Nexus amongst Stock Market Liberalization, Return Volatility, and Information Asymmetry: The Global Panel Data Approach

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Abstract

The study examines does stock market liberalization spur return volatility in emerging, developed, and the global economies? The dynamic daily, weekly, and monthly panel data GARCH and TGARCH model are used to estimate the parameter of interests. The empirical results indicate that the stock market liberalization significantly drives the return volatility. The conditional volatility measure is highest in the liberalization period for emerging economies whereas the conditional measure for the developed economies are greater in the post-liberalization period. Moreover, the conditional measure in the combined liberalization period is evidenced greater before the stock market is open to the foreign investors, in emerging, developed, and the global economies. Further, it is evident that the positive return shocks drive higher volatility than negative shocks.

JEL classification: F37; G12; G15

Keywords: Developed economy; Emerging economy; Panel GARCH; Information asymmetry; Stock market liberalization; Return volatility.

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1 Introduction

Global financial stock market liberalization emphasizes economies to diversify their idiosyncratic risks (Stulz, 1999). The equity market liberalization exerts favorable effects in various phases. However, the impacts of financial market liberalization for the developed and developing economies exerts are manifold. Financial market liberalization unwrapped new channels for foreign capital entry. Conversely, foreign investment inflows, led to the gaining of positive momentum in real exchange rates, broadening the financial services with an expansion of bank lending, and primarily increasing the vulnerability resulting in distortions due to a reversal in capital inflows. Although the empirical studies witnessed that financial market liberalization exerts a positive impact on emerging countries mimicking declined cost of equity, improved private physical investment and increased returns (Han Kim & Singal, 2000; Henry, 2000; Bekaert, Harvey, & Lundblad, 2001, 2005; Klein & Olivei, 2008). Equally, financial liberalization may perhaps prove a country skeptical to the economic and political outbreak abroad, resulting in the domestic market becoming more volatile. Though, in emerging markets, the stock return volatility is perhaps higher and surpasses the developed markets in magnitude (Santis, 1993; Nguyen, 2010; Ben Rejeb & Ben Salha, 2013). The impact of stock market liberalization on return volatility is primarily a significant concern that emerging economies necessarily have to take into consideration in advance prior to their decision to liberalize and perhaps even post-liberalization process. The return volatility possesses the characteristic feature that has an adverse impact pertaining to decision making to the effective apportionment of resources, subsequently for investment (Han Kim & Singal, 1993; Singh, 1993; Bekaert & Harvey, 1997). Hence, the return volatility and financial market liberalization are closely interlinked and consequently is a plausible justification for liberalization to attract a fresh group of investors, mostly the institutional investors. Since the institutional investors versed in developed markets and their decisions are pertaining to rational investment analysis. Thus, the possibility of a reduction in return volatility after liberalization. Contrastingly, the financial market liberalization may impetus the liberating economy to witness distortions in the domestic stock market due to uncertainties prevailing in foreign counterparts. Therefore, there is a likelihood of a volatility surge in stock returns after financial liberalization.

Bekaert & Harvey (1997) opines underdeveloped stock market without financial liberalization are rather exposed to greater stock market volatility. The financial liberalization and volatility literature suggests that financial market openness may lead to decrease or increase in volatility. Subsequently, financial liberalization openness unlocks the gateways for foreign investors to invest in liberalized economy, which leads to capital inflow and allows investors to hold the portfolio with diverse asset class and risk sharing. The existing literature on the impact of financial liberalization on volatility has been diverse. The literature embedded within the intensity of the financial liberalization period implies an increase in return volatility. Huang & Yang (2000) studied the effect of financial liberalization on the stock market volatility in ten emerging markets mimicking post-liberalization period. Findings revealed that volatility rises in Mexico, South Korea, and Turkey, whereas volatility significantly decreases in Malaysia, Chile, Argentina and Philippines. Following Huang & Yang (2000), Levine & Zervos (1998) revealed that the impact of liberalization on volatility in 16 emerging economies witnessed higher volatility in the post-liberalization period. The above studies conclusively evident that financial stock market liberalization derived the return volatility increment in the post-liberalization period.

However, contrarily, there exist significant supportive literature and evidence that stock market liberalization causes lower volatility, as Kwan & Reyes (1997) and Das & Mohapatra (2003) found a significant decline in stock returns volatility in the post-liberalization period. An influential study of Kassimatis (2002) revealed that volatility decreases after key liberalization guidelines were implemented in India, Argentina, Philippines, Pakistan, South Korea, and Taiwan, respectively. Moreover, Bekaert & Harvey (1997) explored the impact of financial liberalization policies on stock return volatility in seventeen emerging stock markets. Findings witnessed a significant decrease in volatility in Argentina, Brazil, Mexico, Taiwan, and Portugal and yet the insignificant decline in volatility in the rest of the stock markets (Li, Nguyen, Pham, & Wei, 2011). Subsequently, Taiwan stock market became highly efficient in processing information compared to the pre-liberalization period. De Santis & İmrohoroğlu (1997) and Bley & Saad (2011) unearth no significant relationship between liberalization and return volatility in Asia, Europe/Middle-East and Latin America. A seminal study of Spyrou & Kassimatis (1999) revealed no significant variation in volatility during the post-liberalization period in Argentina, India, Chile, Mexico, Philippines, Pakistan, and Taiwan. Though Henry (2000) investigated the effect of stock market

liberalization on emerging market stock prices and found the aggregate equity price of a country on an average witnessed excess returns until implementation of its initial stock market liberalization. Successively proposed that stock market liberalization leads to decrease in the country's cost of equity capital through permitting the diversification of risk sharing among domestic and foreign investors.

Concurrently, the prevailing uncertainty with multiple dimensions in financial stock market liberalization and return volatility literature leads further skepticism in the presence of the literature on information asymmetry and return volatility. Information about stock market liberalization is a natural phenomenon for the liberating economy to witness the stock market reaction and efficiency absorb the shocks and its impact on returns volatility. Pagan & Schwert (1990) and Engle & Ng (1993) opines bad news tends to cause high volatility in returns rather than good news. Mutually conditional and unconditional volatility measures are maximum in the liberalization period. Jayasuriya (2005) evidenced that market openness to foreign investors frequently increased or decreased stock return volatility. A seminal study of Demirguc-Kunt & Levine (1996a, 1996b) and Kaminsky & Schmukler (2007) revealed that the impact of stock market liberalization is time-varying in nature which leads to high volatility in short-horizon and less volatility in the long-horizon. Ndako (2012) and Ben Rejeb & Boughrara (2014) reveal that financial liberalization does not spur excessive volatility in emerging stock market rather the volatility declines gradually. Likewise, Diamandis (2008) observes the dynamic behavior of stock market volatility for emerging and developed stock markets. A seminal study of Edwards, Biscarri, & Pérez de Gracia (2003) opines differences emerged through financial liberalization process in emerging economies persist for the short-term period of a high magnitude and volatility relative to developed economies. Thus, given the significant variation in financial liberalization phenomenon, the closer analysis of the financial liberalization process through different phases is an unique attempt (Bekaert, Harvey, & Lundblad, 2003; Jaleel & Samarakoon, 2009). The literature on stock market liberalization and return volatility suggests that most of the studies exclusively confined to the specific economy, emerging economies or developed economies, albeit meagre study tries to cover the global perspective to test the nexus between stock market liberalization, return volatility, and information asymmetry. Moreover, the trade-off among stock market liberalization, return volatility, and information asymmetry are sensitive to the periods of liberalization phenomenon,

and thus the panel dataset employed to quantify the above proposition. Further, to overcome such biases the study employed the daily, weekly and monthly datasets of developed and emerging economies through the phases of liberalization phenomenon, namely, pre-liberalization, liberalization, and post-liberalization, so as to quantify the theoretical framework.

2 Stock market liberalization process

With the limitation of availability of data and information about stock market liberalization, the study considered twenty economies that are categorized into emerging, developed, and the global economies. Table 1.1 reports the specifications about economic groupings. Moreover, the stock market liberalization phenomenon across the economies witnessed in different time frame. The liberalization phenomenon is broadly grouped in pre-liberalization, liberalization, and post-liberalization periods. The basic information about stock market liberalization is specified in Table 1.2.

