepsilon_{it}}$ is the weighted average of monthly firm-specific return volatilities of stocks in a country. $\hat{\sigma}^2_{\varepsilon_{it}}$ is calculated by the difference between the variance of the non-diversified portfolio and the variance of the diversified portfolio as suggested by Bali et al. (2008). The t-statistics are given in parentheses. *, **, and *** represent 10%, 5%, and 1% significance levels, respectively.

3.7 Conclusion

It is important to understand the costs and benefits of foreign equity investment in stock exchanges, as this issue has crucial policy implications, especially for governments. The most important cost that is thought to be brought by foreign equity investment is the increase in return volatility in emerging markets. We specifically investigate the role of foreign equity flow on the aggregated total volatility and its components in the İSE.

The results show that aggregated total volatility is negatively related to the foreign equity flow, even after controlling for market development, liquidity, and volatility persistency effects. This finding suggests a two-way impact of foreign equity flow on the aggregated total volatility. While a positive net equity flow (inflow) has a decreasing impact on aggregated stock return volatility, a negative net equity flow (outflow) has an increasing impact. It is also found that net equity flow shows its effect on the aggregated total volatility through the aggregated idiosyncratic and local volatility. Similar results are obtained with the alternative order of orthogonalization in the volatility decomposition process and with the alternative model-independent definition of idiosyncratic volatility.

CHAPTER 4

DOES ADR LISTING AFFECT THE DYNAMICS OF VOLATILTY IN EMERGING MARKETS?

4.1 Introduction

An ongoing debate exists among economists over the effects of financial liberalization on volatility in emerging markets. On the one hand, some researchers claim that foreign fund flows are very sensitive to slight changes in local factors; thus they drive volatility upward (Jayaraman *et al*. (1993), Ko *et al.* (1997), Bae *et al.* (2004)). On the other hand, some studies show that foreign participation has no significant impact on return volatility (Howe and Madura (1990), Kim and Signal (2000) and Bekaert and Harvey (2000)) and some studies present evidence of volatility reduction after liberalization (De Santis and İmrohoroğlu (1997) and Hargis (2002)). A clear understanding of the role of foreign investors in the economy is crucial for policy makers. For instance, if foreign funds have negative impacts on the local economy or in the firm in which they are invested, restrictions on foreign fund movements can be put into use.

In this chapter, we study the impact of a particular liberalization at the firm level, namely American Depository Receipt (ADR) issuance, on the risk characteristics of underlying stock returns, in a time-series framework. ADR programs allow for cross-listing on US exchanges and thus give access to US investors. Whereas a large body of literature deals with stock price reaction to cross-listing[10], in this study we concentrate on the volatility effects of cross-listing. Specifically, we examine the changes in risk exposures, volatility dynamics, and long-run variances; and the mean level of the conditional volatility of ADR-issued stocks from several emerging markets.

The impact of liberalization on volatility at the aggregate level is analyzed by several studies. The conclusions drawn by these studies are mixed. Bekaert and Harvey (2000) report an ambiguous impact of liberalization on volatility. De Santis and İmrohoroğlu (1997) and Kim and Signal (2000) detect no significant increase in the conditional volatility of market index returns. Moreover, Hargis (2002) finds a decrease in aggregate-level volatility after liberalization in some Latin American countries. Another line of research focuses on indirect foreign ownership, which is inherent in cross-listed stocks. Howe and Madura (1990) examine the volatility around cross-listings, and report no significant change in the systematic and total risk characteristics of listed firms. Jayaraman, Shastri, and Tandon (1993) study the impact of ADR listing on the risk and return of the underlying stocks, and find that the variances of the cross-listed stocks are higher after listing, even after they adjusted for market volatility, for the October 1987 crash, and for the possible changes in return-generating processes. Lau, Diltz and Apilado (1994) conclude that firm volatility is not affected by international listing. Foerster and Karolyi (1999)

[10] See Alexander *et.al* (1988), Doidge *et.al* (2004), Domowitz *et.al* (1998), Errunza and Miller (2000, 2003), Miller (1999), and Varela and Lee (1993).

investigate the changes in risk exposure for the ADR initiations of several countries in a panel study. They find that, in the post-listing period for their overall sample, local market beta declines and no significant change occurs for the world market beta. Coppejans and Domowitz (2000) show that volatility of underlying stocks of Mexican ADRs increases after listing. Ramchand and Sethapakdi (2000) examine changes in systematic risk following global equity issues and find that US firms that issue equity abroad experience a decline in systematic risk subsequent to issuance.

Our study extends previous literature in several ways. First, we propose time-series methods to examine whether or not cross-listed stocks experience volatility changes after their listing. We employ GARCH models in volatility specifications to model the volatility clustering observed in the data. Neglecting the time variation in return volatility may result in model misspecification and inefficient estimates. Although some previous research examines the return volatility of market index returns using GARCH models, this is the first study to examine the return volatilities of ADR-issuing stocks in a time series setting. More specifically, we explore the changes in risk exposures that may stem from shifting from a segmented market to a more integrated market due to cross-listing. If the ADR issuance causes a stock's return to be correlated closer to the world factors, an increase in world risk exposure and a decrease in local risk exposure are expected. In order to test these assertions, we perform the conditional volatility models before and after the listing and search for differences in the local and global market beta.

Second, we extend the literature by investigating changes in the dynamics of the volatility of the cross-listed stocks over these two periods. This practice enables us to understand through which channels the long-run variance is affected. Third, we investigate the changes in systematic risks and conditional volatility around ADR initiations, simultaneously, for the whole period for each firm.

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

4.2 Background on ADRs

As our entire sample consists of ADRs, we provide some of their characteristics for a clear understanding of the data. The definition, properties, establishment mechanism, advantages, and potential disadvantage of ADRs are discussed in this section[11].

ADRs are negotiable certificates that are listed on organized exchanges or on the over-the-counter markets in the USA. An ADR holder obtains ownership of shares of the foreign firms traded in their local markets. Thus an ADR holder has all the rights (such as dividend and voting rights) that result from ownership of the shares. ADRs are created through the following process. First a broker purchases a non-US company's stocks in the local stock market. These stocks are submitted to the depositary's local custodian bank. Then administrated depositary banks (such as Citibank or the Bank of New York) issue receipts (ADRs) against the underlying local shares on the US exchanges or on the over-the-counter markets. ADRs are treated as US securities, which are denominated and pay dividends in US dollars.

[11] More information about ADRs can be found on the Web site of the Bank of New York. (www.adrbny.com).

There are several types of ADR programs. Level I ADR program is the easiest way to access US capital markets because establishment of this program does not require full SEC registration or compliance with US Generally Accepted Accounting Principles (GAAP). Level I ADRs are traded on the over-the-counter (OTC) market. Level II and Level III ADRs are traded on organized stock exchanges such as NYSE, AMEX and NASDAQ. Both Level II and Level III ADR programs require SEC disclosure and compliance with US GAAP. While Level III ADR programs are for raising capital, Level I and Level II ADR programs do not involve raising capital. Another way of accessing US capital markets or others is through SEC Rule 144A or Regulation S Depository Receipt. Both Rule 144A and Regulation S programs are capital raising programs. While the trades for 144A program take place through the PORTAL quote system, Regulation S program allows raising capital through the placement of depository receipts offshore to non-US investors.

