

Chapter 2

Stock Market Cycles and Volatility Regime Switch

*The highest degree of prosperity ... suddenly ... plunged into
embarrassment and distress.*

Martin Van Buren

Abstract This chapter initiates the empirical dissection of stock market crises by an analysis of price movements and isolates two prominent stock market cycles over the study period. While the first cycle occurred during 1998–2005, a discernible second cycle took place from 2006 to 2011. The chapter analyzes the global trends around these cycles and explores the possible presence of intra-regional and inter-regional association and/or global financial integration. The intrinsic nature of different crises is further analyzed and compared in terms of volatility regime switch models where we inquire whether financial crises inevitably take the form of a structural break and whether such breaks follow some discernible pattern across the markets. The second cycle, rather than the first one appears to be truly ‘global’ and is marked by strong financial integration at the global level. Regional associations are however, not so robust. The association between financial crises and volatility breaks has been ambiguous and has varied from cycle to cycle. Such associations have been stronger over the second cycle where financial market changes have almost taken the form of volatility regime switch.

Keywords Financial crises • Stock market cycle • Structural break • Volatility regime • ICSS test • Dynamic interlinkage

2.1 Introduction

The boom-slump cycle of the stock market has been as old as capitalism itself. The fact that, boom-bust cycles had remained and will remain, however, hardly permits one to take these for granted. In reality we cannot afford to ignore such

Martin van Buren, address to Special Session of Congress, 4 September 1837. <http://presidency.ucsb.edu/ws/index.php?pid=67234>. Accessed 13 February 2007.

cycles due to their potential threat to the financial markets as well as to the broader economy. A boom turns into a bust as “irrational exuberance” loses fuel and triggers massive panic leading sometimes to global financial meltdown. A growing body of literature emphasizes that the origin of such cycles might differ but the path followed by the global market during each of these cycles has remained the same. Every time, sheer lack of confidence and panic have overshadowed the initial euphoria and made the market struggle and plunge. Within this broad trend, however, it might be of relevance to trace the regional trends. Particularly, an exploration of whether and how the dynamics of and interlinkages within the global market change as it approaches a peak, slides from it and recovers could be of interest. A related and equally important issue could be an exploration of whether all the markets, irrespective of their levels of financial development, move similarly over different phases of stock market cycles. This is specifically what this chapter probes into.

The empirical anatomy of global market dynamics starts from a simple introspection of stock market movements. The study initiates by exploring the stock price movements across the different stock market cycles and seeks to trace possible presence of intra/inter regional association and/or global financial integration. Apart from such simple analysis of stock price movements, the study will explore the presence of volatility regime switch in stock markets across the globe. Specifically it will identify different volatility breaks in individual stock markets and will attempt to explore whether such volatility break dates are common across markets. This is particularly important because, any financial crisis is often considered as a switch in ‘regime’ that often manifests itself in a structural break in the market volatility. It would thus be interesting to explore whether the financial crises are necessarily associated with a volatility break or whether regime switches necessarily lead to financial crises. Moreover, this will help us analyze and compare the intrinsic nature of the different stock market crises. The possible inter-relationship among the global markets could be effectively analyzed by examining whether volatility break dates coincide or at least follow some lead-lag relationship across markets.

2.2 Two Significant Stock Market Cycles

Simple introspection of stock prices reveals the presence of three significant peaks and two significant troughs in the global market over the period from 1998 to 2011. In this study, the peaks are dates on which the market reaches a local maximum and troughs are those on which any market hits its local minimum in terms of price. On the basis of price movements, the study isolates two significant stock market cycles in the global stock market. While the first cycle occurred from 1998 to 2003, the second cycle covered the period of 2006 to 2011.