3 Data and variables

The study employs stock index returns of emerging, developed, and the global economies in the panel form, to estimate the parameters of interests. Table 1.3 reports the data and variable specifications. Table 2 reports the summary statistics on the stock return of emerging, developed, and the global economies. The daily, weekly, and monthly return panel datasets of emerging, developed, and the global economies, appear to be stationary. The average weekly return for the pre-liberalization (Prelib) period of emerging, developed and the global economies are 18.193, 13.781, 15.386, and different from that in the full period (12.250, 9.060, and 10.510). Though the weekly average return in the liberalization (Lib) period for emerging, developed, and the global economies are 22.988, 13.322, 19.726 implies that the period of stock market opening to foreign investors is associated with higher returns. The average weekly return in the post-liberalization (Postlib) period for emerging, developed, and the global economies are 7.428, 7.067, and 7.276. Moreover, the average weekly return in the combined period of liberalization and post-liberalization (LibPostlib) for emerging, developed, and the global economies are 11.292, 8.171, and 9.632, and different from that of the pre-liberalization period. Conclusively, it is evident that

the average weekly return for emerging, developed, and the global economies are different relative to pre- and post-liberalization periods. The unconditional volatility measured through the standard deviation of weekly returns are 48.330, 42.902, and 46.867, for emerging, developed, and the global economies in the liberalization period relative to 37.368, 26.452, and 30.943 before the liberalization. Besides the volatility is highest in the liberalization period compared with the rest of the periods. The unconditional volatility of weekly returns in the post-liberalization and LibPostlib are relatively lower compared with pre-liberalization. The summary statistics reported in Table 2 indicates higher returns with higher volatility persistence in the liberalization period for emerging, developed, and the global economies.

The summary statistics are shown in Table 2 evidenced that the daily, weekly, and monthly returns of emerging, developed, and the global economies are positively skewed and leptokurtic, which is more persistent in the liberalization period. The Jarque-Bera test statistics rejects the null hypothesis of normal distribution at all conventional levels for all the periods of emerging, developed, and the global economies. Moreover, the Ljung-Box Q-statistic rejects the null hypothesis of no autocorrelation up to 24 lags for all the periods of emerging, developed, and the global economies. This indicates that there exist linear dependency in daily, weekly, and monthly returns, and is likely to predict the returns from the past returns.

Table 1.1 Economy Groupings[1]

Sl. No.	Country (ISO Code[2])	Emerging economies	Developed economies	Global economies
1	CHN	China		China
2	IND	India		India
3	IDN	Indonesia		Indonesia
4	MYS	Malaysia		Malaysia
5	PAK	Pakistan		Pakistan
6	PHL	Philippines		Philippines
7	LKA	Sri Lanka		Sri Lanka
8	TWN	Taiwan		Taiwan
9	THA	Thailand		Thailand
10	TUR	Turkey		Turkey
11	FIN		Finland	Finland
12	KOR		Korea	Korea
13	JPN		Japan	Japan
14	HKG		Hong Kong	Hong Kong
15	CHL		Chile	Chile
16	GRC		Greece	Greece
17	DEU		Germany	Germany
18	CAN		Canada	Canada
19	USA		United States	United States
20	ISR		Israel	Israel

Note: [1] The economy(s) are grouped into three categories, namely, Emerging, Developed, and Global economies, following IMF (2016) Country Data Documentation. [2] The Country ISO Code is obtained from IMF (2016) Country Data Documentation. ISO denotes International Organization for Standardization

Table 1.2 Global Stock market Liberalization: Basic information

Sl. No.	Country	Official Liberalization Date	Literature supporting financial Liberalization	Reason for official Liberalization date
1	China	1991/1992 (January)	Lee & Wong (2012)	-
2	India	1992 (May)	Bekaert et al. (2001, 2005), Bhattacharya & Daouk (2002), Fuchs-Schündeln & Funke (2003), Gupta & Yuan (2002), Han Kim & Singal (2000)	Government announces that foreign portfolio investors will be able to invest directly in listed Indian securities (September).
3	Indonesia	1989 (April)	Bekaert et al. (2001, 2005), Bhattacharya & Daouk (2002), Fuchs-Schündeln & Funke, (2003), Gupta & Yuan (2002), Han Kim & Singal (2000), Henry (2000)	Minister of finance allows foreigners to purchase up to 49 % of all companies listing shares on the domestic exchange excluding financial firms (September).
4	Malaysia	1988 (December)	(Bekaert et al., 2005; Bhattacharya & Daouk, 2002; Fuchs-Schündeln & Funke, 2003; Gupta & Yuan, 2002; Henry, 2000; Kaminsky & Schmukler, 2008)	Budget calls for liberalization of foreign ownership policies to attract more foreign investors (October).
5	Pakistan	1991 (February)	Bae, Bailey, & Mao (2006), Bhattacharya & Daouk (2002), Fuchs-Schündeln & Funke, (2003), Gupta & Yuan (2002), Han Kim & Singal (2000), Jayasuriya (2005)	A new Foreign Investment Law passed in February 1991 allows foreigners to own 100% equity in any industrial or business venture in Pakistan
6	Philippines	1991 (June)	Bhattacharya & Daouk (2002), Fuchs-Schündeln & Funke (2003), Gupta & Yuan (2002), Han Kim & Singal (2000), and Henry (2000)	Country fund introduction: "The Thornton Philippines Redevelopment Fund Limited" (The Wilson Directory of Market Funds, p. 15).
7	Sri Lanka	1990	Gupta & Yuan (2002), Fuchs-Schündeln & Funke (2003)	-
8	Taiwan	1991 (January)	Bhattacharya & Daouk (2002), Fuchs-Schündeln & Funke (2003), Henry (2000), and Kim & Singal (2000)	Opened stock market to foreign investment
9	Thailand	1988 (January)	Han Kim & Singal (2000) and Henry (2000)	Liberalized capital and dividend repatriation

10	Turkey	1989	Das & Mohapatra (2003)	-
11	Finland	1990 (January)	Kaminsky & Schmukler (2008)	-
12	Korea	1992 (January)	Bekaert et al. (2001, 2005), Bhattacharya & Daouk (2002), Fuchs-Schündeln & Funke, (2003), Henry (2000), Kaminsky & Schmukler (2008), and Kim & Singal (2000)	Partial opening of the stock market to foreigners. Foreigners can now own up to 10% of domestically listed firms. Five hundred sixty-five foreign investors registered with the Securities Supervisory Board (January).
13	Japan	1983 (September)	Bekaert et al. (2005), Bhattacharya & Daouk (2002), and Kaminsky & Schmukler (2008)	Finance Ministry announces easing restrictions on investments by stocks by foreigners (September).
14	Hong Kong	1994 (August)	Kaminsky & Schmukler (2008)	-
15	Chile	1992 (January)	Bekaert & Harvey (2000) and Kaminsky & Schmukler (2008)	-
16	Greece	1994	Laopodis (2003)	-
17	Germany	1980	Ranciere, Tornell, & Westermann (2006)	-
18	Canada	1980	Ranciere, Tornell, & Westermann (2006)	-
19	USA	1980	Ranciere, Tornell, & Westermann (2006)	-
20	Israel	1996	Ranciere, Tornell, & Westermann (2006)	-

Table 1.3 Data Specification

Sl. No.	Economies	Stock Index(s) Code	Pre-liberalization	Liberalization	Post-liberalization	Full-Period	Source	Currency	Frequency
	Emerging								
1	CHN	SHCOMP	Jan 1991-Dec 1991	Jan 1992-Dec 2007	Jan 2008-June 2016	Jan 1991-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
2	IND	SENSEX	Jan 1980-Apr 1992	May 1992-Apr 2008	May 2008-June 2016	Jan 1980-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
3	IDN	JCI	-	Jan 1992-Jul 1997	Aug 1997-June 2016	Jan 1992-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
4	MYS	FBMKLCI	Feb 1978-Nov 1988	Dec 1988-April 2001	May 2001-June 2016	Jan 1978-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
5	PAK	KSE100	-	Jan 1992-Dec 1993	Jan 1994-June 2016	Jan 1992-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
6	PHL	PCOMP	-	Jan 1992-Dec 1993	Jan 1994-June 2016	Jan 1992-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
7	LKA	CSEALL	Jan 1986-Oct 1989	Nov 1989-Dec 1994	Jan 1995-June 2016	Jan 1986-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
8	TWN	TWSE	Jan 1984-Dec 1986	Jan 1987-Mar 1998	Apr 1998-June 2016	Jan 1984-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
9	THA	SET	-	Jan 1988-Dec 1989	Jan 1990-June 2016	Jan 1988-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
10	TUR	XU100	Jan 1989-Nov 1989	Dec 1989-Dec 1990	Jan 1991-June 2016	Jan 1989-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
	Developed								
11	FIN	HEX	Jan 1988-Dec 1988	Jan 1989-Jan 1990	Feb 1990-June 2016	Jan 1988-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
12	KOR	KOSPI	Jan 1982-Dec 1990	Jan 1991-Apr 1998	May 1998-June 2016	Jan 1982-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
13	JPN	NKY	Jan 1974-Aug 1983	Sept 1983-Dec 1984	Jan 1985-June 2016	Jan 1974-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
14	HKG	HSI	Jan 1975-July 1994	Aug 1994-Dec 2007	Jan 2008-June 2016	Jan 1975-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
15	CHL	IPSA	Jan 1990-Feb 1991	Mar 1991-Dec 1991	Jan 1992-June 2016	Jan 1990-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
16	GRC	ASE	Jan 1989-Dec 1989	Jan 1990-Dec 1994	Jan 1995-June 2016	Jan 1989-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
17	DEU	DAX	Jan 1974-Dec 1979	Jan 1980-Dec 1980	Jan 1981-June 2016	Jan 1974-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
18	CAN	SPTSX	Jan 1974-Dec 1978	Jan 1979-Dec 1980	Jan 1981-June 2016	Jan 1977-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
19	USA	SPX	Jan 1974-Dec 1977	Jan 1978-Dec 1980	Jan 1981-June 2016	Jan 1974-June 2016	Bloomberg	INR	Daily, Weekly, Monthly
20	ISR	TA100	Jan 1992-Dec 1994	Jan 1995-Dec 1996	Jan 1997-June 2016	Jan 1992-June 2016	Bloomberg	INR	Daily, Weekly, Monthly

Notes: [1] Daily, weekly, and monthly, index returns data for Indonesia, Pakistan, Philippines, and Thailand are not available for the pre-liberalization period.