There are many advantages of the ADR program for both issuers and holders. From the ADR issuer's point of view, expanded market share, increased investor recognition, increased liquidity, and cheaper access to international markets can be major benefits. Holders can benefit from ADRs by eliminating the expense and complexities of investing directly in markets other than in the USA and diversifying their portfolio internationally. On the other hand, one possible disadvantage that ADR issuing firms may face is the volatility increase. Higher volatility hurts firms since it increases their cost of capital.

4.3 Data and Diagnostics

Our data set consists of first-time ADR listings of twelve emerging markets from 1990-2006. We use an event window of a minimum of 260 days (130 days before and after ADR-listing) taking the issuance date as the event date. The event window is extended up to 520 days depending on available data. The ADR data set is obtained from the Bank of New York and contains a complete list of ADRs with information on the country, industry, type of depositary receipt, and effective date. Effective dates (ADR-listing dates) are used as event dates. The data on daily closing prices for underlying shares of the local market, local market index return, and global market index return are obtained from Datastream Advance 3.5. To construct our sample, we screened our data in the following ways. First, the issue of the first-time depository receipt listing in the USA was considered in order to capture the effects of the initiation of foreign investment on the underlying securities. Second, firms that are not tracked by Datastream or do not have daily closing price information covering the event window are dropped from the sample.

We performed diagnostic tests to detect volatility clustering and included only those firms that exhibit time variation in volatility. Volatility clustering is detected by examining the residuals and squared residuals of the following international asset-pricing model.

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

In the above regression, the returns of each ADR-issuing firm are regressed on both the local and world market index returns. Autocorrelation tests are performed on the residuals through Ljung-Box Q-statistics. Some summary statistics describing our final sample are provided in Table 1. Our sample consists of 72 stocks from twelve emerging markets in Asia, Latin America, and Eastern Europe. Most of the listings take place through the 144A program on the PORTAL. This may be due to the fact that the 144A program does not require SEC disclosure and GAAP reporting.

The mean level of market capitalization of the cross-listed firms in our sample is \$2508 million, suggesting that the ADR-issuing firms are big.

4.4 Comparison of Pre- and Post-listing Periods in a Time-Series Framework

In this section we investigate the effect of ADR listing on the risk characteristics of the listed firms. We test whether or not a systematic change occurs after the listing date in the levels of local market beta, world market beta, dynamics of time-varying volatility, and long-run volatility of the cross-listed firms. Unlike previous studies in cross-listing literature, we employ a GARCH framework to model the conditional heteroscedasticity. The GARCH family of models has many appealing characteristics. They capture the time variation of volatility, which is an important empirical feature of return distributions. They also have long-run forecasting abilities in that they capture the concept of mean reversion with the help of a constant intercept term. Although, in the literature, time-varying volatility models are used to examine the effect of market liberalizations on aggregate-level volatility, ours is the first study to account for the time variation in volatility at the firm level. For this purpose, we estimate the following models for the periods before and after the ADR issuance date for each firm in our sample:

$$R_t = \beta_0 + \beta_1 R_{L_t} + \beta_2 R_{M_t} + \varepsilon_t \tag{4.1}$$

$$h_t = \omega_t + \gamma_1 \varepsilon^2{}_t + \gamma_2 h_{t-1} \tag{4.2}$$

where R_t is the daily log return, R_{Lt} is the local market index return, and R_{Mt} is the world market index return.

Table 4.1
Summary Statistics

Panel A
Distribution By Industry

Industry	Frequency
Aerospace & Defense	1
Automobiles & Parts	3
Banks	3
Chemicals	1
Construc. & Materials	3
Electricity	1
Electric Equip.	4
Fixed Line Telecom	6
Food & Drug Retailers	1
Food Producers	3
Forestry & Paper	2
Gas,H_2O & Multiutility	1
General Finance	2
General Retailers	1
Household Goods	2
Industrial Engineering	2
Industrial Metals	6
Industrial Transport	1
Leisure goods	1
Oil & Gas Producers	1
Personal Goods	3
Tech.Hardware, Equip.	21
Travel & Leisure	3

Panel B
Distribution By Country

Country	Frequency
Argentina	2
Brazil	15
Chile	1
Greece	2
Hungary	1
Indonesia	1
Korea	10
Malaysia	2
Mexico	4
Singapore	4
Taiwan	29
Turkey	1

Panel C
Distribution By Listing Year

Listing Year	Frequency
1991	2
1992	1
1993	3
1994	2
1995	2
1996	3
1997	6
1998	3
1999	7
2000	9
2001	3
2002	8
2003	17
2004	2
2005	4

Panel D
Distribution By Listing Exchange

Listing Exchange	Frequency
NYSE	14
NASDAQ	5
Portal	35
OTC	16
Offshore	2

Panel E
Distribution By Type of ADR

Type of ADR	Frequency
Level I	16
Level II	10
Level III	9
144A	35
Reg S	2

Panel F
Market Capitalization ($millions)

Descriptive Statistics	
Mean	2508.058
Median	1244.91
Maximum	30301.81
Minimum	10.64378

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

4.4.1 The Effect of ADR Listing on Systematic Risk

Table 4.2 reports the averages of local and global market betas before and after the listings along with location-difference test results. Location-difference tests are performed to determine if ADR listing causes any significant change in systematic risk. As sample sizes in some countries are rather small, we perform both non-parametric and parametric tests. A non-parametric Wilcoxon Mann-Whitney test is employed to test the null hypothesis that the local market beta is identically distributed with respect to the median, before and after the listings.

The results show that ADR issuance does not significantly change the local and world market betas in any of the countries. We conducted the tests over three regional groupings: Asia, Latin America, and Eastern Europe and found no significant changes in risk characteristics due to ADR listing. Finally, we pooled all the ADR-issuing firms and conduct these tests over the whole sample. Similarly, both parametric and non-parametric test results show no statistically significant changes in systematic risks. Consequently, the results in Table 4.2 suggest that ADR listing does not change the systematic risks of the ADR-issuing firms. These results are in line with those of Howe and Madura (1990) and Jayaraman, Shastri and Tandon (1993), but are in contrast to those of Foerster and Karolyi (1999).

Table 4.2
Difference Tests of Risk Exposures

Panel A	**Changes in Local Market Beta**			
Location	Pre-listing Mean Local Market Beta	Post-listing Mean Local Market Beta	Parametric Mean Difference t-test	Nonparametric Wilcoxon/Mann-Whitney Test
Brazil	0.71	0.75	-0.33	0.06
Korea	0.91	0.90	0.07	0.04
Taiwan	0.96	1.07	-1.50	1.38
Others	0.89	0.84	0.50	0.00
Asia	0.93	1.01	-1.24	1.18
Latin America	0.81	0.80	0.12	0.02
Eastern Europe	0.85	0.71	0.91	0.43
All	0.89	0.92	-0.72	0.77

Panel B	**Changes in Global Market Beta**			
Location	Pre-Listing Mean Global Market Beta	Post-Listing Mean Global Market Beta	Parametric Mean Difference t-test	Nonparametric Wilcoxon/Mann-Whitney Test
Brazil	0.01	0.25	-0.77	0.77
Korea	-0.14	0.04	-1.27	0.87
Taiwan	0.08	-0.02	1.38	1.40
Others	0.03	-0.01	0.47	0.18
Asia	0.02	-0.01	0.54	0.84
Latin America	0.01	0.04	-0.31	0.56
Eastern Europe	0.10	0.13	-0.21	-0.14
All	0.02	0.01	0.23	0.33

Panel A and B provide the mean of the local market beta, global market beta, respectively, across stocks in a country or region before and after the listing date. The Others category includes the stocks from Argentina, Chile, Greece, Hungary, Indonesia, Malaysia, Mexico, Singapore and Turkey. For each stock, the local and global market betas are estimated from the following regression equations for pre- and post-listing periods:

$$R_t = \beta_0 + \beta_1 R_{L_t} + \beta_2 R_{M_t} + \varepsilon_t$$
$$h_t = \omega_t + \gamma_1 \varepsilon^2_t + \gamma_2 h_{t-1}$$

* indicates 10% significance level.

