LIBERALIZATION OF EMERGING EQUITY MARKETS AND VOLATILITY

DUC KHUONG NGUYEN*

CERAG-UMR 5820 CNRS
University Grenoble 2
150 Rue de la Chimie, BP 47, 38040 Grenoble, France
Email: duc.nguyen@upmf-grenoble.fr
Tel.: +33 1 40 78 83 83

Abstract

As will be shown later, finance literature often provides divergent results about the effect of stock market liberalization on emerging market volatility. This paper develops a bivariate conditional GARCH in mean model (GARCH-M) to empirically investigate the dynamic behaviors of conditional volatility around stock market liberalization for some emerging markets. The bivariate nature of the empirical model allows the influences of world market volatility on local market volatility. This is particularly important because emerging markets are not fully segmented from world capital markets when they become more open to foreign portfolio investment. Empirical results show that GARCH-based conditional volatility measures tend to be predictable and persistent over time. Further, when conditional volatility measures are related to a set of proxy variables representing stock market liberalization, the results typically reveal that volatility does not increase after stock market reforms were undertaken. More importantly, the volatility tends to significantly decrease when emerging markets became more open to foreign capital flows.

Key words: Stock Market Liberalization, Return Volatility, Emerging Equity Markets, GARCH in mean models.
JEL Classification: F3, G15

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1. INTRODUCTION

In the late 1980s, many emerging economies had decided to open their capital markets to foreign investors. Under this situation, foreign investors are now able to trade domestic securities and domestic investors are allowed to hold shares traded in foreign markets. This reform has led to significant changes in stock markets of emerging countries due to the increased foreign portfolio investment. The rapid maturation of institutional infrastructure and the substantial growth of market depth witnessed these changes. Currently, the relative size of all emerging markets reaches more than 11% of world market capitalization while it was only 2.5% in 1982[1]. In addition, if we take a close look at the evolving of market liquidity indicator, it appears that many emerging markets have currently a turnover ratio comparable to the one of mature markets.

Since stock market liberalization is considered as one of the major reasons for creating a new environment for financial investments in emerging countries, many studies have empirically examined the changes which occurred in emerging stock markets after the liberalization (see, Bekaert and Harvey, 2003). The majority of these studies report that the liberalization of stock markets was beneficial to emerging countries in that it allows for international risk sharing between domestic and foreign investors through capital market integration (see, e.g., Bekaert and Harvey, 1995; Stulz, 1999; Carrieri and *al.*, 2002; and Iwata and Wu, 2004). There is also empirical evidence to suggest that the actual liberalization may lower the cost of capital leading to economic welfares (see, e.g., Bekaert and Harvey, 2000; Henry, 2000; and Bekaert and *al.*, 2001). In addition, several studies provide evidence that the liberalization of stock markets improves market efficiency as foreign investors often require high transparency and appropriate

[1] See, Global Stock Market Factbook, Standard & Poor's, 2004.

accounting regulations (see, e.g., Kim and Singal, 2000; and Khambata, 2000). However, liberalization could be harmful to stock markets in new liberalized countries. Some authors have argued that foreign trading and free capital mobility resulting from liberalization policies may increase stock market volatility and instability leading to market crashes (see, e.g., Calvo and Reinhart, 1996; Krugman, 1998; Froot and *al.*, 2001; and Borenzstein and Gelos, 2001). The proponents of this view often refer to the advent of financial turmoil during the 1990s as a good example of adverse effects induced by liberalization on emerging economies.

The above ambiguities about the financial impacts of liberalization policies have recently made stock market liberalization under strong debate, essentially in the aftermath of the sonorous 1997 Asian financial crisis. Therefore, asking seriously a question of whether liberalization leads to increased volatility in emerging stock markets is purely rational and of great interest. Various empirical studies have been done concerning this topic (Bekaert and Harvey, 1997; DeSantis and Imrohoroglu, 1997; Bekaert and Harvey, 2000; Kim and Singal, 2000; Kassimatis, 2002; and Miles, 2002). While the majority of these studies report that stock market liberalization contributes to lower emerging market volatility, there is also the empirical evidence suggesting an intensification of volatility after liberalization.