Table 2 Descriptive Statistics

Period		Emerging Economies									Developed Economies									Global								
	f	μ	*Md*	σ	*Skew*	*Kurt*	*JB*[6]	*Q(12)*[7]	*Q(24)*[8]	*N*	μ	*Md*	σ	*Skew*	*Kurt*	*JB*	*Q(12)*	*Q(24)*	*N*	μ	*Md*	σ	*Skew*	*Kurt*	*JB*	*Q(12)*	*Q(24)*	*N*
Prelib[1]	D	18.031	9.094	38.404	3.569	24.425	0.000	0.000	0.000	7396	13.936	8.567	26.547	1.205	4.902	0.000	0.000	0.000	14398	15.326	8.781	31.141	2.835	21.607	0.000	0.000	0.000	21794
	W	18.193	9.029	37.368	3.459	23.883	0.000	0.000	0.000	1649	13.781	8.470	26.452	1.266	5.213	0.000	0.000	0.000	2883	15.386	8.666	30.943	2.790	20.973	0.000	0.000	0.000	4532
	M	19.692	10.345	39.501	3.326	21.028	0.000	0.000	0.000	383	14.616	10.697	27.317	1.196	5.128	0.000	0.000	0.000	713	16.209	10.608	32.218	2.690	19.069	0.000	0.000	0.000	1101
Lib[2]	D	22.952	11.882	49.240	2.956	16.899	0.000	0.000	0.000	18250	12.771	5.045	41.128	4.670	28.648	0.000	0.000	0.000	9523	19.461	8.538	46.867	3.383	19.464	0.000	0.000	0.000	27773
	W	22.988	12.120	48.330	3.080	18.503	0.000	0.000	0.000	3787	13.322	5.246	42.902	4.577	26.986	0.000	0.000	0.000	1929	19.726	8.736	46.789	3.469	20.414	0.000	0.000	0.000	5716
	M	24.580	12.578	53.215	3.129	18.243	0.000	0.000	0.000	893	13.511	5.418	42.928	4.267	24.192	0.000	0.000	0.000	448	20.882	9.350	50.270	3.413	19.793	0.000	0.000	0.000	1341
Postlib[3]	D	7.056	3.959	19.587	0.943	5.938	0.000	0.000	0.000	64062	6.555	4.244	26.473	1.220	9.383	0.000	0.000	0.000	45991	6.847	4.079	22.721	1.148	9.107	0.000	0.000	0.000	110053
	W	7.428	4.352	19.800	0.953	5.973	0.000	0.000	0.000	13378	7.067	4.741	26.446	1.254	9.513	0.000	0.000	0.000	9733	7.276	4.503	22.836	1.173	9.139	0.000	0.000	0.000	23111
	M	7.565	4.375	20.347	0.978	6.058	0.000	0.000	0.000	3080	6.910	4.849	27.783	1.404	11.074	0.000	0.000	0.000	2250	7.288	4.529	23.771	1.287	10.555	0.000	0.000	0.000	5330
LibPostlib[4]	D	11.213	5.750	35.287	3.052	23.584	0.000	0.000	0.000	64242	7.795	4.120	23.586	3.866	39.464	0.000	0.000	0.000	73625	9.388	4.732	29.668	3.497	30.797	0.000	0.000	0.000	137867
	W	11.292	6.104	34.432	3.139	25.751	0.000	0.000	0.000	13468	8.171	4.483	24.048	3.942	39.676	0.000	0.000	0.000	15307	9.632	5.108	29.409	3.560	32.400	0.000	0.000	0.000	28775
	M	11.546	6.470	36.619	3.229	26.651	0.000	0.000	0.000	3132	8.354	4.517	24.460	3.607	34.103	0.000	0.000	0.000	3525	9.857	5.302	30.826	3.561	32.513	0.000	0.000	0.000	6656
Full	D	11.917	6.147	35.681	3.116	23.741	0.000	0.000	0.000	71638	8.801	4.635	24.207	3.280	30.707	0.000	0.000	0.000	87982	10.199	5.201	29.946	3.380	29.084	0.000	0.000	0.000	159620
	W	12.250	6.482	35.120	3.140	24.739	0.000	0.000	0.000	15168	9.060	4.893	24.530	3.396	31.745	0.000	0.000	0.000	18190	10.510	5.544	29.857	3.407	29.780	0.000	0.000	0.000	33358
	M	12.434	6.950	37.026	3.233	25.784	0.000	0.000	0.000	3515	9.409	5.232	25.072	3.072	26.717	0.000	0.000	0.000	4237	10.780	5.980	31.102	3.408	30.025	0.000	0.000	0.000	7752

Notes: [1] Pre-liberalization period, [2] Liberalization period, [3] Post-liberalization period, [4] Liberalization plus post-liberalization period. [5] D, W, M - Daily, Weekly, Monthly, *f* - Frequency, μ - Mean, *Md* - Median, σ - Standard deviation, *Skew* - Skewness, *Kurt* – Kurtosis, *N* - Number of Observations. [6] *p*-Values of the Jarque-Bera (*JB*) statistic for testing the normality of returns. [7] *p*-Values of the Ljung-Box Q-statistic at 12 lag. [8] *p*-Values of the Ljung-Box Q-statistic at 24 lag.

4 Econometric methodology

The study employs autoregressive conditional heteroskedastic (ARCH) and generalized autoregressive conditional heteroskedastic (GARCH) models to develop the framework so as to estimate the parameters of interests, and to quantify the theoretical framework. Engle (1982) coined ARCH models assuming that the variance of the error term in a given period depends on the squared error terms from previous periods. Hence, the volatility in past periods is captured by lags of the squared residuals. Bollerslev (1986) coined the GARCH models in addition to the ARCH model to allow for the variance of the error term to rely on its own lags in addition with lags of the squared errors. Thus, the GARCH model can witness the volatility changes with restricted parameters than the ARCH models.

The autoregressive (AR) model for the indices returns in emerging and developed economies specifies the current returns as a function of lagged returns,

$$R_{it} = \beta_i + \sum_{k=1}^{k} \beta_k R_{it-k} + \varepsilon_{it}, \quad i = 1,\ldots,N; t = 1,\ldots,T \tag{1}$$

Where R_{it} is the current index return for the economy *i* at the time *t*, R_{it-1} is the lagged index return for the economy *i* at the time *t*, and ε_{it} is an error term for the economy *i* at the time *t*. The residuals and squared residuals obtained from the equation (1) are tested for autocorrelation and heteroskedasticity. The daily, weekly, and monthly return series of emerging, developed and the global economies are adjusted for the autocorrelation. Table 3 reports the result of modeling daily, weekly, and monthly return series of emerging, developed, and the global as an AR process. Notably, AR(1) process is sufficient to remove the serial correlation in all periods with an exception in the post-liberalization period where an AR(2) process is essential. Since, autoregressive processes enable to effectively remove the linear dependence of the return series of emerging, developed, and the global economies, the Ljung-Box Q-statistics for squared residuals witness the existence of non-linear dependence in all the periods except in the pre-liberalization period of emerging and developed economies. The ARCH-LM statistics witness the ARCH effects in the errors in all periods with an exception of the pre-liberalization period of developed economies. Thus, we further employ the GARCH-type models as identified below.