4.4.2 The Effect of ADR listing on Time-series Volatility Dynamics

Jayaraman, Shastri and Tandon (1993) and Howe and Madura (1990) investigate volatility changes due to cross-listing. However, their methodology ignores the time-series dynamics of volatility. Ignoring the time variation in volatility may result in a model misspecification problem. Here, our main focus is to investigate the impact of cross-listing on volatility dynamics. However, for comparison with documented evidence in the literature, we first performed a standard F-test by assuming a constant variance throughout the pre- and post-listing periods. The frequencies of F-statistics at the 5% significance level are reported in Table 4.3. For example, although four out of 15 ADR listing firms in Brazil exhibit a statistically significant decrease in volatility, six of them show a statistically significant increase, and the remaining five stocks do not exhibit a significant change. There are almost as many significant rises as there are significant drops, suggesting that the effect of cross-listing on return volatility is unclear. The results of the F-tests in this paper parallel those of F-tests in previous literature (see Howe and Madura (1990), Lau, Diltz and Apilado (1994), and Martell, Rodriguez and Webb (1999)).

Next we employ GARCH methodology to examine whether or not there is a change in the coefficients of the conditional volatility equation. More specifically, the pre-listed, estimated coefficients of the intercept, ARCH, and GARCH terms in equation (2) are compared with their post-listed values. This methodology allows us to model the time variation in volatility and to capture its impact on the results. Table 4 summarizes the mean levels of intercept, ARCH, and GARCH terms for pre- and post-listing periods. As can be seen, the parametric tests indicate a significant

Table 4.3
Comparison of Pre- and Post-listing Variances

	Distribution of F-Statistic Frequencies		
Location	$F \leq F_{0.025}$	$F_{0.025}<F<F_{0.975}$	$F_{0.975} \leq F$
Brazil	4	5	6
Korea	3	3	4
Taiwan	6	14	9
Others	6	6	6
Asia	12	20	14
Latin America	6	7	9
Eastern Europe	1	1	2
All	19	28	25

F-tests are performed to examine if pre-listing return variance is equal to that of post-listing for each stock. The frequencies of F-statistics at the 5% significance level are reported.

difference in the ARCH term for Latin America, the intercept, and the GARCH terms for the "Others" category. However, the non-parametric tests do not signal any significant changes for all of the categories in our sample. As the non-parametric tests are more reliable in small samples, we can conclude that there are no significant changes in volatility dynamics due to cross-listing

ADR listing is an important event that changes the channels and ways of information processing, thus its effects on long-run dynamics are also important. The long-run variances can be estimated from GARCH (1,1) with the following equation:

$$LRV = \frac{\omega}{1-\gamma_1-\gamma_2} \tag{4.3}$$

where ω is the constant term, γ_1 is the coefficient for the ARCH term, and γ_2 is the coefficient for the GARCH term in equation (4.2). Our findings of no significant changes in the intercept, ARCH, and GARCH terms imply that there are no changes in the long-run volatility.

Table 4.4
Difference Tests of Volatility Dynamics

Panel A	**Intercept**			
Location	Pre-listing Mean Intercept ($x10^{-3}$)	Post-listing Mean Intercept ($x10^{-3}$)	Parametric Mean Difference t-test	Nonparametric Wilcoxon/Mann-Whitney Test
Brazil	0.16	0.13	0.54	0.95
Korea	0.39	0.35	0.30	0.11
Taiwan	0.12	0.11	0.28	0.16
Others	0.09	0.19	2.08**	1.15
Asia	0.17	0.19	0.43	0.81
Latin America	0.14	0.11	0.70	1.44
Eastern Europe	0.07	0.20	1.63	1.01
All	0.16	0.17	0.29	0.17

Panel B	**ARCH Term**			
Location	Pre-listing Mean ARCH Coefficient	Post-listing Mean ARCH Coefficient	Parametric Mean Difference t-test	Nonparametric Wilcoxon/Mann-Whitney Test
Brazil	0.17	0.12	0.30	0.54
Korea	0.21	0.16	0.73	0.87
Taiwan	0.11	0.11	0.27	0.03
Others	0.18	0.18	0.07	0.08
Asia	0.13	0.14	0.62	0.33
Latin America	0.19	0.12	1.88*	1.26
Eastern Europe	0.25	0.15	1.54	1.30
All	0.16	0.14	0.97	0.73

Panel C	**GARCH Term**			
Location	Pre-listing Mean GARCH Coefficient	Post-listing Mean GARCH Coefficient	Parametric Mean Difference t-test	Nonparametric Wilcoxon/Mann-Whitney Test
Brazil	0.61	0.69	0.79	0.46
Korea	0.53	0.56	0.24	0.04
Taiwan	0.67	0.68	0.12	0.30
Others	0.64	0.50	1.81*	1.57
Asia	0.65	0.59	1.04	1.13
Latin America	0.60	0.70	1.38	1.23
Eastern Europe	0.59	0.46	0.65	0.43
All	0.63	0.62	0.35	0.44

Panel A, B and C provide the mean of the intercept, ARCH coefficient, and GARCH coefficient, respectively, across stocks in a country, region and the overall sample before and after the listing date. The Others category includes stocks from Argentina, Chile, Greece, Hungary, Indonesia, Malaysia, Mexico, Singapore and Turkey. For each stock intercept, ARCH, and GARCH terms are estimated from the following regression equations for pre- and post-listing periods:

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

$$h_t = \omega_t + \gamma_1 \varepsilon^2{}_t + \gamma_2 h_{t-1}$$

** and * indicate 5% and 10% significance level, respectively.

4.5 Conditional Volatility Models with ADR-listing Dummy

In this section we test the effect of ADR listing on risk for individual firms, using conditional volatility models with a listing-time dummy. We estimate the following modified equations by using a full data set for each firm.

$$R_t = \beta_0 + \beta_1 R_{L_t} + \beta_2 D * R_{L_t} + \beta_3 R_{W_t} + \beta_4 D * R_{w_t} + \eta_t \quad (4.4)$$

$$h_t = \mu + \gamma_1 \eta^2{}_t + \gamma_2 h_{t-1} + \gamma_3 D_t \quad (4.5)$$

where D is the dummy variable, which takes a value of 0 before the ADR listing date and 1 afterwards. In this specification, the significance of γ_3 determines whether or not the mean level of conditional volatility changes after the listing. Meanwhile, the time dummy enters the mean equation via interaction terms. These interaction terms detect changes in the systematic risk before and after the listing date. A positive and significant coefficient for the interaction term is interpreted as an increase in the particular risk exposure after the listing date, and vice versa. This allows us to do robustness checks on our previous results.