2.2.1 The First Cycle Revisited

Analysts might find it difficult to label the first cycle as ‘truly’ global because of its failure to have an all-embracing impact on the global stock market. Out of the thirty markets selected, the cycle remained significant in only twenty of them. The crisis failed to hit the African (Cairo) and the Middle East (Tel Aviv) markets, and the Asia–Pacific markets such as Australia, New Zealand and Indonesia could avoid the heat of this cycle. A few markets from the European region (such as Austria, Oslo and Stockholm) and the American region (such as Mexico and Argentina) too managed to escape the crisis. The impact of the cycle, however, has been tremendous on the markets on which it hit hard. In six out of these twenty markets, affected intensely by the crisis, the peak-price attained during the cycle has remained the all-time high. For these six markets of Taiwan, Japan, UK, France, Austria and the US (NASDAQ only) the first cycle brought about incredible prosperity that could not be outshined even in the next 13 years. Moreover, the slump associated with the cycle has been the all-time dip for fifteen out of these twenty markets. It has been the worst crisis that these economies have seen. The journey towards the first peak was initiated by the European markets. The Swiss market was the first to reach the peak in July 1998 followed by Belgium that reached the summit in January 1999. Specifically, it is since December 1999 that markets starting from the London stock market began to reach their respective peaks one after another. However, it is difficult to trace out any regional pattern in this movement. The process of reaching peaks continued for a sufficiently long period of time. It took almost four and a half years (from July 1998 to April 2002) for all the markets to reach their respective peaks. The process of reaching the trough had been more of a global phenomenon rather than a regional one. The markets started hitting their slumps since April 2002. Within a short span of one year all the twenty markets reached their respective trough. Out of these twenty markets, three hit their slumps in September–October 2001. In October 2002, six markets touched their minima with five (including the three US indexes) of them reaching slump simultaneously on 9 October 2002. The nose-diving completed in March–April 2003, when eight markets hit their slumps. Of these eight markets, five from the European region touched their lowest on 12 March 2003. Thus, the first recession considered in this study has been a truly global phenomenon. However, some regional association might be expected to be present within the European region and among the US markets. The peaks and troughs associated with the first cycle in global market are shown in Fig. 2.1.

2.2.2 The Second Cycle Revisited

The second cycle has remained prominent in all the thirty markets selected. For seventeen markets, out of the chosen thirty, prices have been all-time high