Table 3 Box-Jenkins estimation and specification tests

		Emerging Economies					Developed Economies					Global				
f	**Specification**	**Prelib**	**Lib**	**Postlib**	**LibPostlib**	**Full**	**Prelib**	**Lib**	**Postlib**	**LibPostlib**	**Full**	**Prelib**	**Lib**	**Postlib**	**LibPostlib**	**Full**
Daily	β_0	23.473***	23.112***	0.065***	11.231***	11.933***	13.703***	12.793	6.576***	7.788***	8.792***	15.200***	19.458***	6.840***	9.383***	10.194***
	β_1	0.993***	0.991***	0.995***	0.991***	0.991***	0.990***	0.995***	1.006***	0.992***	0.992***	0.988***	0.992***	1.001***	0.991***	0.991***
	β_2			-0.004					-0.015***					-0.010***		
	Q(12)[a]	127.82***	63.090***	47.593***	103.10***	45.761***	20.967**	61.433***	41.400***	71.055***	58.455***	129.34***	79.348***	62.914***	168.95***	80.065***
	Q(24)[b]	132.90***	284.41***	83.122***	674.74***	103.47***	30.375	83.201***	64.918***	105.28***	90.478***	154.71***	324.03***	100.55***	790.97***	152.57***
	Q^2 *(12)*[c]	414.58***	2.294	1.272	8.630	35.604***	0.212	0.103	13.054	0.947	0.951	207.35***	3.046	24.593***	16.772	66.374***
	Q^2 *(24)*[d]	414.62***	111.37***	2.494	3409.4***	37.442**	0.266	0.423	14.492	2.928	2.495	208.27***	143.38***	27.746	6165.6***	70.523***
	ARCH-LM[e]	116.145***	48.594***	21.770***	86.341***	31.681***	13.182***	19.944***	13.282***	25.972***	22.989***	113.026***	63.073	28.020***	132.554***	52.389***
Weekly	β_0	25.704**	23.121***	7.402***	11.296***	12.251***	13.539***	0.137	7.068***	8.167***	9.050***	15.232***	19.713***	7.266***	9.626***	10.504***
	β_1	0.979***	0.954***	0.920***	0.953***	0.959***	0.956***	0.976***	0.928***	0.964***	0.963***	0.953***	0.961***	0.924***	0.957***	0.960***
	β_2			0.037***					0.030***					0.033***		
	Q(12)	22.634**	67.069***	26.804***	133.38***	67.725***	11.420	56.992***	25.197***	80.338***	60.484***	51.435***	83.042***	45.682***	152.40***	107.56***
	Q(24)	35.691**	84.948***	38.670***	150.80***	121.21***	12.454	127.94***	34.792**	100.07***	73.945***	60.956***	116.32***	56.680***	179.49***	166.14***
	Q^2 *(12)*	1.449	35.428***	7.361	765.42***	37.432***	0.876	1.711	32.294***	13.935	13.108	21.590***	45.703***	61.630***	1394.1***	75.417***
	Q^2 *(24)*	4.261	35.745***	9.853	766.64***	139.69***	1.427	14.019	34.769**	58.713***	49.222***	30.279	46.817	66.860***	1399.4***	270.88***
	ARCH-LM	15.561***	11890**	9.524**	25.690***	22.750***	3.048	20.109***	18.717***	43.354***	32.153***	18.421***	13.126***	29.704***	54.829***	48.197***
Monthly	β_0	26.254**	24.679***	7.556***	11.553***	12.445***	14.425***	13.563	0.976***	8.337***	9.403***	16.083***	20.861***	7.303***	9.849***	10.775***
	β_1	0.901***	0.829***	0.833***	0.802***	0.828***	0.827***	0.892***	0.813***	0.848***	0.846***	0.811***	0.846***	0.821***	0.818***	0.835***
	β_2			-0.012					-0.002					-0.006		
	Q(12)	17.126	70.721***	99.977***	33.910***	54.318***	47.818***	84.647***	45.791***	92.934***	133.28***	51.459***	118.09***	56.376***	70.793***	126.12***
	Q(24)	24.469	81.387***	163.65***	47.262***	71.549***	67.265***	89.461***	63.481***	130.74***	195.18***	71.882***	131.11***	116.09***	99.322***	175.56***
	Q^2 *(12)*	6.561	108.89***	580.44***	348.94***	495.08***	47.813***	128.56***	214.75***	318.55***	368.89***	145.50***	162.68***	515.86***	741.96***	1027.9***
	Q^2 *(24)*	26.469	109.32***	698.24***	349.57***	499.90***	96.751***	131.68***	242.58***	339.64***	416.32***	147.93***	163.88***	599.52***	744.68***	1046.1**
	ARCH-LM	15.099***	16.622***	7.649	27.382***	36.018***	2.458	18.756***	20.540***	27.056***	15.279***	18.735***	26.038***	30.416***	46.632***	54.955***

Notes: [a,b] Q(12) and Q(24) specify the Ljung-Box Q-statistic at lags 12 and 24, respectively. [c,d] Q^2 *(12)* and Q^2 *(24)* indicate Ljung-Box Q-statistic of squared residuals at lags 12 and 24 respectively. [e] *ARCH-LM* test statistics at lag 4. ** and *** denotes statistical significance at 5 and 1 percent level respectively.

$$R_{it} = \beta_i + \sum_{k=1}^{k} \beta_k R_{it-k} + \varepsilon_{it}, \quad i = 1,\ldots,N; t = 1,\ldots,T \tag{1}$$

4.1 The GARCH model of volatility

For a cross-section of N economies and T time periods, the conditional mean equation R_{it} can be denoted as a dynamic panel with fixed effects,

$$R_{it} = \beta_i + \sum_{k=1}^{k} \beta_k R_{i,t-k} + \varepsilon_{it}, \quad i = 1,\ldots,N; t = 1,\ldots,T \tag{2}$$

Where R_{it} is the current index return for the economy *i* at the time *t*, $R_{i,t-1}$ is the lagged index return for the economy *i* at the time *t*, β_i captures the economy-specific effects, ε_{it} is a white noise process with a zero mean and normal distribution along with the following conditional moments:

$$E[\varepsilon_{it}\varepsilon_{js}] = 0 \qquad for\ i \neq j\ and\ t \neq s,$$

$$E[\varepsilon_{it}\varepsilon_{js}] = 0 \qquad for\ i = j\ and\ t \neq s,$$

$$E[\varepsilon_{it}\varepsilon_{js}] = h_{ij,t} \qquad for\ i \neq j\ and\ t = s,$$

$$E[\varepsilon_{it}\varepsilon_{js}] = h_{it} \qquad for\ i = j\ and\ t \neq s$$

The conditional variance of R_{it} is assumed to follow GARCH(1,1) process,

$$h_{it} = \alpha_i + \sum_{j=1}^{q} \alpha_1 \varepsilon_{i,t-j}^2 + \sum_{k=1}^{p} \beta_k h_{i,t-k} \tag{3}$$

Where h_{it} is the current conditional volatility for the economy *i* at the time *t*, $h_{i,t-k}$ is the lagged conditional volatility for the economy *i* at the time *t-k*. The coefficients $\alpha_i > 0, \alpha_{ij} \geq 0$ and $\beta_{ik} \geq 0$ for all *i*, and $\left(\sum_{j=1}^{q} \alpha_{ij} + \sum_{k=1}^{p} \beta_{ik}\right) < 1$. The sum of the slope coefficients $\left(\sum_{j=1}^{q} \alpha_{ij} + \sum_{k=1}^{p} \beta_{ik}\right)$ measures the persistence of volatility. The Maximum Likelihood (ML) method is employed to estimate the parameters of the conditional mean equation (2), and variance equation (3). Multiple ARCH(q) and AR(s)-GARCH(q,p) models were estimated. The AR(1) process is adequate to overcome the serial correlation in all periods with an exception in post-liberalization, where an AR(2) process is necessary. Consequently, the model is specified as follows,

$$R_{it} = \phi_i + \phi_1 R_{t-1} + \phi_2 R_{i,t-2} + \varepsilon_{it} \tag{4}$$

$$\varepsilon_{it} / \Psi_{i,t-1} \sim N(0, h_{it})$$

$$h_{it} = \alpha_i + \alpha_1 \varepsilon_{i,t-1}^2 + \beta_1 h_{i,t-1} + \lambda_1 Lib_{it} + \lambda_2 Postlib_{it} \quad (5)$$

$$h_{it} = \alpha_i + \alpha_1 \varepsilon_{i,t-1}^2 + \beta_1 h_{i,t-1} + \lambda_3 LibPostlib_{it} \quad (6)$$

To estimate the impact of stock market liberalization on return volatility, two dummy variables, Lib and Postlib, are introduced in the conditional variance equation (5). The variable Lib takes the value 'one' in the liberalization period and 'zero' otherwise, and Postlib equals 'one' in the post-liberalization period and 'zero' otherwise. A statistically significant λ_1 will specify that liberalization has had an impact on the return volatility, whereas a significant λ_2 will indicate that the return volatility in the post-liberalization period is statistically different from that in the pre-liberalization period for emerging, developed, and the global economies. Further, we examine that whether there is a shift in the volatility regime after the initial liberalization (liberalization plus post-liberalization period or LibPostlib) relative to the pre-liberalization period when the stock market was closed. Practically, this is achieved through the specification of the alternative conditional variance equation (6), where LibPostlib takes the value of 'one' in the liberalization and post-liberalization periods and 'zero' otherwise for emerging, developed, and the global economies.