To start, the proposition that emerging stock markets become less volatile after liberalization is supported by papers such as Bekaert and Harvey (1997, 2000), Kim and Signal (2000), and Kassimatis (2002). Precisely, the purpose of Bekaert and Harvey (1997) is to investigate stock market volatility using monthly data of twenty emerging markets from the International Finance Corporation. They use a semi-parametric ARCH (SP-ARCH) model to estimate the volatilities of each market and document that thirteen of seventeen countries that opened their stock markets to foreign capital flows experience a decline in volatility while only four countries exhibit a slight increase in volatility. After controlling the potential influences on conditional volatility of several variables such as asset concentration, stock market development and integration indicators, microstructure effects, and macroeconomic influences and political risk, Bekaert and Harvey (1997) found that stock market liberalization significantly decreases volatility in emerging markets. In a related work, Bekaert and Harvey (2000) extended the time series data used in Bekaert and Harvey (1997) to study the effect of liberalization over a longer period and estimate the volatility of sample markets from a time series model which allows both the conditional mean and conditional variance to vary through time. The conditioning variables they use essentially reflect changes in the degree of capital market integration between emerging and world markets. Then, these authors employ the estimates of this model in a pooled time series/cross-sectional framework to evaluate the impact of liberalization on stock market volatility. Overall, after taking into account control variables, their adjusted results indicate that, on average, annualized volatility decreases by one basis point. In their study, Kim and Signal (2000) focused on the volatility changes around market liberalization for fourteen markets from an initial sample of twenty emerging markets. Using various versions of ARCH/GARCH models to measure conditional volatilities of each market and an event study methodology, they found that the volatility of emerging markets under consideration is lowered over the post-liberalization period. Kassimatis (2002) also analyzed the effect of liberalization on emerging market volatility and provided evidence that EGARCH-based volatility measure significantly decreased following liberalization policy in 6 emerging countries such as Argentina, India and Pakistan.

More interestingly, the author showed that the nature of stock market volatility has not changed under liberalization.

Other attempts such as Levine and Zervos (1998), and Miles (2002) reported empirical results which are in contrast to those of the above studies. For example, Levine and Zervos (1998) examined the links between capital control liberalization and volatility in sixteen emerging stock markets and found that conditional volatility as measured by the rolling standard deviation of monthly market returns in most countries tends to grow up following the liberalization of capital controls and dividend flows. In a more recent study, Miles (2002) discussed the effect of stock market openings on the volatility using monthly data from a sample of seventeen emerging markets. The author proposes to capture the effect of market liberalization by defining five different dates associated with liberalization policy: the month of official liberalization, the month which is marked by a significant change in the US capital flows to emerging markets, the month of December 1989, the month of the first country fund (CF) introduction and the month of the first American Depository Receipt (ADR) admission. According to the author, the month of December 1989 was used because it marked the time when investors in developed countries have rights to purchase financial securities in emerging countries. After selecting the appropriate models of volatility for each market under study (ARCH/GARCH models), the author tested the relationship between his measures of liberalization and stock market volatility. As regard to empirical results, Miles (2002) points out that they tend to be country-specific and do not support the hypothesis of decreased volatility in emerging markets following the reforms. Specifically, in three fifth of sample markets, liberalization events have tendency to increase rather than to lower stock market volatility.

Another kind of results is provided by DeSantis and Imrohoroglu (1997) who examined the behavior of return volatility under market liberalization by specifying a GARCH model in which the unconditional variance can change with market liberalization. To do so, they added onto the conditional variance equation a dummy variable which is equal to zero before liberalization date and one afterwards. Using data from five emerging markets (India, Taiwan, Argentina, Brazil and Colombia); they demonstrated that the impact of liberalization on emerging market volatility is economically insignificant.

According to the previous literature, it is clear that the effect of liberalization on the volatility of stock returns in emerging markets is still under debate. In addition, it is worth notifying that earlier works have two major limitations when exploring the relationship between market liberalization and volatility. First, the majority of the aforementioned papers have treated emerging markets as perfectly segmented markets due to the use of univariate ARCH/GARCH processes to model stock market volatility while these markets are found to be reasonably integrated with world capital markets after being liberalized (see, e.g., Bekaert and Harvey, 1995). Since liberalization renders emerging markets more dependent upon the world markets, a bivariate GARCH model for stock market volatility or a world factor model of conditional variances as in Bekaert and Harvey (1997) which allows for the influences of both local and world market information on the return generating process would be preferred. The second limitation is directly linked to the measure of liberalization effects. Effectively, some papers attempted to assess the changes in return volatility by splitting the study period into two sub-samples, which is questionable because the volatility of stock markets may react to liberalization policy just before the official liberalization date. In addition, if some papers (e.g., Miles, 2002) have merit to consider a variety of market liberalization reforms, they do not yet take into account control variables and thus, the effect of market liberalization on volatility might be overvalued.

To avoid the methodological limitations discussed above, in this paper, we specify a bivariate GARCH-M model to conditionally measure emerging market volatility. The importance of this specification is that, if the linkage between emerging markets and the world market has been effectively increased as a result of liberalization, the volatility of local market should be affected by the world market volatility. We then analyze the relationship between market liberalization and volatility in a pooled time series regression framework. It should be noted that our explanatory variables are constructed so that they capture different stages of the liberalization policy. Using monthly data from eight emerging markets and the world market index, we mainly find that return volatility does not increase after stock market liberalization. Even more importantly, the volatility tends to significantly decrease at the time of structural breaks in the US capital flows to emerging markets.

The remainder of this paper is organized in the following sections: Section 2 lays out the empirical model used in the paper. Section 3 describes sample data and stochastic characteristics of stock returns. Section 4 reports and discusses the main empirical results. Section 5 summarizes the paper and provides some policy implications.

2. THE EMPIRICAL MODEL

In this section, we describe the theoretical motivations that lead to the bivariate specification of our empirical model. We then introduce pooled regression methodology used to test the relation between stock market liberalization and volatility in emerging market countries. The main advantage of this analysis is that we can observe the reaction of stock market volatility to different stages of financial liberalization and acknowledge the gradual effects of liberalization on market volatility.