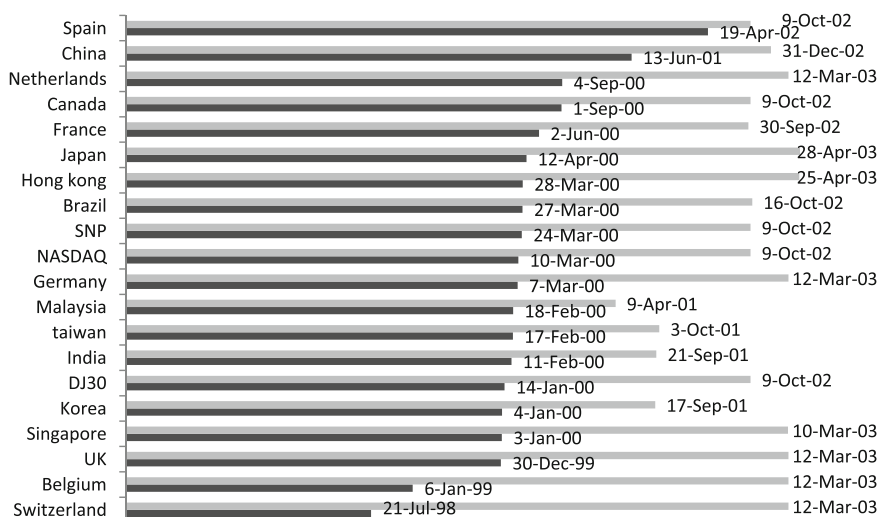


Fig. 2.1 First peak and first trough in global stock market

around this peak. For thirteen markets, prices have been all-time low around the slump. Clearly, the prosperity that it brought about was enormous while the distress that followed was toe-curling. As is evident from the dates of reaching the respective peaks, the European markets (and two Asia Pacific markets) were once again to initiate the move. The nature of the movement around the second cycle has been quite different from the first one in the sense that stock market movements toward peak were much more 'global' in nature. In contrast to the first cycle, the process of reaching their respective peaks by the stock markets in the second phase completed within a relatively shorter period of time. The process continued for a period of one year starting from May 2007. The markets reached their respective peaks either simultaneously or within a short span of time. Eleven markets reached their respective peaks within a short span of two months starting from May 2007. New Zealand and Belgium reached their respective peaks on two consecutive days. Switzerland and France reached their peaks on the same day (that is on 1 June 2007). Same was the case for the Japan-Austria market pair. They reached their peaks on 9 July 2007. Stock markets of Stockholm and Germany reached summit on 16 July 2007. Nine markets reached their peaks in October 2007. Once again, Dow Jones and S&P reached their peaks simultaneously on 9 October. Tel Aviv and Taiwan reached their peak on 29 October. NASDAQ, Argentinean and Korean markets reached their respective peaks on 31 October. Asian markets attained their individual peaks in two phases: the first one was in October 2007 and the other one was in January 2008. The process of hitting the slump has been really a global phenomenon. Out of the thirty markets, twenty-one reached their respective slumps in March 2009. More interestingly, nine out of these markets touched

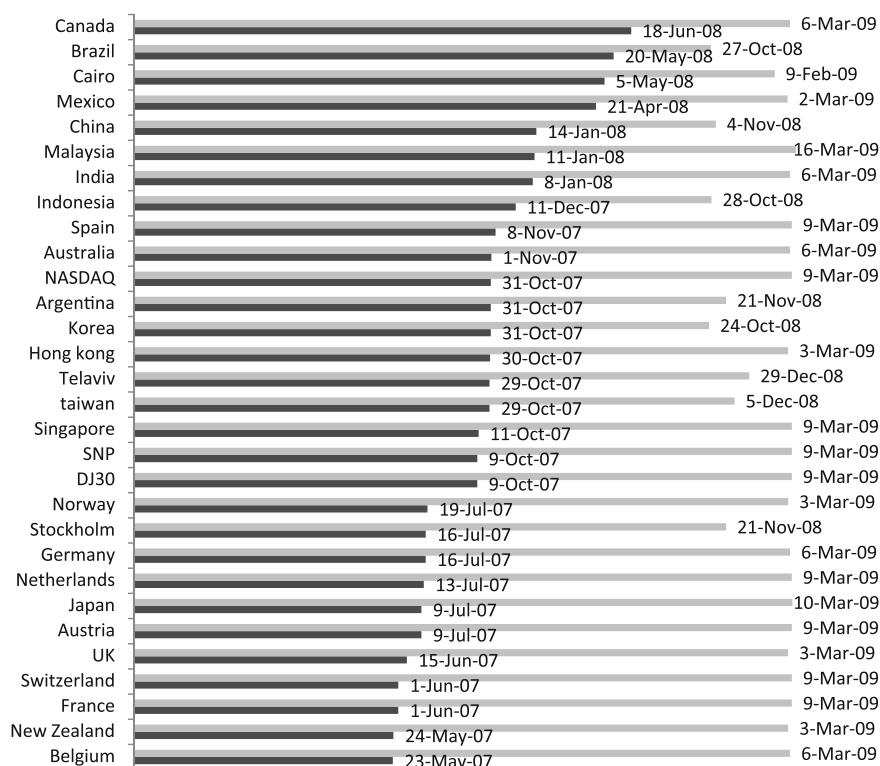


Fig. 2.2 Second peak and second trough in global stock market

their trough on 9 March; five hit slump on 6 March and three dipped on 3 March 2009. Thus, like the first cycle considered earlier, while some regional association could be expected to exist during the pre-crisis period of this second phase, the recession has been more of a global nature. Figure 2.2 depicts the second peak and second trough in the global stock market.