The summary results are presented in Table 4.5 (full estimation results for each firm in the sample can be found in Table 4.6 in the Appendix). For example, in Taiwan, although four out of 29 listed firms experienced a statistically significant decrease in their local market betas, nine firms experienced a significant increase. The remaining 16 firms do not encounter any significant change in their local market betas. The results of the overall sample show that there is no significant change in the local market beta after the listing date for 45 out of 72 firms. However, we find 12 significant decreases and 15 significant increases for the local market beta. As the numbers of positive and negative significant changes do not predominantly overweigh each other, it is hard to conclude that ADR listing affects the local market beta. The findings are similar for the world market beta; 85% of the firms do not undergo a significant change in world market beta. Thus we conclude that there is no change in the systematic risk exposures of the ADR-listed firms. This result is in line with our previous findings.

Furthermore, we focus on the time dummy in the variance equation to see the effects of the listing on the mean level of conditional volatility. The general criticism about liberalization is that it drives volatility upward. So if this assertion is true, an increase in volatility after the listing should be observed. However, a vast number of firms (55 out of 72) exhibit no significant change. Only two firms have a significant positive coefficient, and five firms have a significant negative coefficient for the time dummy. These findings suggest that conditional volatility is not affected by ADR listing either.

Table 4.5
Summary Results of t-statistics for the GARCH(1,1) Model with ADR-listing Dummy

	t-statistic Frequencies								
	β_2			β_4			γ_3		
Location	$t \le t_{0.05}$	$t_{0.05} < t < t_{0.95}$	$t \ge t_{0.95}$	$t \le t_{0.05}$	$t_{0.05} < t < t_{0.95}$	$t \ge t_{0.95}$	$t \le t_{0.05}$	$t_{0.05} < t < t_{0.95}$	$t \ge t_{0.95}$
Brazil	2	11	2	1	14	0	2	12	1
Korea	1	8	1	0	9	1	0	10	0
Taiwan	4	16	9	6	21	2	2	27	0
Others	5	10	3	0	17	1	1	16	1
Asia	7	28	11	6	37	3	2	44	0
Latin America	3	16	3	1	20	1	3	18	1
Eastern Europe	2	1	1	0	4	0	0	3	1
All	12	45	15	7	61	4	5	65	2

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

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

$$h_t = \mu + \gamma_1 \eta^2{}_t + \gamma_2 h_{t-1} + \gamma_3 D_t$$

The frequency of t-statistics at the 10% significance level is reported for the coefficients of interaction and dummy terms, namely β_2, β_4 and γ_3. Full estimation results for each stock are presented in the Appendix.

4.6 Conclusion

In this chapter, we investigate whether or not ADR listing affects the volatility dynamics and risk characteristics of the stocks in their local markets. Unlike previous studies, we employ a time-series framework to handle the impact of cross-listing on the return volatility of the underlying shares in the context of ADRs from emerging markets. We perform our analysis on the pre- and post-listing periods separately to compare the risk characteristics of the two periods. We find that there is no statistically significant change in the local and global market betas after cross-listing. Moreover, we document no significant change in the dynamics of the volatility due to listing. Therefore we conclude that the ADR listing of stocks does not lead to an increase in the risk characteristics of the underlying shares.

Our results have important implications for portfolio managers, policy makers, and firms' financial managers. Share holders of these stocks are not subject to adverse volatility effects due to listing. Therefore portfolios that contain these stocks will not experience a change in their risk return profiles. Moreover, volatility also has implications for the firm's financing decisions, as it directly affects the firm's cost of capital. Since ADR issuing firms do not experience significant volatility change, it is unlikely that managers' financing decisions are altered due to the volatility impact of ADR issuance.

CHAPTER 5

CONCLUSION

The main motivation behind analyzing foreign investor participation in emerging equity markets is the change in market dynamics when shifting from a segmented market to an integrated market[12]. As the foreign funds flow into the local capital markets, and thus the local markets become more integrated into global capital markets, the exposure of local assets to local and global factors changes. As one of the consequences, the components of the volatility and the volatility induced by these factors might be subject to change in the transition from a segmented market to an integrated market through financial liberalization and the inflow of foreign equity investment.

We address the question that whether the degree of financial liberalization affects the aggregated total volatility of stock returns by considering the time-varying nature of financial liberalization in the second chapter. We explore the channels through which the degree of financial liberalization impacts aggregated total volatility and find a positive relation to the degree of financial liberalization, after controlling for

[12] In the seminal works of Solnik (1974) and Stehle (1977), a market is considered to be integrated when there are no barriers to international capital flows. In the review study of Bekaert and Harvey (2002), financial integration is defined as the free access of foreigners to local capital markets and of local investors to foreign capital markets.

size, liquidity, country, and year effects. Moreover, we find that the degree of financial liberalization impacts the aggregated total volatility through aggregated idiosyncratic and local volatility. We obtain similar results with the alternative order of orthogonalization in the volatility decomposition process and with the alternative model-independent definition of idiosyncratic volatility.

In the third chapter, we study the effects of foreign equity investment on the return volatility of stocks by using aggregate foreign equity flow data which is publicly available for İstanbul Stock Exchange (İSE). We investigate the ways the aggregated total volatility may be affected in İSE by applying the volatility decomposition methodology introduced in the second chapter. We find that aggregated total volatility is negatively related to the net equity flow under the control of market development, liquidity, and volatility persistency effects. Furthermore, net equity flow shows its effect on the aggregated total volatility through the local and the aggregated idiosyncratic volatility which were also shown to be the channels of influence for the degree of financial liberalization in the previous chapter. A negative relation between the net equity flow and the aggregated total volatility implies a two-way impact. While a positive net equity flow (inflow) has a decreasing impact on aggregated stock return volatility, a negative net equity flow (outflow) has an increasing impact.

In the fourth chapter, we analyze the effects of financial liberalization at the firm level. More specifically, we investigate the time-series variation in return volatility of non-US stocks that are cross-listed on US exchanges. Unlike previous studies in cross-listing literature, return volatility is modeled using conditional heteroscedasticity models. We find that firms' exposure to risks such as local and global market betas remain unchanged after cross-listing. Moreover, we identify no change in the dynamics of the volatility of cross-listed stocks after cross-listing. Furthermore we show that the mean level of conditional variance is not affected by the decision to cross-list. Thus our results provide counter evidence to the belief that cross-listing drives volatility upward.

The results at the aggregate level have important implications for government policy makers when deciding whether or not to impose regulatory restrictions over foreign equity investment. The results at the firm level have implications for financial managers of firms who try to understand the cost and benefits of opening their stocks to foreign investors.