2.1 Measuring Stock Market Volatility in Partially Integrated Emerging Markets

Asset pricing theory states that returns on financial securities depend upon their volatility (or risk). In this schema of things, volatility estimation and forecasting have become central to portfolio selection models as efficient portfolios are constructed by searching the highest return for a predetermined level of volatility. In finance literature, the empirical characteristics of stock volatility on speculative markets such as volatility clustering and persistence are often handled with the autoregressive conditional heteroscedasticity model (ARCH) introduced by Engle (1982) or its generalized version (GARCH) proposed by Bollerslev (1986)[2].

In the context of emerging markets, previous empirical studies have mostly employed GARCH models to measure stock market volatility (e.g., Bekaert and Harvey, 1997; Kim and Singal, 2000; Miles, 2002). One of the most important conclusions they made is that GARCH models appear to successfully describe the stochastic properties of stock price volatility. It should be however noted that the majority of these studies estimated emerging market volatility by using a univariate form of ARCH class models. The critical drawback of this specification is that it ignores the time-varying correlations between emerging market returns and world market returns. The reason is that stock returns in emerging markets are relatively dependent on the changes in world market

[2] A detailed survey about theoretical features and empirical applications of various GARCH/ARCH models is presented in Bollerslev and *al.* (1994).

returns as these markets become more integrated into world financial system after being liberalized (see, e.g., Bekaert and Harvey, 1995; Carrieri and *al.*, 2003; and Gerard and *al.*, 2003). More importantly, some empirical studies focusing on the international transmission of volatility reported that volatility interactions exist between emerging and developed markets (see, e.g., Liu and Pan, 1997; He, 2001, and Nguyen, 2005). Therefore, in this paper, we use a bivariate GARCH-M model to estimate volatility in emerging markets (see, Bollerslev and *al.*, 1988; and Engle and Kroner, 1995).

To illustrate the empirical model, we consider the following bivariate autoregressive process for stock index return series:

$$R_{w,t} = \alpha_0 + \alpha_1 R_{w,t-1} + \alpha_2 \sigma^2_{w,t} + \varepsilon_{w,t} \tag{1}$$

$$R_{i,t} = \lambda_0 + \lambda_1 R_{i,t-1} + \lambda_2 R_{w,t-1} + \lambda_3 \sigma^2_{i,t} + \lambda_4 \sigma^2_{iw,t} + \varepsilon_{i,t} \tag{2}$$

In these formulations, $R_{w,t}$ and $R_{i,t}$ are the returns on a world market index and returns on a local market index of an emerging market respectively. $\sigma^2_{w,t}$ and $\sigma^2_{i,t}$ are the variance of world and local market returns respectively. $\sigma^2_{iw,t}$ is the covariance between returns in local market and world market returns. $\varepsilon_{w,t}$ and $\varepsilon_{i,t}$ are observed errors which are assumed to follow a normal distribution with zero mean and time dependent variance in a GARCH process. So, if we let $\varepsilon_t = (\varepsilon_{w,t},\varepsilon_{i,t})^T$ denote a bi-dimensional error process, a general bivariate GARCH(1,1) model is given by the following equation[3]:

$$H_t = \begin{pmatrix} \sigma^2_{w,t} & \sigma^2_{wi,t} \\ \sigma^2_{iw,t} & \sigma^2_{i,t} \end{pmatrix} = C_0^T C_0 + A_1^T \varepsilon_{t-1} \varepsilon_{t-1}^T A_1 + B_1^T H_{t-1} B_1 \tag{3}$$

[3] In this paper, we decide to consider the GARCH(1,1) model because in applied works, this specification has turned out to be appropriate in describing a wide range of financial market data (Bollerslev and *al.*, 1994)

Where A_1 and B_1 are (2×2) parameter matrices and C_0 is an upper triangular matrix. This is the bivariate case of the so-called BEKK multivariate GARCH model (see, Engle and Kroner, 1995) which ensures the cross dynamics of conditional covariances. Within the bivariate BEKK model, the number of parameters to be estimated is equal to eleven. Since the right hand side of (3) contains only quadratic terms, and then, given convenient initial conditions, H_t is positive definite under the weak condition that at least one of the matrices C_0 or B_1 has the full rank (see, Engle and Kroner, 1995).

Combining the equations from (1) to (3), we see obviously that the bivariate structure of our empirical model allows for the influence of world market on emerging market volatility throughout the conditional variance equation and the covariance term in the conditional mean equation. Further, the presence of conditional variances in mean equations is useful because it allows for controlling the expected linkage between returns and risk. It should be noted that in the above model emerging markets are assumed to be partially integrated with the world market. This is particularly important since the complete segmentation and integration assumptions are not accurate for actual emerging markets.