2.2.3 *The Peak in the Recent Years*

The markets have started recovering since March 2009. They have approached their respective peaks once again in more recent years. This is depicted in Fig. 2.3. For seven markets, prices have been all-time high around this peak. However, due to lack of sufficient data in recent years, it would be too early to explain it as the initiation of the third cycle. Our study clubs the period from 2009 to 2011 in the second phase of stock market movement. Simple introspection of stock price movement hints toward possible presence of some intra-regional association,

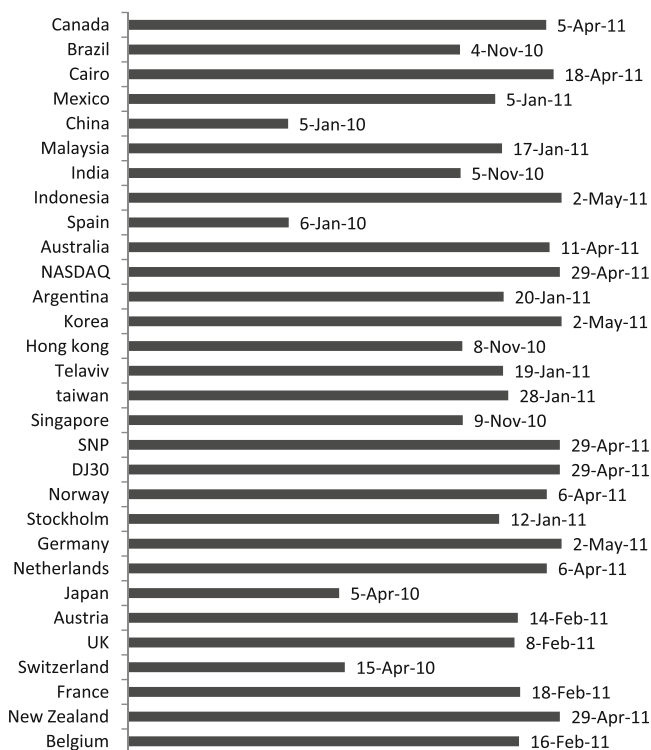


Fig. 2.3 Third peak in global stock market

particularly within the Asian region, European region and the US region. Some kind of lead-lag relationship might also be expected to hold.

2.2.4 Three Peaks and Two Troughs

A comparison among the stock prices that the markets attained during their respective peaks and slumps might be of interest in this context (Fig. 2.4). The nineteen markets that have passed through both the cycles can be clubbed under three categories. For eleven of them, the second peak has been more significant than the first one in the sense that prices have been significantly higher around the second peak. The difference has been maximum for the Indian market. Out of these eleven markets as many as six come from the Asian region. For some European markets and the S&P index, prices around the two peaks have been more or less the same. For the remaining markets, the first peak has been more significant.

A comparison of the two slumps (Fig. 2.5) reveals that prices around the first trough has been much lower compared to the second one in most of the markets. On average, prices have been 47% higher around the second trough. The difference

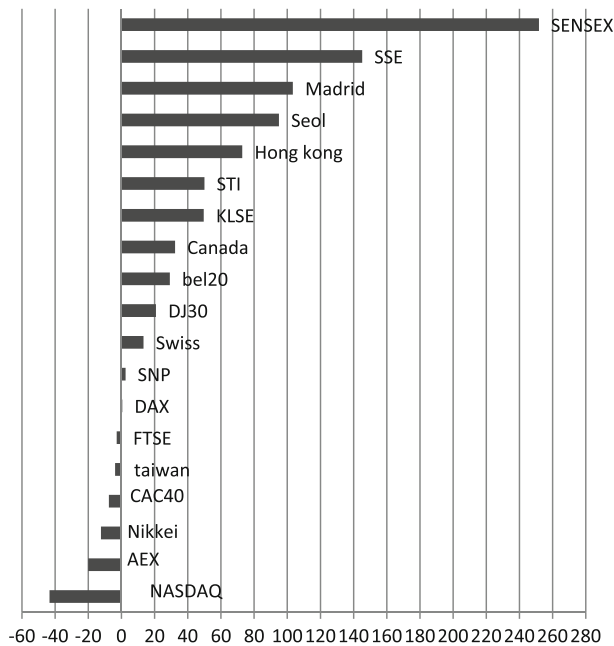


Fig. 2.4 Price difference between the first and second peaks (in percentage)