4.2 TGARCH model and asymmetric shock

The GARCH model eliminates the asymmetric changes in return volatility. The literature symbolizes the negative stock return shock cause additional volatility than the positive return shocks since the argument is primarily based on the leverage effect (Black, 1976; Christie, 1982). The leverage impact indicates that when stock prices plunged to lowest due to negative shocks, the leverage of the firm increases led to increasing in stock price volatility. Thus, to comply with the asymmetric effect, we employ the TGARCH model coined by Glosten, Jagannathan, & Runkle (1993) and Zakoian (1994). The TGARCH model introduced a dummy variable to apprehend the effect of unexpected returns on the conditional variance of returns. The conditional variance of the TGARCH is denoted as,

$$h_{i,t} = \alpha_i + \sum_{j=1}^{q} \alpha_1 \varepsilon_{i,t-1}^2 + \sum_{k=1}^{p} \beta_k h_{i,t-1} + \gamma \varepsilon_{i,t-1}^2 d_{i,t-1} + \lambda_1 Lib_{i,t} + \lambda_2 Postlib_{i,t} \quad (7)$$

$$h_{i,t} = \alpha_i + \sum_{j=1}^{q} \alpha_1 \varepsilon_{i,t-1}^2 + \sum_{k=1}^{p} \beta_k h_{i,t-1} + \gamma \varepsilon_{i,t-1}^2 d_{i,t-1} + \lambda_3 LibPostlib_{i,t} \quad (8)$$

Where $d_{i,t-1} = 1$ if $\varepsilon_{i,t-1} < 0$ and 'zero' otherwise. If $\gamma > 0$ and significant, then there exist a leverage effect. It means that poor market conditions or negative shocks cause more volatility than positive shocks.

5 Empirical Results

The parameters of GARCH and TGARCH models are estimated employing maximum likelihood method. Table 4 reports the result of the GARCH(1,1) model, and Table 5 summarizes the estimates of TGARCH(1,1) model.

5.1 Impact of stock matket liberalization on return volatility

At the first instance, we assess the impact of past volatility through examining the GARCH coefficient (β_1). The coefficient during the full period is estimated as 0.474 and 0.479 (weekly), and, 0.47 and 0.466 (monthly) for emerging economies, -0.073 and -0.085 (weekly), and, 0.407 and 0.399 (monthly) for developed economies, 0.515 and 0.515 (weekly), and, 0.456 and -0.012 for the global economies, respectively, in the two conditional variance equations (5 and 6). They are statistically significant at all conventional levels representing that current volatility is affected by past volatility. The magnitude of GARCH coefficient in either of the frequencies, witnessed highest in the liberalization period, for emerging, developed, and the global economies relative to the aggregate of liberalization and post-liberalization period. These results indicate that the impact of past volatility on the current volatility is highest during the liberalization period as shown in Table 4.

The better understanding that the impact of stock market liberalization on return volatility is to examine the coefficients on the dummy variables, Lib (liberalization), Postlib (post-liberalization), and LibPostlib (liberalization plus post-liberalization). The daily and weekly Lib coefficients are -108.417 and 1.683 for emerging, -25.430 and -33.398 for developed, and, -22.499 and 0.855 for the global economies in the GARCH model (Eq. 5), whereas 101.751 and 1.695 for emerging,

0.337 and 3.704 for developed, and, -64.579 and 4.629 for the global economies in the TGARCH model (Eq. 7 in Table 5), and all of which are significant at the one percent level. The results imply that the volatility is significantly higher during the liberalization period. The weekly and monthly coefficient for Postlib is smaller and not significant in emerging and the global economies except developed economies (significant at 1 percent) in GARCH model, whereas weekly and monthly coefficient for Postlib is significant at the 1 percent level in emerging, developed, and the global economies, in the TGARCH model. The higher volatility persistence is evident in emerging, developed, and the global economies in the liberalization period, albeit we are unable to deny the evidence that suggests the volatility in the post-liberalization period in emerging, developed, and the global economies, is significantly different from the pre-liberalization period. Irrefutably, results imply that the past volatility exerts the highest impact on current volatility during the period of liberalization, proposing that stock market liberalization drives a reliable increment in volatility.

The LibPostlib coefficient to measure if the volatility in the combined period of liberalization and post-liberalization is different relative to the pre-liberalization period. The daily and weekly coefficients in the GARCH model and TGARCH model for emerging, developed, and the global economies are significant at the 1 percent level. This signifies that there has been an increase in the stock return volatility following stock market liberalization relative to the period when it is not open to the foreign investors. Moreover, the greater volatility in the LibPostlib may be bestowed to the high volatility in the liberalization period.

5.2 Asymmetric shocks and return volatility

Table 5 reports the result of the impact of asymmetric shocks on return volatility in the TGARCH model. The asymmetric coefficient (γ) captures the impact of negative versus positive shocks on the return volatility. An asymmetric coefficient that is significantly greater than zero will indicate that negative shocks cause more volatility than positive shocks. The asymmetric coefficient (daily, weekly, and monthly) in the full period (Eq. 7 and Eq. 8) for emerging, developed, and the global economies are significantly less than zero, albeit the magnitude of the asymmetric coefficient is more negative in the liberalization period. Hence, the negative shocks are significantly negatively related to the return volatility proposing negative shocks indeed cause the stock market less volatile in both liberalization and full periods.

Table 4 Maximum Likelihood Estimates for the AR(s)-GARCH(1,1)

		Emerging Economies						Developed Economies						Global					
f		**Prelib**	**Lib**	**Postlib**	**LibPostlib**	**Full**	**Full**	**Prelib**	**Lib**	**Postlib**	**LibPostlib**	**Full**	**Full**	**Prelib**	**Lib**	**Postlib**	**LibPostlib**	**Full**	**Full**
		AR(1)-ARCH(1)	AR(1)-GARCH(1,1)	AR(2)-GARCH(1,1)	AR(1)-GARCH(1,1)	AR(1)-GARCH(1,1)	AR(1)-GARCH(1,1)	AR(1)-ARCH(1)	AR(1)-GARCH(1,1)	AR(2)-GARCH(1,1)	AR(1)-GARCH(1,1)	AR(1)-GARCH(1,1)	AR(1)-GARCH(1,1)	AR(1)-ARCH(1)	AR(1)-GARCH(1,1)	AR(2)-GARCH(1,1)	AR(1)-GARCH(1,1)	AR(1)-GARCH(1,1)	AR(1)-GARCH(1,1)
D	ϕ_i	-1.297**	19.030***	1.901***	8.835***	34.941***	10.966***	1.963***	5.768***	6.156	5.925***	8.254***	8.286***	-2.652***	15.840***	2.273***	7.537***	9.644***	9.617***
	ϕ_1	0.955***	0.734***	0.955***	0.714***	0.824***	0.747***	0.946***	0.915***	0.502***	0.858***	0.747***	0.748***	0.953***	0.740***	0.977***	0.718***	0.743***	0.743***
	ϕ_2			-0.014***						0.473***						-0.035***			
	α_i	9.895***	1518.690***	0.069***	732.797***	663.322***	1192.928***	2.469***	328.298***	375.468***	96.283***	456.414***	473.466***	5.011***	1368.342***	0.079***	487.343***	789.903***	808.655***
	α_1	1.479***	0.202***	0.389***	0.183***	0.074***	0.142***	1.894***	0.098***	0.150***	0.070***	0.092***	0.093***	1.780***	0.221***	0.450***	0.180***	0.135***	0.135***
	β_1		-0.064***	0.750***	-0.032***	-0.050	-0.065***		-0.061***	-0.198***	-0.029***	-0.088***	-0.092***		-0.053***	0.726***	-0.025***	-0.038**	-0.040***
	λ_1					-108.417***						-25.430***						-22.449***	
	λ_2					-468.879***						-109.450***						-83.118***	
	λ_3						-70.149***						-101.087***						-77.804***
	LL[a]	-20661.70	-84225.85	-137361.3	-274620.2	-276460.3	-318602.5	-34086.16	-36790.15	-175576.1	-241264.6	-342579.9	-344107.2	-55993.76	-126735.6	-243173.3	-561595.4	-677015.3	-678371.2
	AIC[b]	5.589	9.231	4.288	8.549	7.718	8.895	4.735	7.728	7.635	6.554	7.787	7.822	5.139	9.127	4.419	8.147	8.482	8.499
W	ϕ_i	2.415***	6.044***	2.670***	0.903***	3.715***	3.629***	5128.131	9.231	8.128	3.079***	0.997	5.521***	-4.830***	3.812***	14.848***	0.390***	3.133***	3.126***
	ϕ_1	0.874***	0.909***	0.868***	0.881***	0.880***	0.880***	1.000***	0.747***	0.520***	0.864***	0.721***	0.725***	0.979***	0.891***	0.521***	0.858***	0.847***	0.874***
	ϕ_2			-0.004						0.434***						0.408***			
	α_i	14.042***	4.650***	1.511***	15.127***	2.097***	2.037***	28.929***	1087.955***	235.150***	1.846***	420.426***	472.906***	23.372***	3.134***	165.565***	5.776***	1.842***	1.861***
	α_1	1.436***	1.048***	0.574***	0.787***	0.801***	0.796***	2.099***	0.260***	0.214***	0.605***	0.111***	0.124***	2.843***	0.858***	0.268***	0.787***	0.692***	0.693***
	β_1		0.426***	0.565***	0.352***	0.474***	0.479***		-0.118**	-0.164***	0.540***	-0.073***	-0.085***		0.476***	-0.126***	0.423***	0.515***	0.515***
	λ_1					1.683***						-33.398						0.855***	
	λ_2					0.218						-147.869***						0.048	
	λ_3						0.550***						-105.851***						0.151***
	LL	-5369.155	-13002.39	-39568.19	-46047.38	-48737.99	-48753.49	-9710.488	-8549.774	-36261.72	-45565.32	-70351.03	-72051.41	-15293.99	-18967.06	-82650.25	-92550.89	-103145.6	-103158.7
	AIC	6.520	6.871	5.917	6.839	6.427	6.429	6.741	8.874	7.454	5.954	7.736	7.923	6.752	6.639	7.153	6.433	6.184	6.185
M	ϕ_i	5.578***	5.167***	2.827***	-3.503***	3.741***	3.742***	7.299***	4.281***	3.008***	3.805***	3.254***	3.462***	6.254***	4.702***	2.850***	-0.151	3.369***	6.772
	ϕ_1	0.644***	0.768***	0.740***	0.695***	0.731***	0.732***	0.709***	0.670***	0.752***	0.696***	0.708***	0.708***	0.667***	0.743***	0.745***	0.685***	0.719***	0.905***
	ϕ_2			-0.038						-0.041						-0.039***			
	α_i	94.874***	27.066***	12.492***	80.227***	21.162***	21.495***	59.660***	33.271***	15.058***	21.240***	21.333***	22.126***	70.027***	27.529***	12.414***	49.159***	18.688***	804.303***
	α_1	1.011***	0.755***	0.586***	1.623***	0.594***	0.603***	1.132***	0.543***	0.478***	0.586***	0.602***	0.598***	1.084***	0.668***	0.528***	1.261***	0.592***	0.460***
	β_1		0.406***	0.428***	0.058***	0.472***	0.466***		0.344***	0.538***	0.357***	0.407***	0.399***		0.413***	0.492***	0.107***	0.456***	-0.012
	λ_1					2.703						3.721***						4.997***	
	λ_2					-5.252						-7.943***						-5.834***	
	λ_3						-3.472						-6.432***						-126.687**
	LL	-1590.730	-3800.768	-11305.30	-13304.49	-14148.33	-141.51.28	-2811.110	-1730.429	-8852.813	-13102.85	-15816.83	-15826.49	-4443.563	-5546.29	-20181.85	-26688.41	-2.9984.54	-33949.25
	AIC	8.349	8.533	7.349	8.501	8.056	8.057	7.907	7.764	7.881	7.439	7.471	7.475	8.086	8.285	7.578	8.022	7.738	8.761