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APPENDIX A

Because the potential exists for an overpurging problem for the local factors under the introduced order of orthogonalization in Section 2.2, the global index return is now isolated in a component that is not correlated with the local index return through the following linear regression:

$$\tilde{R}_{wt} = \beta_{lw}\tilde{R}_{lt} + \tilde{\varepsilon}_{wt} \ . \tag{A1}$$

The modified market model is now formulated as

$$\tilde{R}_{ilt} = \beta_{iw}\tilde{\varepsilon}_{wt} + \beta_{il}\tilde{R}_{lt} + \tilde{\zeta}_{ilt} \tag{A2}$$

where $\beta_{il} = \text{cov}(\tilde{R}_{ilt}, \tilde{R}_{lt}) / \text{var}(\tilde{R}_{lt})$, $\beta_{iw} = \text{cov}(\tilde{R}_{ilt}, \tilde{\varepsilon}_{wt}) / \text{var}(\tilde{\varepsilon}_{wt})$, and $\tilde{R}_{lt} = \sum_{i \in l} w_i \tilde{R}_{ilt}$.

Note that $\sum_{i \in l} w_i \beta_{il} = \text{cov}(\sum_{i \in l} w_i \tilde{R}_{it}, \tilde{R}_{lt}) / \text{var}(\tilde{R}_{lt}) = \text{cov}(\tilde{R}_{lt}, \tilde{R}_{lt}) / \text{var}(\tilde{R}_{lt}) = 1$.

Similarly, $\sum_{i \in l} w_i \beta_{iw} = \text{cov}(\sum_{i \in l} w_i \tilde{R}_{it}, \tilde{\varepsilon}_{wt}) = \text{cov}(\tilde{R}_{lt}, \tilde{\varepsilon}_{wt}) = 0$ because $\tilde{R}_{lt}$ and $\tilde{\varepsilon}_{wt}$ are orthogonal by construction.

A similar version of Campbell et al.'s (2001) market-adjusted model is introduced as follows:

$$\tilde{R}_{ilt} = \tilde{R}_{lt} + \tilde{\varepsilon}_{wt} + \zeta_{ilt} \, . \tag{A3}$$

Equating (A2) to (A3) produces the following equality that shows in which channel the two equations are related:

$$\zeta_{ilt} = \tilde{R}_{lt}(\beta_{il} - 1) + \tilde{\varepsilon}_{wt}(\beta_{iw} - 1) + \tilde{\zeta}_{ilt} \, . \tag{A4}$$

Taking the variance of (A3) yields

$$\operatorname{var}(\tilde{R}_{ilt}) = \operatorname{var}(\tilde{R}_{lt}) + \operatorname{var}(\tilde{\varepsilon}_{wt}) + \operatorname{var}(\zeta_{ilt}) + 2\operatorname{cov}(\tilde{R}_{lt}, \zeta_{ilt}) + 2\operatorname{cov}(\tilde{\varepsilon}_{wt}, \zeta_{ilt}) \, . \tag{A5}$$

Now, inserting (A4) in (A5) for covariance terms only and rearranging results in the following:

$$\operatorname{var}(\tilde{R}_{ilt}) = \operatorname{var}(\tilde{R}_{lt}) + \operatorname{var}(\tilde{\varepsilon}_{wt}) + \operatorname{var}(\zeta_{it}) + 2(\beta_{il} - 1)\operatorname{var}(\tilde{R}_{lt}) + 2(\beta_{iw} - 1)\operatorname{var}(\tilde{\varepsilon}_{wt}) \, . \tag{A6}$$

Aggregating (A6) over i in country l yields the following aggregate level volatility decomposition after necessary cancellations:

$$\begin{aligned} \sum\nolimits_{i \in l} w_i \operatorname{var}(\tilde{R}_{ilt}) &= \operatorname{var}(\tilde{R}_{lt}) - \operatorname{var}(\tilde{\varepsilon}_{wt}) + \sum\nolimits_{i \in l} w_i \operatorname{var}(\zeta_{ilt}) \\ &= \sigma^2_{lt} - \sigma^2_{\varepsilon_{wt}} + \sigma^2_{rt} \end{aligned} \tag{A7}$$

where $\sigma^2{}_{lt}$ is the return variance of the local market portfolio, $\sigma^2{}_{\varepsilon_{wt}}$ is the return variance of the component of the global market portfolio that is isolated from local effects, and $\sigma^2{}_{rt}$ is the aggregated firm-specific residuals obtained from the market-adjusted model in (A3). Equation (A7) summarizes the aggregated total volatility decomposition of an average stock in a local market portfolio.

Estimation details of the volatility components in (A7) can be summarized as follows: The return variance of the local index is computed as

$$Local = \hat{\sigma}^2_{lt} = \sum\nolimits_{s\in t} (R_{ls} - \mu_l)^2 \tag{A8}$$

where μ_l is the mean of the local index return. The variance of the global index return that is isolated from the local index return is computed by summing up the squares of the world-specific residuals of equation (A1) within period t. More explicitly, it is computed as

$$Global = \hat{\sigma}^2_{\varepsilon w_{lt}} = \sum\nolimits_{s\in t} \hat{\varepsilon}^2_{w_{ls}} \; . \tag{A9}$$

For estimating the idiosyncratic volatility component, first we sum up the squares of the firm-specific residuals in equation (A3) for each firm within period t:

$$\hat{\mathrm{var}}_{\zeta_{ilt}} = \sum\nolimits_{s\in t} \hat{\zeta}^2_{ils} \; . \tag{A10}$$

Next, we aggregate equation (A10) over the firms in a market, to reach value-weighted idiosyncratic volatility estimates,

$$Idiosyncratic = \hat{\sigma}^2_{\zeta_{lt}} = \sum\nolimits_{i\in l} w_{it} \; \hat{\mathrm{var}}(\zeta_{ilt}) \; . \tag{A11}$$

In the regression analysis framework, we use the volatility components as dependent variables to understand the impact channels of net equity flow.