To obtain the estimates of conditional volatility of each emerging market, we follow a two-step procedure. First, we estimate the world stock market volatility using a univariate GARCH(1,1) in mean process and equation (1), and save the estimated coefficients. Second, we estimate stock market volatility in emerging countries by employing the above bivariate model imposing estimated coefficients issued from the first step. This procedure aims to keep the influences of world market equal across emerging markets. All models are estimated by Quasi-Maximum Likelihood discussed in Bollerslev and Wooldridge (1992), which corrects for non Gaussian errors. The assumed Gaussian log-likelihood function to be maximized in the bivariate case for N observations is given as:

$$L = -\frac{1}{2}\sum_{n=1}^{N}\left(\ln(2\pi) + \ln(|H_t|) + \varepsilon_t^T H_{t-1}^{-1}\varepsilon_t\right)$$

2.2 Testing the Linkage between Market Liberalization and Stock Market Volatility

When stock market volatility indices (i.e., GARCH-based measures of conditional volatility for each emerging market) become available, we can explore the linkages between conditional volatilities and market liberalization. Previous attempts solved this question by estimating return volatility over the pre- and post-liberalization periods, and then comparing the results. One drawback of using this method is the possible loss of information about the dynamic interactions between volatility and the graduation of liberalization. This paper is different in that it tries to relate the dynamics of emerging market volatility to a number of representative variables of market liberalization.

In empirical literature, dummy variables are often used to capture the seasonal effects in different stages of stock market liberalization. This is very important because such policy does not consist of a unique event, but rather a set of subsequent events (see, Henry, 2000). Hence, in this paper we use six dummy variables. They include *BEFORE*, *PRE*, *DURING*, *POST*, *ADR* and *USCF*. *BEFORE* refers to 36 months prior to the official date of market openings. PRE refers to 36 to 7 months before official date of market openings. *DURING* refers to 6 months prior to 3 months after official liberalization event. *POST* covers the period starting in the 4^{th} month after official liberalization event and terminating at the end of estimation period. These variables are equal to one on the specified periods and zeros otherwise. *ADR* takes the value of one when the first American Depositary Receipts is announced in favor of a matching emerging market and zeros otherwise. *USCF* takes the value of one when the series of US capital flows to emerging markets reaches a structural break and zeros otherwise. The official dates of market liberalization, the dates of the first *ADR* as well as the dates of structural changes in the US capital flows series for sample markets are taken from Bekaert and Harvey (2000). We do not study the impact of the first closed-end country funds introduction because it is unavailable in the case of Venezuela.

Since the dynamics of market liberalization can be reflected by some market development and economic indicators, we then use three information variables. These variables stand for the evolution of market size measured by the ratio of market capitalization to GDP (*MCAP/GDP*), market liquidity measured by the ratio of trading value to market capitalization or turnover ratio (*TURNOVER*), and economic integration degree measured by the total of imports plus exports as a proportion of GDP (*TRADE/GDP*). As these variables might be influenced by stock market and economic developments subjected to changes when emerging markets become more open to foreign capital flows, it is expected that they incorporate information about stock market liberalization. In finance literature, a number of works have studied the relation between these variables and market liberalization. For instance, Errunza (2001) examined the changes in *MCAP/GDP* ratio, value traded to GDP, and turnover ratios for a sample of 31 emerging stock markets before and after market liberalization, and reported an improvement of these ratios over the post-liberalization period. Bekaert and Harvey (1997) used the *TRADE/GDP* ratio as a proxy of market integration and showed that it typically increases following liberalization due to increasing cross-country exchanges of products and services.

Additionally, it should be noted that stock market liberalization is usually implemented together with other economic reforms such as exchange rate and interest rate reforms. Under this context, general economic and political conditions of local markets might be an important contributor to stock market volatility. To explore the part of volatility changes attributable to only stock market liberalization, control variables are needed. Here we consider the followings: growth rate of real exchange rate, inflation rate, interest rate, and political stability index. Similar variables have been used in finance literature to isolate the effect of economic and political context (see, e.g., Henry, 2000; Bekaert and Harvey, 2000).

According to the above discussion, we will test the following model:

$$VOLATILITY_t = CONST + \sum_{i=1}^{6} \beta_i D_{i,t} + \sum_{j=1}^{3} \delta_j PROXY_{j,t} + \sum_{p=1}^{4} \varphi_p CONTROL_{p,t} + \varepsilon_t \qquad (4)$$

Where, *CONST* is a constant. $D_{i,t}$ is the set of liberalization dummies. $PROXY_{j,t}$ refers to the set of information variables. $CONTROL_{p,t}$ refers to the set of control variables. We estimate the model in (4) by pooled OLS method. The White heteroscedasticity consistent covariance matrix is used in order to generate correct estimates of coefficient covariances. All regressions are performed over the period from January 1986 to March 2000 given the data availability.

3. SAMPLE DATA AND RETURN CHARACTERISTICS

The present study examines some of the most advanced emerging markets: Argentina, Brazil, Chile, Colombia, Malaysia, Mexico, Thailand and Venezuela. The sample period is comprised between January 1976 and January 2003 except for Colombia, Malaysia and Venezuela where data are started in January 1986. The data for emerging markets consists of S&P's IFCG total return indices while the world market index is represented by the MSCI World Index. All data were extracted from Datastream and measured in US dollars. Data on trading value and market capitalization are from S&P's Emerging Market Data Base while data on imports, exports, GDP, and control variables are from International Financial Statistics (International Monetary Fund)[4].