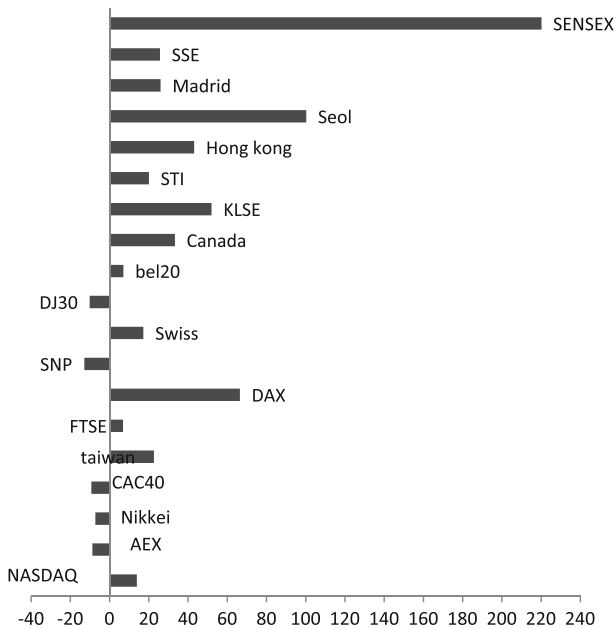


Fig. 2.5 Price difference between the first and second trough (in percentage)

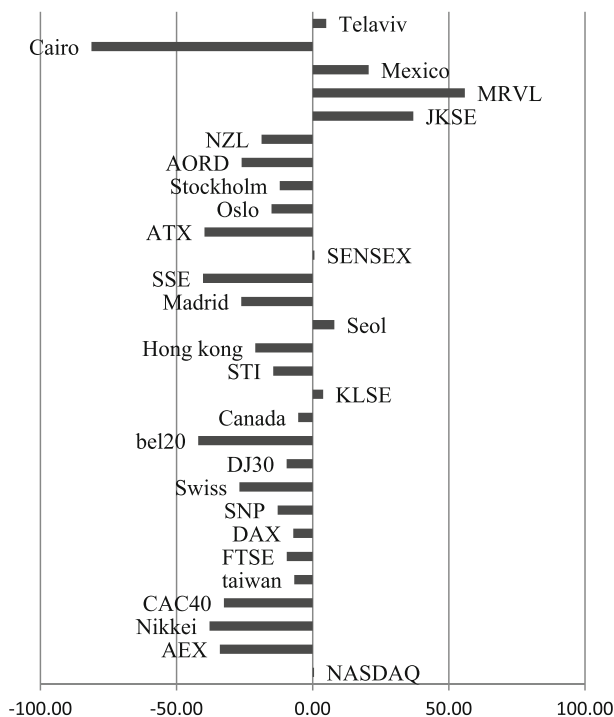


Fig. 2.6 Price difference between the second and the recent peak (in percentage)

has been widest for the Indian market (220%) and narrowest for the UK market (6%). Only for five markets, prices around the first trough have been higher than the second one. On average, prices have been 9.67% lower around the second trough, the difference being the widest in case of S&P. Thus, for most of the markets, slump has been deeper in the first cycle.

A comparison of the second peak and the recent peak is shown in Fig. 2.6. For most of the markets, prices around the second peak have been much higher compared to the recent one. On average, prices have been higher by 24.8% around the second peak. For only eight markets prices were higher (on average by 16%) around the recent peak.

Finally, a look at the price difference between a peak and the corresponding trough might be of interest (Fig. 2.7). On average, prices have fallen by 55.34% in almost 1 year when the markets moved from the first peak to the first trough. The journey from the second peak to second trough continued for 1 year and was associated by a price drop of 57.8%. On the basis of price drop while moving from a peak to trough, countries could be categorized into three. For some countries (such as Hong Kong, Singapore, Belgium, India, China, Spain and the US markets) price shedding has been more around the first cycle. The reverse is true for the markets such as Germany, Taiwan, Austria and NASDAQ. For few other markets price change has been more or less the same around the two cycles.