APPENDIX B

Table B.1 Changes in Risk Exposures and Conditional Volatility after ADR-listing

Stocks	Country	β_0 (x10^{-3})	β_1	β_2	β_3	β_4	μ (x10^{-3})	γ_1	γ_2	γ_3 (x10^{-3})
Mirgor 'C'	Argentina	1.33	0.67[a]	-0.23	0.08	0.22	0.07	0.12[c]	0.74[a]	-0.01
		(1.02)	(4.92)	(-1.39)	(0.29)	(0.54)	(1.11)	(1.71)	(4.52)	(-0.31)
Siderar 'A'	Argentina	2.80[b]	0.70[a]	0.02	0.02	0.14	0.23[c]	0.21[c]	0.41[c]	-0.06
		(2.22)	(4.22)	(0.08)	(0.10)	(0.39)	(1.80)	(1.81)	(1.68)	(-0.80)
Acesita Pn	Brazil	-0.46	1.33[a]	-0.16	-0.42[c]	0.28	0.09[c]	0.11[c]	0.77[a]	-0.02
		(-0.34)	(7.79)	(-0.86)	(-1.67)	(0.85)	(1.83)	(1.75)	(7.43)	(-0.84)
Banco Ita.Hld.	Brazil	-0.42	0.97[a]	0.36[a]	-0.09	-0.31[c]	0.05	0.11[c]	0.71[a]	0.01
		(-0.46)	(20.32)	(4.42)	(-0.63)	(-1.67)	(1.25)	(1.83)	(3.83)	(0.80)
Bombril Pn	Brazil	-2.71[c]	0.08	0.14	0.45	0.18	0.37[a]	0.38[a]	0.22	0.31
		(-1.68)	(0.59)	(0.77)	(1.20)	(0.30)	(2.97)	(2.75)	(1.45)	(1.45)
Brasil Tel. Pn	Brazil	0.80	1.13[a]	-0.04	-0.15	0.32	0.37[a]	0.22	0.02	-0.20[a]
		(0.93)	(13.92)	(-0.35)	(-0.80)	(1.39)	(4.36)	(1.49)	(0.12)	(-2.82)
C.Brasil.Dist.Pn	Brazil	0.17	0.10	0.14	0.31[c]	0.66	0.04[c]	0.34[a]	0.52[a]	0.16[b]
		(0.25)	(1.38)	(1.02)	(1.88)	(1.19)	(1.80)	(2.59)	(3.87)	(2.28)
Coteminas Pn	Brazil	1.30	0.72[a]	-0.18	-0.11	0.27	0.26[a]	0.17[b]	0.38[b]	0.00
		(1.22)	(10.07)	(-1.53)	(-0.82)	(1.00)	(2.76)	(2.06)	(1.98)	(0.08)
Vale D.R.D Pna	Brazil	0.22	0.68[a]	0.03	0.09	-0.00	0.04[b]	0.08[a]	0.84[a]	-0.02[c]
		(0.26)	(6.96)	(0.25)	(0.41)	(-0.01)	(2.27)	(2.74)	(15.48)	(-1.93)
Embraer On	Brazil	2.43	0.85[a]	0.01	-0.14	0.08	0.28[b]	0.19[b]	0.50[a]	-0.07
		(1.55)	(6.69)	(0.05)	(-0.47)	(0.21)	(2.02)	(2.21)	(2.91)	(-0.84)
Iochp-Max .Pn	Brazil	2.65[c]	0.50[a]	0.04	0.45	-0.32	0.13	0.07[b]	0.87[a]	-0.08
		(1.71)	(5.33)	(0.40)	(0.88)	(-0.46)	(1.35)	(2.02)	(13.00)	(-1.23)
Perdigao Pn	Brazil	-0.21	0.53[a]	-0.13	0.01	0.11	0.32	0.11	0.51	-0.20
		(-0.18)	(3.77)	(-0.80)	(0.03)	(0.29)	(0.90)	(0.74)	(0.94)	(-0.90)
Petr. Disb.Pn	Brazil	1.11	0.85[a]	0.06	-0.10	-0.20	0.15[c]	0.11[b]	0.58[c]	-0.04
		(1.27)	(10.52)	(0.49)	(-0.54)	(-0.88)	(1.69)	(2.01)	(2.80)	(-1.01)
Sabesp ON	Brazil	-1.16	0.95[a]	0.13	0.11	-0.40	0.07	0.08[b]	0.80[a]	-0.01
		(-0.91)	(7.65)	(0.87)	(0.43)	(-1.32)	(1.53)	(2.11)	(7.71)	(-0.41)
Suzano Pet. Pn	Brazil	0.48	0.71[a]	0.30[c]	-0.13	0.54	0.12[c]	0.16[b]	0.70[a]	-0.01
		(0.32)	(9.38)	(1.70)	(-0.65)	(1.52)	(1.94)	(2.26)	(6.30)	(-0.26)
Usiminas Pna	Brazil	-0.95	0.95[a]	-0.18[b]	0.37	-0.63	0.05	0.07[b]	0.89[a]	-0.04
		(-0.88)	(15.77)	(-2.22)	(0.81)	(-1.23)	(1.38)	(2.46)	(17.89)	(-1.34)
VCP PN	Brazil	0.94	0.62[a]	-0.17[b]	-0.17	0.35	0.02	0.04	0.93[a]	-0.00
		(1.01)	(9.73)	(-2.06)	(-0.82)	(1.43)	(0.98)	(1.63)	(19.02)	(-0.70)
LAN	Chile	1.31	1.46[b]	-0.49	-0.34[a]	0.58[b]	0.05	0.17[b]	0.66[a]	0.03
		(1.46)	(5.56)	(-1.38)	(-2.58)	(2.11)	(1.33)	(2.01)	(3.90)	(1.15)
Blue Star M.	Greece	-0.97	0.66[a]	0.32[b]	-0.08	-0.01	0.14[b]	0.18[a]	0.62[a]	0.06
		(-0.84)	(7.39)	(2.84)	(-0.56)	(-0.05)	(2.37)	(3.07)	(4.91)	(0.94)
OTE-Hel.Tel.	Greece	-1.27[b]	0.95[a]	-0.10[c]	0.06	0.03	0.12[a]	0.18[a]	0.14	0.08[c]
		(-1.99)	(25.12)	(-1.66)	(0.78)	(0.19)	(2.65)	(2.96)	(0.55)	(1.86)
NABI	Hungary	0.91	0.95	-0.35	0.23	-0.18	0.07	0.17	0.77	-0.04
		(0.99)	(10.34)	(-2.89)	(0.96)	(-0.62)	(2.61)	(4.24)	(17.59)	(-1.80)
Toba Pulp L.	Indonesia	0.34	0.95[a]	0.33	-0.05	-0.06	0.17	0.04	0.87[a]	-0.08
		(0.15)	(2.92)	(0.70)	(-0.28)	(-0.17)	(0.80)	(0.82)	(5.91)	(-0.77)

Table B.1 (continued) Changes in Risk Exposures and Conditional Volatility after ADR-listing