Notes: ** and *** denotes statistical significance at 5 and 1 percent level respectively. [a] Value of log-likelihood function. [b] Akaike Information Criterion

$$R_{it} = \phi_i + \phi_1 R_{t-1} + \phi_2 R_{i,t-2} + \varepsilon_{it} \quad (4)$$

$$h_{it} = \alpha_i + \alpha_1 \varepsilon_{i,t-1}^2 + \beta_1 h_{i,t-1} + \lambda_1 Lib_{it} + \lambda_2 Postlib_{it} \quad (5)$$

$$h_{it} = \alpha_i + \alpha_1 \varepsilon_{i,t-1}^2 + \beta_1 h_{i,t-1} + \lambda_3 LibPostlib_{it} \quad (6)$$

Table 5 Maximum Likelihood Estimates for the AR(s)-TGARCH(1,1)

		Emerging Economies					Developed Economies					Global				
f		**Lib**	**Postlib**	**LibPostlib**	**Full**	**Full**	**Lib**	**Postlib**	**LibPostlib**	**Full**	**Full**	**Lib**	**Postlib**	**LibPostlib**	**Full**	**Full**
		AR(1)-TGARCH(1,1)	AR(2)-TGARCH(1,1)	AR(1)-ARCH(1,1)	AR(1)-TGARCH(1,1)	AR(1)-TGARCH(1,1)	AR(1)-TGARCH(1,1)	AR(2)-GARCH(1,1)	AR(1)-TGARCH(1,1)	AR(1)-TGARCH(1,1)	AR(1)-TGARCH(1,1)	AR(1)-TGARCH(1,1)	AR(2)-TGARCH(1,1)	AR(1)-TGARCH(1,1)	AR(1)-TGARCH(1,1)	AR(1)-TGARCH(1,1)
D	ϕ_i	18.570***	3.592***	1.455***	8.858***	10.034***	9.128***	0.946***	7.521	7.541***	4.946***	14.916***	3.660***	4.448***	7.951***	8.166***
	ϕ_1	0.380***	0.958***	0.934***	0.395***	0.381***	0.409***	0.984***	0.993***	0.690***	0.730***	0.382***	0.980***	0.978***	0.555***	0.547***
	ϕ_2		-0.016***					-0.002					-0.038***			
	α_i	1493.975***	0.070***	0.273***	831.446***	1138.525***	954.209***	0.047***	43.508***	283.000***	300.609***	1326.231***	0.080***	1.543***	535.735***	585.661***
	α_1	0.181***	0.433***	1.155***	0.177***	0.156***	0.199***	0.028***	0.276***	0.217***	0.217***	0.190***	0.499***	0.684***	0.212***	0.207***
	β_1	0.262***	0.773***	0.567***	0.181***	0.250***	0.241	0.986***	-0.0195	-0.088***	-0.123***	0.249***	-0.740***	0.697***	-0.092***	-0.059
	λ_1				-101.751***					-85.299***					-105.808***	
	λ_2				-316.681***					-224.893***					-291.652***	
	λ_3					-1117.697***					-240.515***					-277.725***
	γ	-0.384***	-0.185***	-0.412***	-0.292***	-0.323***	-0.420***	-0.030***	-0.277***	-0.196***	-0.200***	-0.394***	-0.167***	-0.685***	-0.194***	-0.204***
	LL[a]	-88990.77	-136834.5	-161704.9	-316783.1	-334001.9	-43697.61	-113177.5	-213117.6	-297157.5	-289087.20	-133258.1	-242651.7	-333417.2	-628897.5	-638577.1
	AIC[b]	9.753	4.272	5.034	8.844	9.325	9.179	4.922	5.789	6.755	6.571	9.597	4.409	4.836	7.880	8.001
W	ϕ_i	11.503***	4.610***	7.181***	5.926***	9.519***	3.196	4.743***	-28.223	4.927***	4.928***	14.305***	4.626***	2.270***	6.394***	3.653***
	ϕ_1	0.907***	0.881***	0.923***	0.881***	0.395***	0.369***	0.925***	0.963***	0.872***	0.872***	0.392***	0.898***	0.858***	0.445***	0.438***
	ϕ_2		-0.013					-0.0551***					-0.030***			
	α_i	5.207***	1.369***	10.535***	2.028***	1098.027***	698.089***	2.292***	42.596	1.537***	1.657***	1310.083***	1.642***	5.290***	592.855***	633.059***
	α_1	1.185***	0.668***	0.465***	0.914***	0.158***	0.246***	0.814***	0.221***	0.710***	0.712***	0.184***	0.718***	0.835***	0.166***	0.164***
	β_1	0.483***	0.618***	0.694***	0.510***	0.274***	0.138*	0.516***	0.244***	0.599***	0.598***	0.281**	0.580***	0.503***	0.165***	0.176***
	λ_1				1.695***					0.337***					-64.579***	
	λ_2				0.366***					0.020					-245.599***	
	λ_3					-122.295***					-0.082					-221.949***
	γ	-0.750***	-0.364***	-0.476***	-0.420***	-0.357***	-0.482***	-0.285***	-0.222***	-0.402***	-0.403***	-0.425***	0.328***	-0.466***	-0.246***	-0.252***
	LL	-12942.75	-39375.25	-45825.18	-48603.97	-70642.31	-8547.316	-30451.54	-50025.49	-54088.54	-54090.06	-27542.72	-69879.62	-92250.33	-140625.5	-142605.8
	AIC	6.840	5.888	6.806	6.410	9.316	8.872	6.260	6.537	5.948	5.948	9.640	6.048	6.412	8.432	8.550
M	ϕ_i	13.689***	5.419***	12.904***	7.329***	7.367***	5.975***	26.349***	6.071***	5.973***	6.151***	9.728***	5.307***	10.461***	6.425***	6.560***
	ϕ_1	0.855***	0.770***	0.843***	0.751***	0.752***	0.683***	0.990***	0.731***	0.739***	0.740***	0.775***	0.767***	0.466***	0.742***	0.744***
	ϕ_2		-0.034					-0.026					-0.041**			
	α_i	56.313***	11.285***	103.930***	20.184***	20.449***	30.852***	147.322***	19.083***	19.300***	19.536***	32.653***	11.515***	546.080***	16.979***	17.143***
	α_1	1.035***	0.749***	0.542***	0.778***	0.784***	0.752***	0.437***	0.781***	0.799***	0.792***	0.983***	0.667***	0.138***	0.771***	0.774***
	β_1	0.439***	0.517***	0.759***	0.499***	0.496***	0.376***	-0.024***	0.445***	0.475***	0.477***	0.433***	0.549***	0.511***	0.506***	0.505***