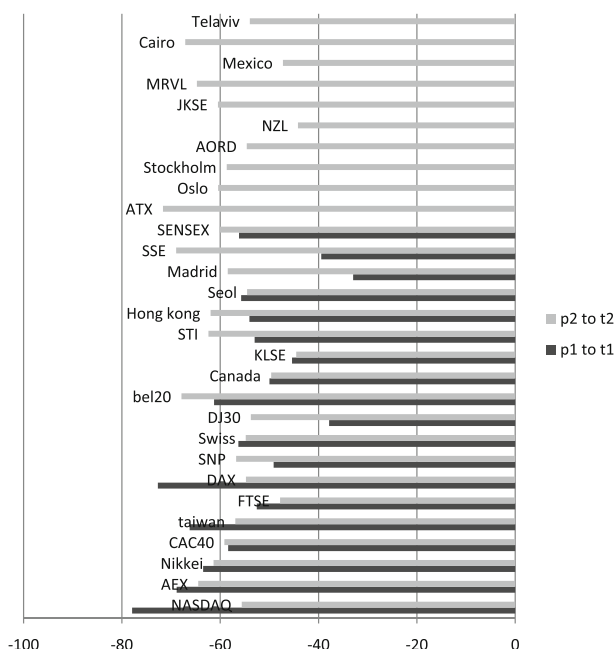


Fig. 2.7 Price shedding during the journey from peak to trough (in percentage)

Thus, simple introspection of stock price movements reveals some trends that need further analysis. To summarize:

- Two prominent stock market cycles could be traced in the global market over a period of 13 years from 1998 to 2011.
- The second cycle (covering the period from 2006 to 2011), rather than the first one (1998–2004) has been more general, or ‘global’ in nature.
- For most of the markets, the prices around the second peak (around 2007–2008) have been the all-time high.
- For most of the markets, the prices around the first trough (around 2002–2003) have been the all-time low.
- It could hardly be expected to have any regional pattern in stock price movements during the first cycle. However, some regional association might be expected during the second cycle, particularly when the markets were approaching their respective peaks. Recessions have been truly global in both the cycles, although the extent of ‘being global’ varies.
- Since during both the cycles, markets reached their respective peaks (and troughs) either simultaneously or in consecutive days, some kind of financial integration (or, lead-lag relationship) might be expected to prevail in the global market.

With these findings in the back of our mind, we now proceed to explore the possible intrinsic inter-relationship among stock markets of the world in a more

technical way. To supplement our previous analysis, we now look for the presence or otherwise of volatility breaks in these markets within the study period. This is particularly because, any financial crisis could well be thought of as a switch in regime that is often reflected in a structural break in the market volatility. The study now extends itself to seek and to explore whether and how the markets have passed through different volatility regimes around these stock market cycles. In that way, we check whether the financial crises could necessarily be associated with a volatility break or whether regime switches necessarily lead to financial crises. The possible inter-relationship among the global markets has been analyzed by examining whether volatility break dates coincide or at least follow some lead-lag relationship across markets.

2.3 Detection of Structural Break in Volatility

The parameters of a typical time series do not remain constant over time. It makes paradigm shifts in regular intervals. The time of this shift is the structural break. And the period between two breakpoints is known as a regime. There have been several studies aimed at measuring the breakpoints. As usual, majority of them are in the stock market. As only the algorithm used to detect the breakpoints is important rather than the underlying time series, the following section discusses the studies with important breakthroughs in the algorithm irrespective of the market.

The first group of studies was able to detect only one unknown structural breakpoint. Perron (1990), Hansen (1990, 1992), Banerjee et al. (1992), Perron and Vogelsang (1992), Chu and White (1992), Andrews (1993), Andrews and Ploberger (1994), Perron (1997a) did some major works in this area. Studies by Nelson and Plosser (1982), Perron (1989), Zivot and Andrews (1992) tested unit root in presence of structural break. Bai (1994, 1997) considered the distributional properties of the break dates.

The second group of studies was an improvement over the first as it was able to detect multiple structural breaks in a financial time series, most importantly endogenous break points. Significant contributions were made by Zivot and Andrews (1992). Perron (1989, 1997b), Bai and Perron (2003), Lumsdaine and Papell (1997) tests for unit root allowing for two breaks in the trend function. Hansen (2001) considers multiple breaks, although he considers the breaks to be exogenously given.