[Please insert table 1 about here]

Monthly returns in market indices are computed as follows: $\text{Returns} = \ln(P_t) - \ln(P_{t-1})$, where P_t is the price of stock market index for the month t. Descriptive statistics and stochastic properties of monthly returns are presented in table 1. We first observe that monthly return series are significantly deviated from the normal distribution according to the Jarque and Bera (1980) test for normality. Moreover, in most markets, it is shown that stock return distribution is often negatively skewed. Second, the Ljung and Box (1978) test for non autocorrelation applied to stock returns in levels cannot reject the hypothesis of serial correlation in five emerging markets. When testing the serial correlation in square returns, the Ljung-Box test highly rejects the null hypothesis of non autocorrelation with an exception of the Venezuelan stock market. This nonlinear autocorrelation suggests the persistence of the variance of stock returns. Third, the Engle (1982) test for conditional heteroscedasticity reject the null hypothesis of no ARCH effects in return series, which implies that GARCH specifications are typically suitable for enhancing the explanatory power of return generating models. Finally, as the null hypothesis of non stationary return series is rejected in accordance with the

[4] Annual GDP is divided by 12 in order to obtain monthly GDP.

Dickey and Fuller (1981) augmented test, there is no need for integrated series treatments.

4. INTERPRETATIONS OF EMPIRICAL RESULTS

In this section, we begin with presentation of the empirical results issued from the bivariate autoregressive model with GARCH-in-mean effects. What follows is a detailed discussion of results from cross-sectional regression analysis which relates conditional volatility measures of emerging stock markets to liberalization variables.

4.1 Estimates of Conditional Volatility

Recall that the time-varying conditional volatility of the MSCI World index is estimated by combining equation (1) with a univariate GARCH process. Table 2 reports estimation results. Panel A indicates that none of the coefficients in mean equation is significant at conventional levels. The lack of significance of the risk premium coefficient particularly suggests that the level of market returns is not linked to the risk exposure. We also note the persistence of the world market volatility as the β coefficient in the equation of conditional variance is strongly significant and very close to one. Besides, in view of panels B and C, it is worth noting that the volatility of world index returns is very low as, on average, it only stands at about 0.178 percent on monthly basis.

[Please insert table 2 about here]

Conditional volatility of each emerging market is obtained by estimating the system of equations from (1) to (3). Estimation results and residual diagnostics are provided in table 3. If we look at the coefficients expressing the local and world market risk premiums, it appears that most of them are negative and insignificant. The conditional covariances have significant impacts on stock market returns in only two countries (Brazil and Venezuela), but the sign of effect is not identical across markets. Precisely, a negative relation between world market risk and local returns in Brazilian stock markets is difficult to interpret. The rational is that this situation may lead to the dysfunction of financial markets because risk adverse investors will sell up risky assets and deposit money in the bank. On the other hand, a positive relation between world market risk and local returns means that higher risk implies higher returns. This market condition permits to guarantee the interests of stock markets. There is also evidence of positive and significant relation between local market variance and stock market returns in Brazil. Finally, it is essential to remark that most of the coefficients in the conditional variances and covariances are highly significant at conventional levels of confidence. They are all available under request addressed to the author.

[Please insert table 3 about here]

Panel B of table 3 reports descriptive statistics of conditional volatility series in emerging markets. As can be observed, Argentina and Brazil are the most volatile markets of the sample, followed by Venezuela, Mexico, Thailand, Malaysia, Chile and Colombia. The evidence of autocorrelation in volatility series as shown by the Ljung-Box statistical test provides a clear-cut proof of volatility persistence in sample markets. As our sample period covers all recent crises in emerging markets, then it is interesting to know how conditional volatilities have evolved over different periods. As shown in figure 1, emerging markets seem to be not so volatile during the 1980s except for three months following the stock market crash happened in October 1987. It appears that the

Asian crisis generated a notable increase of conditional volatility in Thailand and Malaysia. We also find that changes in emerging market volatility are often associated with economic and political events. For example, Argentinean stock market appeared to be greatly volatile just before its official liberalization, while the volatility of the Colombian stock market was exceptionally intensified when the government announced that it would allow the peso to devaluate at a faster rate in September, 2nd 1998.

[Please insert figure 1 about here]

The diagnostic of estimated residuals in panel C typically suggests that our bivariate conditional model is highly appropriate in modeling stock market volatility in emerging countries. The point to be emphasized here is the disappearance of ARCH effects in all residuals series.