λ_1				3.142					3.704*					4.629***	
λ_2				0.032***					-6.221***					-3.346**	
λ_3					0.922					-4.902***					-1.897
γ	-1.072***	-0.546***	-0.645***	-0.515	-0.525***	-0.471***	-0.435***	-0.584***	-0.584***	-0.583***	-0.826***	-0.411***	-0.321***	-0.523	-0.532***
LL	-3730.931	-11211.68	-13572.06	-14073.16	-14073.63	-1723.676	-9273.360	-13001.52	-15690.67	-15699.34	-5483.290	-20078.06	-30526.18	-29793.58	-29803.33
AIC	8.378	7.289	8.673	8.014	8.014	7.739	8.256	7.382	7.412	7.415	8.192	7.539	9.175	7.689	7.691

Notes: *, **, and *** denotes statistical significance at 10, 5, and 1 percent level respectively. **[a]** Value of log-likelihood function. **[b]** Akaike Information Criterion.

$$R_{it} = \phi_i + \phi_1 R_{t-1} + \phi_2 R_{i,t-2} + \varepsilon_{it} \tag{4}$$

$$h_{i,t} = \alpha_i + \sum_{j=1}^{q} \alpha_1 \varepsilon_{i,t-1}^2 + \sum_{k=1}^{p} \beta_k h_{i,t-1} + \gamma \varepsilon_{i,t-1}^2 d_{i,t-1} + \lambda_1 Lib_{i,t} + \lambda_2 Postlib_{i,t} \tag{7}$$

$$h_{i,t} = \alpha_i + \sum_{j=1}^{q} \alpha_1 \varepsilon_{i,t-1}^2 + \sum_{k=1}^{p} \beta_k h_{i,t-1} + \gamma \varepsilon_{i,t-1}^2 d_{i,t-1} + \lambda_3 LibPostlib_{i,t} \tag{8}$$

5.3 Volatility persistence

We further observe the return volatility persistence through examining whether they are different in the liberalization period. Table 6 reports the result of parameter estimates. The volatility persistence is measured through $\alpha_1 + \beta_1$ in GARCH model, and through $\alpha_1 + \beta_1 + \gamma/2$ in the TGARCH model. In emerging economies, both the GARCH equations evident greater volatility persistence in liberalization and post-liberalization period. However, in developed economies both the GARCH equations based on weekly and monthly frequencies evident higher volatility persistence in the post-liberalization period relative to liberalization period. Subsequently, in the global economies both the GARCH equations estimated on weekly and monthly frequencies evidenced higher volatility persistence in during liberalization and post-liberalization periods. In the TGARCH model, there exist evidence of greater volatility persistence in the post-liberalization and LibPostlib period relative to liberalization period. Conclusively, the volatility persistence in emerging, developed, and the global economies are greatest in liberalization and post-liberalization periods.

Table 6 Persistence of Volatility

Model	Period	Volatility Persistence											
		Emerging Economies				Developed Economies				Global			
		$\alpha_1+\beta_1$		$\alpha_1+\beta_1+\gamma/2$		$\alpha_1+\beta_1$		$\alpha_1+\beta_1+\gamma/2$		$\alpha_1+\beta_1$		$\alpha_1+\beta_1+\gamma/2$	
		Weekly	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly	Weekly	Monthly
GARCH	Lib	1.474	1.161			0.378	0.887			1.334	1.081		
	Postlib	1.139	1.014			0.378	1.016			0.394	1.02		
	LibPostlib	1.139	1.681			1.145	0.943			1.21	1.368		
	Full	1.275	1.066			0.184	1.009			1.207	1.048		
	Full	1.275	1.069			0.209	0.997			1.208	0.472		
TGARCH	Lib			1.293	0.938			0.143	0.8925			0.2525	1.003
	Postlib			1.104	0.993			1.1875	0.1955			1.462	1.0105
	LibPostlib			0.921	0.9785			0.354	0.934			1.105	0.4885
	Full			1.214	1.0195			1.108	0.982			0.208	1.0155
	Full			0.2535	1.0175			1.1085	0.9775			0.214	1.013

Notes: [a] The series for the pre-liberalization period is modeled with AR(1)-ARCH(1). Hence, volatility persistence is not calculated for that period.

6 Findings and discussions

We examine the impact of stock market liberalization on return volatility on the panel data of emerging, developed, and the global economies. A fixed effects dynamic panel data model with GARCH specifications has estimated by using the daily, weekly, and monthly frequencies. The empirical results indicate that the stock market liberalization significantly drives the return volatility. Moreover, the conditional volatility measure is highest in the liberalization period for emerging economies whereas the conditional measure for the developed economies are greater in the post-liberalization period. Concurrently, the conditional measure in the combined liberalization period (LibPostlib) is evidenced greater before the stock market is open to the foreign investors, in emerging, developed, and the global economies. Further, it is evident that the positive return shocks drives higher volatility than negative shock in emerging, developed, and the global economies.

The cause behind return volatility increment may be the result of the arrival of fresh information and the trading behavior of the rational investors. With the decision of deregulating the stock market to the foreign investors evidenced fresh listings on the respective stock exchanges in emerging, developed, and the global economies. Moreover, the stock market liberalization trailed by further measures, which made the stock market investments more attractive. The entry of international rational investors considered as prospects that increased the confidence among the country investors. Foreign investors pose the new counterpart to transactions and enabled the local investors an opportunity to engage in frequent trading. Hence, stock market liberalization drives a multitude of factors, which may emphasize to greater market volatility.

The findings of the study witnessed several financial and economic implications, primarily the study provides regulators in emerging and developed economies, a common platform to mitigate risk through efficient management and financial market firmness. Secondly, it helps domestic and foreign investors to perceive the execution of functionalities and volatility persistence of stock markets and thus to arrive at the optimal portfolio investment with the aim to diversify the risks. Finally, the economies propose to liberalize capital market, the empirical findings of the study may

help to ascertain the framework and take the favorable position from the benefits of financial liberalization in mitigating the risk attached to return volatility.

7 Conclusion

The present study examines the impact of stock market liberalization on the return volatility in the panel data of emerging, developed, and the global economies. The findings evidenced that the measure of the conditional volatility is highest in the liberalization period for emerging and the global economies, whereas the measure of conditional volatility is highest in the post-liberalization period for the developed economies. Further, we find that positive return shocks drives more volatility than negative shocks in emerging, developed, and the global economies. The scope for future research might involve a framework that accounts for time effects along with individual effects.

References

Bae, K.-H., Bailey, W., & Mao, C. X. (2006). Stock market liberalization and the information environment. *Journal of International Money and Finance*, *25*(3), 404–428. http://doi.org/10.1016/j.jimonfin.2006.01.004

Bekaert, G., & Harvey, C. R. (1997). Emerging equity market volatility. *Journal of Financial Economics*, *43*(1), 29–77. http://doi.org/10.1016/S0304-405X(96)00889-6

Bekaert, G., & Harvey, C. R. (2000). Foreign Speculators and Emerging Equity Markets. *The Journal of Finance*, *55*(2), 565–613. http://doi.org/10.1111/0022-1082.00220

Bekaert, G., Harvey, C. R., & Lundblad, C. (2001). Emerging equity markets and economic development. *Journal of Development Economics*, *66*(2), 465–504. http://doi.org/10.1016/S0304-3878(01)00171-7

Bekaert, G., Harvey, C. R., & Lundblad, C. (2005). Does financial liberalization spur growth? *Journal of Financial Economics*, *77*(1), 3–55. http://doi.org/10.1016/j.jfineco.2004.05.007

Bekaert, G., Harvey, C. R., & Lundblad, C. T. (2003). Equity Market Liberalization in Emerging Markets. *Journal of Financial Research*, *26*(3), 275–299. http://doi.org/10.1111/1475-6803.00059

Ben Rejeb, A., & Ben Salha, O. (2013). Financial crises and emerging stock markets volatility: do internal factors matter? *Macroeconomics and Finance in Emerging Market Economies*, *6*(1), 146–165. http://doi.org/10.1080/17520843.2012.698630

Ben Rejeb, A., & Boughrara, A. (2014). The relationship between financial liberalization and stock market volatility: the mediating role of financial crises. *Journal of Economic Policy Reform*, *17*(1), 46–70. http://doi.org/10.1080/17487870.2013.827967

Bhattacharya, U., & Daouk, H. (2002). The World Price of Insider Trading. *The Journal of Finance*, *57*(1), 75–108. http://doi.org/10.1111/1540-6261.00416

Black, F. (1976). *Studies of stock price volatility changes*. *Proceedings of the 1976 Meeting of the Business and Economic Statistics Section*. Washington, D.C: American Statistical Association.