Stocks	Country	β_0 ($x10^{-3}$)	β_1	β_2	β_3	β_4	μ ($x10^{-3}$)	γ_1	γ_2	γ_3 ($x10^{-3}$)
Digiwave Tec.	Korea	-0.76	0.75[a]	-0.18	-1.07[c]	0.79	0.93[c]	0.18[b]	0.24	0.30
		(-0.33)	(4.23)	(-0.48)	(-1.69)	(0.77)	(1.81)	(2.38)	(0.73)	(0.95)
Hanaro Tel.	Korea	-3.30	0.71[a]	0.06	0.08	-0.21	0.36[a]	0.28[a]	0.45[a]	0.07
		(-2.12)	(7.30)	(0.43)	(0.21)	(-0.37)	(2.68)	(2.68)	(2.88)	(0.49)
Hynix Sem.	Korea	-5.41[b]	1.64[a]	-0.08	-0.32	0.52	0.97	0.15[b]	0.40	0.95
		(-2.07)	(11.59)	(-0.23)	(-0.85)	(0.79)	(1.28)	(2.12)	(1.05)	(1.19)
KCC	Korea	1.02	0.77[a]	-0.10	0.17	-0.55	0.32[a]	0.33[b]	0.30[c]	-0.03
		(0.77)	(7.22)	(-0.56)	(0.76)	(-1.28)	(3.22)	(2.56)	(1.66)	(-0.39)
KIA Motors	Korea	0.273	1.034[a]	0.030	0.091	0.444[b]	0.015	0.098[b]	0.817[a]	0.001
		(0.417)	(14.245)	(0.328)	(0.681)	(2.116)	(1.085)	(2.112)	(9.034)	(0.082)
Mirae	Korea	-0.89	0.59[a]	0.45[a]	0.10	-0.40	0.69[a]	0.31[a]	0.35[b]	-0.14
		(-0.54)	(6.33)	(3.32)	(0.20)	(-0.71)	(2.72)	(2.98)	(2.53)	(-0.74)
Samsung SDI	Korea	-2.24	0.78[a]	-0.01	-0.20	0.24	0.09	0.13[b]	0.68[a]	0.06
		(-1.79)	(12.85)	(-0.12)	(-0.84)	(0.57)	(1.36)	(2.39)	(4.35)	(1.35)
Shinhan Fin.Gr.	Korea	-0.14	1.22[a]	-0.30[b]	-0.29	0.49	0.20	0.04	0.81[a]	-0.01
		(-0.07)	(10.11)	(-1.92)	(-1.14)	(1.10)	(0.73)	(1.16)	(3.81)	(-0.14)
Shindegae	Korea	2.54	0.64[a]	0.06	-0.17	0.18	0.23[c]	0.12[c]	0.70[a]	-0.09
		(1.63)	(6.56)	(0.44)	(-0.60)	(0.51)	(1.70)	(1.95)	(5.24)	(-1.30)
Webzen Com.	Korea	-2.98	1.01[a]	0.05	0.23	0.04	0.30[c]	0.08	0.72[a]	-0.08
		(-1.52)	(3.52)	(0.15)	(0.38)	(0.06)	(1.88)	(1.40)	(6.21)	(-0.97)
Kuala L.K	Malaysia	1.14	0.31[b]	0.68[a]	0.15	-0.23	0.04	0.19[b]	0.47	0.04
		(1.49)	(2.57)	(2.87)	(1.10)	(-1.46)	(1.39)	(2.42)	(1.58)	(1.11)
Tenaga Nas.	Malaysia	-0.08	1.32[a]	-0.26[a]	0.11	-0.08	0.21[c]	0.21[c]	0.47[c]	-0.08
		(-0.07)	(18.37)	(-3.15)	(0.41)	(-0.26)	(1.95)	(1.66)	(1.92)	(-1.64)
Gfinbur 'O'	Mexico	0.19	1.09[a]	0.07	-0.28[c]	-0.21	0.04[b]	0.19[a]	0.68[a]	-0.01
		(0.29)	(8.17)	(0.34)	(-1.72)	(-0.73)	(2.28)	(3.30)	(7.65)	(-1.32)
Kimber 'A'	Mexico	0.50	0.72[a]	0.22[a]	0.05	-0.23	0.01	0.08[b]	0.83[a]	0.00
		(1.21)	(14.81)	(3.17)	(0.47)	(-1.23)	(1.58)	(2.03)	(9.49)	(0.89)
Telmex 'A'	Mexico	0.31	1.13[a]	-0.35[b]	0.13	0.11	0.24[c]	0.07	0.61[a]	-0.17[c]
		(0.35)	(9.48)	(-2.19)	(0.57)	(0.38)	(1.75)	(1.19)	(2.72)	(-1.69)
Vitro 'A'	Mexico	-2.79[b]	1.04[a]	0.06	0.23	-0.95	0.12[b]	0.27[a]	0.50[a]	0.08
		(-2.36)	(3.91)	(0.17)	(0.46)	(-1.44)	(2.55)	(2.86)	(3.67)	(1.41)
Del Monte Pac.	Singapore	-1.78	0.91[a]	-0.70[a]	0.05	0.27	0.21	0.13[c]	0.60[b]	-0.06
		(-1.16)	(7.86)	(-3.33)	(0.26)	(0.90)	(1.28)	(1.82)	(2.34)	(-1.03)
Flextech Hold.	Singapore	2.56	0.76[a]	0.34	0.18	-0.77	0.20	0.14[c]	0.54[b]	0.22
		(1.59)	(2.70)	(1.02)	(0.47)	(-1.18)	(1.52)	(1.82)	(2.26)	(1.40)
Singapore Tel.	Singapore	0.26	0.74[a]	-0.03	-0.24	-0.01	0.09[b]	0.29[a]	0.26	-0.04
		(0.35)	(4.67)	(-0.14)	(-1.01)	(-0.02)	(2.27)	(3.07)	(1.21)	(-1.63)
Stamford Land	Singapore	-1.45	0.72[a]	0.14	-0.43	0.66	0.17[b]	0.28[c]	0.21	0.05
		(-1.17)	(4.64)	(0.66)	(-1.30)	(1.31)	(2.47)	(1.90)	(0.94)	(0.76)
Acer	Taiwan	0.47	1.24[a]	0.10	0.16	-0.03	0.31	0.14[b]	0.43	-0.13
		(0.48)	(16.70)	(0.96)	(0.92)	(-0.17)	(1.63)	(2.26)	(1.53)	(-1.38)
Asustek Comp.	Taiwan	3.38[a]	1.22[a]	0.03	0.32	-0.37	0.08	0.10[b]	0.83[a]	-0.05
		(2.92)	(4.47)	(0.12)	(0.70)	(-0.76)	(1.64)	(2.52)	(14.66)	(-1.29)
AU Optronics	Taiwan	-0.53	1.37[a]	0.13	-0.82[a]	0.87[a]	0.53	0.12[c]	0.41	-0.24
		(-0.46)	(12.95)	(0.94)	(-3.71)	(3.43)	(1.58)	(1.87)	(1.23)	(-1.48)
Cathay Fin.Hold.	Taiwan	0.41	0.74[a]	0.39[a]	-0.09	0.14	0.08[b]	0.15[a]	0.56[a]	-0.01
		(0.60)	(12.49)	(4.51)	(-1.10)	(0.76)	(2.10)	(2.92)	(3.58)	(-0.45)
Chi Mei Opt.	Taiwan	0.20	0.96[a]	0.48[a]	0.08	-0.75[a]	0.02	0.07[b]	0.90[a]	0.00
		(0.22)	(9.92)	(3.38)	(0.52)	(-2.59)	(1.18)	(2.28)	(18.64)	(0.33)
Chia Hsin Cem.	Taiwan	-0.33	0.87[a]	-0.32[a]	0.09	-0.05	0.02[b]	0.14[b]	0.73[a]	-0.01
		(-0.67)	(19.29)	(-5.08)	(0.79)	(-0.28)	(2.23)	(2.26)	(7.64)	(-1.36)
China Steel	Taiwan	-0.49	0.89[a]	-0.06	0.03	0.19	0.04	0.11[b]	0.69[a]	0.02
		(-0.75)	(19.53)	(-0.78)	(0.21)	(0.74)	(1.53)	(2.38)	(4.80)	(1.30)
Chunghwa P. T.	Taiwan	-0.55	1.32[a]	0.20	0.31[c]	-0.81[a]	0.04	0.05	0.89[a]	-0.02
		(-0.54)	(14.17)	(1.56)	(1.83)	(-2.74)	(1.08)	(1.58)	(11.90)	(-0.95)

Table B.1 (continued) Changes in Risk Exposures and Conditional Volatility after ADR-listing