4.2 Impact of Stock Market Liberalization on Volatility

On testing the impact of stock market liberalization increases return volatility, the idea that immediately comes to mind is to compare the level of volatility before and after the reform. Using the official liberalization dates of Bekaert and Harvey (2000) as break point, we compute and compare the average value of five-year conditional volatility measured by the square root of conditional variance prior to liberalization with the one posterior to liberalization[5]. Table 4 displays the results. According to the two samples Z-test for means, we found that Thailand is the only one market that experiences a significant increase in volatility following market liberalization. In remaining markets,

[5] Depending on the data availability, the considered period for Malaysia is 45 months before and 45 months after official liberalization dates, whereas it is 48 months before and 48 months after official liberalization dates in the case of Venezuela.

the null hypothesis that conditional volatility before liberalization is higher than the volatility post-liberalization can not be rejected, indicating that stock market volatility is significantly reduced after liberalization policies. Albeit the results show tendency of decreased volatility, we are unable to conclude that stock market liberalization leads to more tranquil markets in emerging countries. The simple reason is that market reforms may not be the only relevant factor influencing the variance of stock returns.

[Please insert table 4 about here]

Given the weakness of the above analysis, the cross-sectional regressions presented in table 5 are crucial as they permit to evaluate the specific effects of stock market liberalization on volatility. In the first regression, we only use liberalization dummies as explanatory variables. On average, the results show a significant reduction of sample market volatility over the period after liberalization as indicated by the coefficient related to *POST* variable. Moreover, the examination of the coefficient of *USCF* variable suggests that conditional volatility is significantly lowered at 10% following a considerable amount of US capital flows into emerging markets. We also find that other liberalization dummies do not affect significantly market volatility.

[Please insert table 5 about here]

The results of the second regression in which we use both liberalization dummies and information variables as explanatory variables are quite interesting. In this case, the *POST*'s coefficient becomes insignificant, albeit negative. This indicates that the return volatility is no longer to be impacted by market liberalization. The *USCF* variable continues to significantly reduce stock market volatility at conventional levels of confidence. However, we recognize a significant increase of volatility at the time of market openings according to the *DURING*'s coefficient. With regard to information variables, the results demonstrate that a greater degree of economic integration measured by *TRADE/GDP* ratio and an increase in the relative size of stock market measured by *MCAP/GDP* ratio typically contribute to diminish stock market volatility. We finally observe a positive relation between turnover ratio and stock market volatility. This is not surprising because an important number of trades often raise the volatility of financial securities.

The results of the third regression where control variables are introduced are not much different from the second regression. It is demonstrated that stock market liberalization does not increase the volatility of emerging markets as evidenced by the insignificance of the *POST*'s coefficient. Further, stock market volatility specifically decreases when emerging markets become more mature and open to foreign portfolio investment. In addition, among control variables, only the growth rate of inflation rate and real exchange rate significantly influences the emerging market volatility.

In summary, our results are in line with empirical findings of Bekaert and Harvey (1997), De Santis and Imrohoroglu (1997), and Bekaert and Harvey (2000), but they are in contrast to recent findings of Miles (2002).

5. CONCLUDING REMARKS

Measuring volatility is of paramount importance in the literature of financial economics and econometrics. For example, portfolio managers can evaluate and hedge against risk or to price derivatives based on volatility measures. Measuring the effect on stock market volatility of financial liberalization is particularly important for policymakers in emerging markets because the latter ones wish to know the typical benefits and costs associated with their policies so as to make a harmonious arbitrage between financial deregulation and regulation.

Using a bivariate model for stock market volatility which explicitly allows the world market influences on the volatility of domestic markets, the paper presents some significant contributions to the related empirical literature. Based on the country by country analysis, the results show that financial liberalization policies do not lead to increased volatility. In addition, among eight considered markets, the reforms lead to more tranquil markets in two cases. As for the cross-market analysis, it shows evidence that on average the effect of market reforms is insignificant. It also suggests that the variance of stock returns is significantly lowered when foreign participations become significant on domestic stock markets as indicated by the break in the US capital flows into emerging markets.

As regards to the question of economic policies, if financial liberalization does not drive up stock market volatility according to our results, it would be the best way for emerging and developing countries to enjoy the beneficial effects of foreign equity flows such as reduced cost of capital and diversification opportunities. Meanwhile, it is also essential to underline that the embankment of financial liberalization course needs to be gradual in order to gain investors' confidence and to prevent the adverse impacts of foreign capital flows.

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Table 1
Summary Statistics of Monthly Returns

	Argentina	Brazil	Chile	Colombia	Malaysia	Mexico	Thailand	Venezuela	MSCI World
Periods	1976-2003	1976-2003	1976-2003	1985-2003	1985-2003	1976-2003	1976-2003	1985-2003	1976-2003
Mean	1.150	0.522	1.619	1.326	0.254	0.998	0.622	0.394	0.868
Std. Dev.	21.884	15.795	9.694	8.365	9.896	12.924	10.348	13.921	4.179
Skewness	0.115	-0.436**	0.334*	0.640**	-0.189	-2.028**	-0.461**	-0.993**	-0.679**
Kurtosis	5.401**	2.856**	2.035**	2.095**	3.540**	10.279**	3.052**	4.769**	1.745**
Q(6)	5.629	2.835	19.599++	38.418++	16.510+	23.527++	15.721++	5.032	8.355
Q(12)	10.992	11.002	51.999++	41.747++	34.051++	31.962++	45.377++	10.722	16.583
$Q^2(12)$	56.320++	51.587++	56.726++	122.952++	116.344++	36.561++	186.793++	5.513	9.720
JB	395.762++	120.845++	62.147++	54.547++	114.622++	1653.747++	137.748++	241.314++	66.294++
ARCH(6)	35.154++	7.460	8.940	15.128+	27.798++	39.816++	49.931++	5.704	2.825
ARCH(12)	43.333++	36.535++	25.633+	27.479+	38.474++	42.006++	58.160++	5.985	9.686
ADF	-9.007++	-8.835++	-7.170++	-5.301++	-6.575++	-7.461++	-8.454++	-5.874++	-7.028++