The major breakthrough was the study by Inclan and Tiao (1994), who proposed a test to detect shifts in unconditional variance that is the volatility. This test is used extensively in financial time series to identify breaks in volatility (Wilson et al. 1996; Aggarwal et al. 1999; Huang and Yang 2001). This test was later modified by Sansó et al. (2004) to account for conditional variance as well.

Hsu et al. (1974) proposed in their study a model with nonstationary variance which is subjected to changes. This is probably the first work involving structural breaks in variance. Hsu's later works in (1977, 1979 and in 1982) were aimed at

detecting a single break in variance in a time series. Abraham and Wei (1984) discussed methods of identifying a single structural shift in variance. An improvement came in the study of Baufays and Rasson (1985) who addressed the issue with multiple breakpoints in their paper. Tsay (1988) also discussed ARMA models allowing for outliers and variance changes and proposed a method for detecting the breakpoint in variance. More recently, Cheng (2009) provided an algorithm to detect multiple structural breakpoints for a change in mean as well as a change in variance.

This study does not explicitly incorporate any regime switching model but considers the period between two breaks as a regime. Schaller and Norden (1997) used Markov Switching model to find very strong evidence of regime switch in CRSP value-weighted monthly stock market returns from 1929 to 1989. Marcucci (2005) used a regime switching GARCH model to forecast volatility in S&P 500 which is characterized by several regime switches. Structural breaks and regime switch is addressed by Ismail and Isa (2006) who used a SETAR type model to test structural breaks in Malaysian Ringgit, Singapore Dollar and Thai Baht.

Theoretically, volatility break dates are basically structural breaks in variance of a given time series. Structural breaks are often defined as persistent and pronounced macroeconomic shifts in the data generating process. Usually, the probability of observing any structural break increases as we expand the period of study. The methodology used in this chapter is the line of analysis that was followed by Inclan and Tiao (1994). In the following section, we are briefly recapitulating the methodology.

We may start from a simple AR (1) process as that described in (2.1) and (2.2).

$$y_t = \alpha + \rho y_{t-1} + \varepsilon_t \quad (2.1)$$

$$E\varepsilon_t^2 = \sigma^2 \quad (2.2)$$

Here ε_t is a time series of serially uncorrelated shocks. If the series is stationary, the parameters α , ρ and σ^2 are constant over time. By definition, a structural break occurs if at least one of the parameters changes permanently at some point in time (Hansen 2001). The time point where the parameter changes value is often termed as a “break date”. According to Brooks (2002), structural breaks are irreversible in nature. The reasons behind occurrence of structural breaks, however, are not very specified. Economic and non-economic (or even unidentifiable) reasons are equally likely to bring about structural break in volatility (Valentinyi- Endr  sz 2004).

2.3.1 Detection of Multiple Structural Breaks in Variance: The ICSS Test

The Iterative Cumulative Sum of Squares (or the ICSS) algorithm by Inclan and Tiao (1994) can very well detect sudden changes in unconditional variance for a

stochastic process. Hence, the test is often used to detect multiple shifts in volatility. The algorithm starts from the premise that over an initial period, the time series under consideration displays a stationary variance. The variance changes following a shock to the system and continues to be stationary till it experiences another shock in the future. This process is repeated over time till we could identify all the breaks. Structural breaks can effectively capture regime switches (Altissimo and Corradi 2003; Gonzalo and Pitarakis 2002; Valentinyi-Endr sz 2004). The different tests for identifying volatility breaks isolate dates where conditional volatility moves from one stationary level to another. The idea is similar to those lying behind the Markov regime switching models, where a system jumps from one volatility regime to another.

2.3.1.1 The Original Model: Breaks in Unconditional Variance

The original model of Incl n and Tiao (1994) is reproduced as follows:

Let $C_k = \sum_{t=1}^k a_t^2$, $k = 1, \dots, T$ is the cumulative sum of squares for a series of independent observations $\{a_t\}$, where $a_t \sim iidN(0, \sigma^2)$ and $t = 1, 2, \dots, T$, σ^2 is the unconditional variance.

$$\sigma^2 = \begin{cases} \tau_0, 1 < t < \kappa_1 \\ \tau_1, \kappa_1 < t < \kappa_2 \\ \dots \\ \tau_{N_T}, \kappa_{N_T} < t < T \end{cases} \quad (2.3)$$

where $1 < \kappa_1 < \kappa_2 < \dots < \kappa_{N_T} < T$ are the break points that is where the breaks in variances occur. N_T is the total number of such changes for T observations. Within each interval, the variance is τ_j^2 , $j = 0, 1, \dots, N_T$.