Stocks	Country	β_0 ($x10^{-3}$)	β_1	β_2	β_3	β_4	μ ($x10^{-3}$)	γ_1	γ_2	γ_3 ($x10^{-3}$)
Chunghwa Tel.	Taiwan	0.18	0.23[a]	0.26[a]	-0.17[b]	0.23	0.09[a]	0.14	0.23	0.04
		(0.30)	(4.84)	(3.01)	(-2.25)	(1.57)	(3.33)	(1.53)	(1.15)	(0.99)
D-Link	Taiwan	0.99	1.08[a]	-0.32[c]	-0.01	-0.11	0.26[c]	0.15[b]	0.59[a]	-0.06
		(0.85)	(6.56)	(-1.67)	(-0.04)	(-0.38)	(1.85)	(2.05)	(3.31)	(-1.06)
Evergreen Mr.	Taiwan	-0.64	0.83[a]	0.14	-0.04	0.29	0.03	0.12[a]	0.75[a]	0.00
		(-1.15)	(13.49)	(1.04)	(-0.18)	(1.04)	(1.55)	(2.81)	(7.04)	(0.39)
Far Eastern T.	Taiwan	0.22	0.97[a]	0.04	0.09	0.17	0.08	0.08[c]	0.79[a]	0.03
		(0.20)	(11.51)	(0.32)	(0.44)	(0.67)	(1.62)	(1.86)	(7.31)	(1.01)
First Fin. Hold.	Taiwan	-0.15	1.03[a]	-0.01	0.18	-0.06	0.02	0.06[a]	0.90[a]	-0.00
		(-0.19)	(13.31)	(-0.09)	(1.52)	(-0.28)	(1.60)	(2.65)	(23.51)	(-0.59)
Hannstar Disp.	Taiwan	-1.11	1.31[a]	0.05	0.11	-0.54[c]	0.07[b]	0.06[b]	0.87[a]	-0.04[c]
		(-1.11)	(14.59)	(0.36)	(0.79)	(-1.87)	(2.00)	(2.16)	(15.82)	(-1.90)
High Tec. Comp.	Taiwan	1.12	0.71[a]	-0.06	0.43[b]	-0.72[b]	0.49[a]	0.20[a]	0.12	-0.25[b]
		(1.28)	(6.16)	(-0.42)	(2.10)	(-2.53)	(3.20)	(2.79)	(0.57)	(-2.52)
Lite-On Tech.	Taiwan	0.83	0.60[a]	0.60[a]	0.19	-0.20	0.16[c]	0.14[b]	0.56[a]	0.10
		(0.68)	(5.87)	(3.20)	(0.57)	(-0.42)	(1.89)	(2.44)	(2.98)	(1.37)
Macronix Intl.	Taiwan	-0.23	0.96[a]	-0.19	-0.00	0.16	0.02	0.09[a]	0.88[a]	-0.00
		(-0.27)	(11.40)	(-1.32)	(-0.01)	(0.43)	(1.47)	(3.05)	(21.74)	(-0.14)
Mosel Vitelic	Taiwan	0.15	0.98[a]	0.23[c]	-0.07	0.19	0.05	0.07[a]	0.86[a]	0.01
		(0.13)	(10.32)	(1.67)	(-0.41)	(0.75)	(1.52)	(2.92)	(15.16)	(0.55)
Nanya Tech.	Taiwan	-0.31	1.22[a]	0.07	0.35[b]	-0.73[b]	0.02	0.05[b]	0.91[a]	-0.00
		(-0.33)	(16.45)	(0.52)	(2.50)	(-2.47)	(1.50)	(2.23)	(23.02)	(-0.50)
Power Chip Sem.	Taiwan	0.80	0.96[a]	0.15	-0.20	0.55	0.28[c]	0.11[b]	0.68[a]	-0.09
		(0.60)	(7.52)	(1.01)	(-0.58)	(1.44)	(1.79)	(2.50)	(5.12)	(-1.29)
Quanta Comp.	Taiwan	-0.58	1.20[a]	-0.26[b]	0.09	-0.12	0.22	0.08	0.25	-0.03
		(-0.74)	(13.85)	(-2.12)	(0.53)	(-0.44)	(1.46)	(1.35)	(0.55)	(-0.71)
Quanta Display	Taiwan	-0.85	1.18[a]	0.29[b]	0.22	-0.86[a]	0.06[b]	0.10[a]	0.83[a]	-0.02
		(-0.76)	(12.47)	(2.06)	(1.29)	(-2.59)	(2.00)	(2.93)	(14.23)	(-1.09)
Realtek Sem.	Taiwan	0.49	1.12[a]	0.05	-0.16	0.19	0.07	0.06	0.85[a]	-0.02
		(0.50)	(14.87)	(0.44)	(-0.83)	(0.81)	(0.97)	(1.54)	(6.61)	(-0.87)
Synnex Tec.Int.	Taiwan	2.45[b]	0.83[a]	0.39[b]	-0.36	0.94[b]	0.11[b]	0.20[a]	0.69[a]	0.02
		(1.99)	(5.91)	(2.19)	(-1.10)	(2.23)	(2.48)	(4.16)	(8.92)	(0.68)
Systex	Taiwan	0.48	1.10[a]	0.13	-0.21	-0.01	0.07	0.09[a]	0.86[a]	-0.01
		(0.36)	(11.29)	(1.00)	(-1.02)	(-0.02)	(1.12)	(3.02)	(13.32)	(-0.22)
Teco El.&Mach.	Taiwan	-0.63	0.54[a]	0.17[c]	0.47[b]	-0.43	0.03	0.07[c]	0.75[a]	0.04
		(-0.96)	(6.47)	(1.67)	(2.05)	(-1.57)	(1.43)	(1.91)	(4.98)	(1.21)
Tungho S.E.	Taiwan	1.35	0.74[a]	0.20	0.12	-0.40	0.19[c]	0.11[a]	0.70[a]	-0.01
		(1.05)	(7.16)	(1.07)	(0.77)	(-1.05)	(1.75)	(2.67)	(5.20)	(-0.34)
Walsin Lihwa	Taiwan	-0.92	1.09[a]	-0.25[b]	0.49[b]	-0.06	0.07[b]	0.16[a]	0.62[a]	-0.02
		(-1.55)	(16.77)	(-2.51)	(1.97)	(-0.17)	(2.20)	(2.77)	(4.86)	(-1.48)
Wistron	Taiwan	1.70[c]	0.56[a]	0.65[a]	0.67[b]	-0.63	0.35[b]	0.15[b]	0.27	-0.08
		(1.65)	(3.50)	(2.97)	(2.06)	(-1.55)	(2.28)	(2.38)	(1.05)	(-1.22)
Uzel Makina	Turkey	-0.30	0.84[a]	-0.39[b]	0.25	0.32	0.07[c]	0.23[c]	0.65[a]	0.08
		(-0.20)	(9.00)	(-2.24)	(0.71)	(0.60)	(1.88)	(1.87)	(5.32)	(0.96)

The following model is estimated:

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

$$h_t = \mu + \gamma_1 \eta^2_t + \gamma_2 h_{t-1} + \gamma_3 D_t$$

R_t is the return of stock at time t, R_L is the local market index return of the country that the stock belongs to, R_W is the global market index return, and D is a dummy variable that takes on the value of one after the cross-listing and zero otherwise. All returns are daily log returns. a, b and c indicate 1%, 5% and 10% significance levels, respectively.