Notes: Sample mean and standard deviations are reported in percentage. Q-statistics are the Ljung-Box test for autocorrelation applied to returns in level and square returns. JB refers to the Jarque and Bera (1980)'s test for normality. ARCH is the Engle (1982)'s test for conditional heteroscedasticity. ADF refers to Dickey and Fuller (1981)'s augmented test for stationarity (no trend. with constant and four additional autoregressive components).
*, ** indicate significance at 5% and 1% levels of confidence respectively.
+, ++ indicate rejection of the null hypothesis (no autocorrelation, normality, homocedasticity and non-stationarity) at 5% and 1% levels of significance respectively for statistical tests.

Table 2
Volatility of the MSCI World Index

Panel A: Estimated coefficients						
α_0 ($\times 10^2$)	α_1 ($\times 10^2$)	α_2	ω ($\times 10^2$)	α	β	Values of log-likelihood
0.833 (1.22)	0.655 (6.637)	0.033 (6.989)	0.008 (0.008)	0.048 (0.034)	0.908** (0.071)	-868.337
Panel B: Summary statistics of conditional volatility						
Mean ($\times 10^2$)	Std. Dev. ($\times 10^2$)	Minimum ($\times 10^2$)	Maximum ($\times 10^2$)	Skewness	Kurtosis	Q(12)
0.178	0.044	0.011	0.353	1.073	1.191	1665.857++
Panel C: Diagnostic of standardized residuals						
Mean	Std. Dev.	Skewness	Kurtosis	Q(12)	$Q^2(12)$	ARCH(4)
0.003	0.992	-0.767**	1.882**	16.661	6.196	1.458

Notes: Conditional volatility of the world market is estimated using the following model and monthly returns from the MSCI World index:

$$R_{w,t} = \alpha_0 + \alpha_1 R_{w,t-1} + \alpha_2 \sigma^2_{w,t} + \varepsilon_{w,t}$$

$$\sigma^2_{w,t} = \varpi + \alpha \varepsilon^2_{w,t-1} + \beta \sigma^2_{w,t-1}$$

Bollerslev and Wooldridge (1992)'s robust standard deviations are given in parentheses. Q-statistics are the Ljung-Box test for serial correlation applied to both returns in level and square returns up to 12 lags. ARCH is the Engle (1982)'s test for conditional heteroscedasticity.

*, ** indicate significance at 5% and 1% levels of confidence respectively.

+, ++ indicate rejection of the null hypothesis (no autocorrelation, normality, homocedasticity and non-stationarity) at 5% and 1% levels of confidence respectively for statistical tests.

Table 3
Condiitonal Volatility of Sample Emerging Markets

	Argentina	Brazil	Chile	Colombia	Malaysia	Mexico	Thailand	Venezuela
Panel A: Estimated coefficients								
λ_0	0.010* (0.004)	-0.055 (0.040)	0.081 (0.130)	-0.003 (0.032)	0.007 (0.006)	0.049 (0.034)	0.014 (0.013)	-0.027* (0.011)
λ_1	0.023 (0.092)	0.040 (0.049)	0.234** (0.043)	0.372** (0.092)	0.154* (0.078)	0.188** (0.060)	0.314** (0.050)	-0.008 (0.063)
λ_2	-0.058 (0.220)	0.229 (0.189)	0.129 (0.125)	0.385** (0.122)	-0.122 (0.123)	0.229 (0.157)	-0.014 (0.161)	0.132 (0.183)
λ_3	0.265 (1.622)	-10.273** (3.235)	4.750 (12.047)	3.098 (3.741)	-1.270 (1.289)	4.878 (5.174)	-1.891 (2.331)	5.460** (1.617)
λ_4	-0.137 (0.388)	3.384* (1.695)	-7.551 (14.558)	-0.267 (4.459)	0.675 (0.969)	-3.568 (2.902)	-0.899 (1.466)	-0.105 (0.167)
Values of log-likelihood	1157.071	1293.245	1431.870	983.988	974.036	1375.712	1445.844	845.861
Panel B: Summary statistics of conditional volatility series								
Mean	0.077	0.034	0.011	0.008	0.012	0.018	0.015	0.025
Std. Dev.	0.084	0.022	0.003	0.002	0.010	0.007	0.014	0.006
Minimum	0.012	0.013	0.009	0.005	0.004	0.012	0.005	0.019
Maximum	0.570	0.168	0.034	0.027	0.073	0.069	0.116	0.062
Skewness	3.411**	3.088**	3.589**	2.968**	2.927**	3.123**	3.454**	2.620**
Kurtosis	13.982**	12.675**	19.727**	14.171**	9.686**	14.331**	14.481**	8.626**
Q(12)	304.854++	224.852++	35.335++	82.800++	388.440++	85.469++	669.827++	161.802++
ADF(4)	-5.336++	-4.669++	-5.850++	-4.629++	-2.976++	-6.061++	-3.589++	-3.876++
Panel C: Diagnostic of standardized residuals								
Mean(×10)	0.086	-0.003	-0.003	0.030	-0.039	-0.015	0.014	0.007
Std. Dev.	0.193	0.239	0.388	0.492	0.433	0.315	0.390	0.274
Skewness	-0.586**	-0.755**	-0.672**	-0.729**	-0.849**	-0.766**	-0.390**	-0.714**
Kurtosis	2.952**	2.120**	1.809**	2.260**	3.249**	2.124**	1.217**	1.913
Q(12)	12.947	17.585	17.292	16.896	14.054	16.164	20.134	16.353
$Q^2(12)$	21.230+	13.242	17.644	12.653	18.244	8.539	20.556	8.266
JB	131.579++	91.203++	68.402++	97.478++	180.959++	92.417++	28.177++	76.759++
ARCH(4)	1.097	2.051	1.911	1.819	2.507	2.376	0.564	1.770