Bley, J., & Saad, M. (2011). The effect of financial liberalization on stock-return volatility in GCC markets. *Journal of International Financial Markets, Institutions and Money*, *21*(5), 662–685. http://doi.org/10.1016/j.intfin.2011.04.003

Bollerslev, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, *31*(3), 307–327. http://doi.org/10.1016/0304-4076(86)90063-1

Christie, A. (1982). The stochastic behavior of common stock variances Value, leverage and interest rate effects. *Journal of Financial Economics*, *10*(4), 407–432. http://doi.org/10.1016/0304-405X(82)90018-6

Das, M., & Mohapatra, S. (2003). Income inequality: the aftermath of stock market liberalization in emerging markets. *Journal of Empirical Finance*, *10*(1–2), 217–248. http://doi.org/10.1016/S0927-5398(02)00025-7

De Santis, G. (1993). Asset pricing and portfolio diversification: Evidence from emerging financial markets. *World Bank Discussion Papers*, 145.

De Santis, G., & İmrohoroğlu, S. (1997). Stock returns and volatility in emerging financial markets. *Journal of International Money and Finance*, *16*(4), 561–579. http://doi.org/10.1016/S0261-5606(97)00020-X

Demirguc-Kunt, A., & Levine, R. (1996a). Stock Market Development and Financial Intermediaries: Stylized Facts. *The World Bank Economic Review*, *10*(2), 291–321.

http://doi.org/10.1093/wber/10.2.291
Demirguc-Kunt, A., & Levine, R. (1996b). Stock Markets, Corporate Finance, and Economic Growth: An Overview, *10*(2), 223–239. Retrieved from http://www.jstor.org/stable/3990061
Diamandis, P. F. (2008). Financial liberalization and changes in the dynamic behaviour of emerging market volatility: Evidence from four Latin American equity markets. *Research in International Business and Finance*, *22*(3), 362–377. http://doi.org/10.1016/j.ribaf.2008.02.004
Edwards, S., Biscarri, J. G., & Pérez de Gracia, F. (2003). Stock market cycles, financial liberalization and volatility. *Journal of International Money and Finance*, *22*(7), 925–955. http://doi.org/10.1016/j.jimonfin.2003.09.011
Engle, R. F. (1982). Autoregressive Conditional Heteroscedasticity with Estimates of the Variance of United Kingdom Inflation. *Econometrica*, *50*(4), 987–1007. http://doi.org/10.2307/1912773
Engle, R. F., & Ng, V. K. (1993). Measuring and Testing the Impact of News on Volatility. *The Journal of Finance*, *48*(5), 1749–1778. http://doi.org/10.2307/2329066
Fuchs-Schündeln, N., & Funke, N. (2003). Stock market liberalizations: Financial and macroeconomic implications. *Review of World Economics*, *139*(4), 730–761. http://doi.org/10.1007/BF02653111
Glosten, L. R., Jagannathan, R., & Runkle, D. E. (1993). On the Relation between the Expected Value and the Volatility of the Nominal Excess Return on Stocks. *The Journal of Finance*, *48*(5), 1779–1801. http://doi.org/10.2307/2329067
Gupta, N., & Yuan, K. (2002). Financial Dependence, Stock Market Liberalizations, and Growth. *William Davidson Working Paper Number 562*. Retrieved from http://deepblue.lib.umich.edu/handle/2027.42/39947
Henry, P. B. (2000). Stock Market Liberalization, Economic Reform, and Emerging Market Equity Prices. *The Journal of Finance*, *55*(2), 529–564. http://doi.org/10.1111/0022-1082.00219
Huang, B.-N., & Yang, C.-W. (2000). The Impact of Financial Liberalization on Stock Price Volatility in Emerging Markets. *Journal of Comparative Economics*, *28*(2), 321–339. http://doi.org/10.1006/jcec.2000.1651
IMF. (2016). World Economic Outlook (WEO); WEO Database - Country Data Documentation. Retrieved from https://www.imf.org/external/pubs/ft/weo/2016/01/weodata/co.pdf
Jaleel, F. M., & Samarakoon, L. P. (2009). Stock market liberalization and return volatility: Evidence from the emerging market of Sri Lanka. *Journal of Multinational Financial Management*, *19*(5), 409–423. http://doi.org/10.1016/j.mulfin.2009.07.006
Jayasuriya, S. (2005). Stock market liberalization and volatility in the presence of favorable market characteristics and institutions. *Emerging Markets Review*, *6*(2), 170–191. http://doi.org/10.1016/j.ememar.2005.03.001
Kaminsky, G. L., & Schmukler, S. L. (2008). Short-Run Pain, Long-Run Gain: Financial Liberalization and Stock Market Cycles. *Review of Finance*, *12*(2), 253–292. http://doi.org/10.1093/rof/rfn002
Kassimatis, K. (2002). Financial liberalization and stock market volatility in selected developing countries. *Applied Financial Economics*, *12*(6), 389–394. http://doi.org/10.1080/09603100010001937
Kim, E. H., & Singal, V. (1993). Opening up of stock markets by emerging economies: effect on portfolio flows and volatility of stock prices. *Portfolio Investment in Developing Countries*, 383–403.

Kim, E. H., & Singal, V. (2000). Stock Market Openings: Experience of Emerging Economies. *The Journal of Business*, *73*(1), 25–66. http://doi.org/10.1086/209631

Klein, M. W., & Olivei, G. P. (2008). Capital account liberalization, financial depth, and economic growth. *Journal of International Money and Finance*, *27*(6), 861–875. http://doi.org/10.1016/j.jimonfin.2008.05.002

Kwan, F. B., & Reyes, M. G. (1997). Price effects of stock market liberalization in Taiwan. *The Quarterly Review of Economics and Finance*, *37*(2), 511–522. http://doi.org/10.1016/S1062-9769(97)90040-5

Laopodis, N. T. (2003). Financial market liberalization and stock market efficiency: the case of Greece. *Managerial Finance*, *29*(4), 24–41. http://doi.org/10.1108/03074350310768274

Lee, J. K.-Y., & Wong, A. Y.-T. (2012). Impact of financial liberalisation on stock market liquidity: experience of China. *Journal of Chinese Economic and Foreign Trade Studies*, *5*(1), 4–19. http://doi.org/10.1108/17544401211197922

Levine, R., & Zervos, S. (1998). Capital control liberalization and stock market development. *World Development*, *26*(7), 1169–1183. http://doi.org/10.1016/S0305-750X(98)00046-1

Li, D., Nguyen, Q. N., Pham, P. K., & Wei, S. X. (2011). Large Foreign Ownership and Firm-Level Stock Return Volatility in Emerging Markets. *Journal of Financial and Quantitative Analysis*, *46*(4), 1127–1155. http://doi.org/10.1017/S0022109011000202

Ndako, U. B. (2012). Financial liberalization, structural breaks and stock market volatility: evidence from South Africa. *Applied Financial Economics*, *22*(15), 1259–1273. http://doi.org/10.1080/09603107.2012.654911

Nguyen, D. (2010). The Dynamics of Stock Market Volatility around the Opening of Capital Markets. *Economie & Prévision*, *192*(1), 65–82. Retrieved from http://www.cairn.info/revue-economie-et-prevision-2010-1-page-65.htm

Pagan, A. R., & Schwert, G. W. (1990). Alternative models for conditional stock volatility. *Journal of Econometrics*, *45*(1–2), 267–290. http://doi.org/10.1016/0304-4076(90)90101-X

Ranciere, R., Tornell, A., & Westermann, F. (2006). Decomposing the effects of financial liberalization: Crises vs. growth. *Journal of Banking & Finance*, *30*(12), 3331–3348. http://doi.org/10.1016/j.jbankfin.2006.05.019

Singh, A. (1993). The Stock Market and Economic Development: Should Developing Countries Encourage Stock Markets? *UNCTAD Review*, *4*, 1–28.

Spyrou, S. I., & Kassimatis, K. (1999). Did Equity Market Volatility Increase Following the Opening of Emerging Markets to Foreign Investors?, *24*(1), 39–51.

Stulz, R. M. (1999). International Portfolio Flows and Security Markets. *SSRN Electronic Journal*, (March), 257–293. http://doi.org/10.2139/ssrn.155188

Zakoian, J.-M. (1994). Threshold heteroskedastic models. *Journal of Economic Dynamics and Control*, *18*(5), 931–955. http://doi.org/10.1016/0165-1889(94)90039-6