Notes: Conditional volatility of sample emerging markets is estimated using our bivariate model for stock market volatility. Bollerslev and Wooldridge (1992)'s robust standard deviations are given in parentheses. Q-statistics are the Ljung-Box test for serial correlation applied to both returns in level and square returns up to 12 lags. ARCH is the Engle (1982)'s test for conditional heteroscedasticity. ADF refers to Dickey and Fuller (1981)'s augmented test for stationarity (no trend with constant and four additional autoregressive components).
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+, ++ indicate rejection of the null hypothesis (no autocorrelation, normality, homocedasticity and non-stationarity) at 5% and 1% levels of significance respectively for statistical tests.

Table 4
Changes in Stock Market Volatility

Markets	Conditional volatility before market liberalization		Conditional volatility after market liberalization		Changes in volatility	
	Mean (%)	Standard deviations (%)	Mean (%)	Standard deviation (%)	Change (%)	P-value of Z-test
Argentina	28.800	14.938	25.054	10.278	-3.745	0.997
Brazil	22.088	6.366	16.055	2.944	-6.033	1.000
Chile	11.251	1.311	10.325	0.643	-0.927	1.000
Colombia	9.398	1.654	8.705	0.950	-0.693	1.000
Malaysia	10.420	2.919	8.684	1.365	-1.736	1.000
Mexico	14.359	2.728	13.716	1.929	-0.643	0.995
Thailand	9.303	1.704	11.201	3.227	1.898	0.000
Venezuela	16.331	2.384	16.171	2.099	-0.160	0.701

Notes: Stock market volatility is measured by the square root of conditional variances. Z-test is a two-tailed statistical test which examines whether the mean of the conditional volatility over the pre-liberalization period (five years before market opening) is greater than the observed mean of the conditional volatility over the post-liberalization period (five years after market opening). Under the null hypothesis, all conditional volatility series are assumed to have a normal distribution.

Table 5
Impact of Stock Market Liberalization on Volatility

Pooled OLS Estimation
Dependent Variable: VOLATILITY
Method: Pooled Least Squares
Number of cross-sections used: 8
White Heteroscedasticity-Consistent Standard Errors & Covariance

Dependent variables	Regression 1	Regression 2	Regression 3
PRE	-0.017 (0.022)	-0.026 (0.026)	-0.024 (0.020)
BEFORE	0.016 (0.023)	0.027 (0.027)	0.019 (0.020)
DURING	0.021 (0.013)	0.024[c] (0.014)	0.015* (0.007)
POST	-0.005* (0.002)	-0.003 (0.004)	0.000 (0.003)
ADR	-0.002 (0.009)	-0.004 (0.008)	-0.004 (0.006)
USCF	-0.005[c] (0.002)	-0.012* (0.005)	-0.015* (0.007)
MCAP/GDP (×10)		-0.002* (0.001)	-0.003** (0.001)
TRADE/GDP		0.227** (0.054)	0.174** (0.050)
TURNOVER		0.017** (0.003)	0.008** (0.002)
INF			0.070** (0.022)
INT			-0.010 (0.061)
EXC			-0.010** (0.003)
PSI			0.058 (0.055)
CONST	0.027** (0.002)	0.029** (0.004)	0.020** (0.003)
Number of Observations	1368	992	992
Adjusted R-squared	0.050	0.124	0.359

Notes:
This table reports estimated coefficients from the pooled OLS estimation of the regression model in (4). Standard errors which are robust to general heteroscedasticity are given in parentheses.
*. ** indicate significance at 5% and 1% levels of confidence respectively.
[c] indicates significance at 10% level of confidence.

Figure 1
Dynamic patterns of stock market volatility