The centralized or normalized cumulative sum of squares is denoted by D_k where

$$D_k = \frac{C_k}{C_T} - \frac{k}{T} D_0 = D_T = 0 \quad (2.4)$$

C_T is the sum of squared residuals for the whole sample period. If there is no volatility shift D_k will oscillate around zero. With a change in variance, it will drift upward or downward and will exhibit a pattern going out of some specified boundaries (provided by a critical value based on the distribution of D_k) with high probability. If at some k , say k^* , the maximum absolute value of D_k , given by $\max_k |\sqrt{T/2D_k}|$ exceeds the critical value, the null hypothesis of constant variance is rejected and k^* will be regarded as an estimate of the change point. Under variance homogeneity, $\sqrt{T/2D_k}$ behaves like a Brownian bridge asymptotically.

For multiple breakpoints, however, the usefulness of the D_k function is questionable due to the “masking effect”. To avoid this, Incl n and Tiao designed an iterative algorithm that uses successive application of the D_k function at different points in the time series to look for possible shift in volatility.

2.3.1.2 Modified ICSS Test: Breaks in Conditional Variance

The modified ICSS test will now be reproduced and used in this study. Sansó et al. (2004) found significant size distortions for the ICSS test in presence of excessive kurtosis and conditional heteroscedasticity. This makes original ICSS test invalid in context of financial time series that are often characterized by fat tails and conditional heteroscedasticity. As a remedial measure, they introduced two tests to explicitly consider the fourth moment properties of the disturbances and the conditional heteroscedasticity.

The first test, or the κ_1 test, makes the asymptotic distribution free of nuisance parameters for *iid* zero mean random variables.

$$\kappa_1 = \sup_k |T^{-1/2} B_k|, \quad k = 1, \dots, T \quad (2.5)$$

$$B_k = \frac{C_k - \frac{k}{T} C_T}{\sqrt{\hat{\eta}_4 - \hat{\sigma}^4}}, \quad \hat{\eta}_4 = T^{-1} \sum_{t=1}^T \varepsilon_t^4 \text{ and } \hat{\sigma}^4 = T^{-1} C_T$$

This statistic is free of any nuisance parameter. The second test, the κ_2 test solves the problems of fat tails and persistent volatility.

$$\kappa_2 = \sup_k |T^{-1/2} G_k| \quad (2.6)$$

where $G_k = \hat{\omega}_4^{-\frac{1}{2}} (C_k - \frac{k}{T} C_T)$

$\hat{\omega}_4$ is a consistent estimator of ω_4 . A nonparametric estimator of ω_4 can be expressed as:

$$\hat{\omega}_4 = \frac{1}{T} \sum_{i=1}^T (\varepsilon_i^2 - \hat{\sigma}^2)^2 + \frac{2}{T} \sum_{l=1}^m \omega(l, m) \sum_{i=1}^T (\varepsilon_i^2 - \hat{\sigma}^2)(\varepsilon_{i-l}^2 - \hat{\sigma}^2) \quad (2.7)$$

$\omega(l, m)$ is a lag window, and is defined as $\omega(l, m) = [1 - l/(m+1)]$. The bandwidth m is chosen by the Newey-West (1994) technique. The κ_2 test is more powerful than the original Inclán-Tiao test or even the κ_1 test and is best fit for our purpose.

2.3.2 Volatility Breaks in Global Stock Market

On the basis of the modified ICSS test, the study has identified different volatility break dates in the global stock market. The break dates are presented in the following tables. Break dates are shown for two subperiods. The first subperiod, defined around the first cycle, considers the period from 1998 to 2004 (Table 2.1). The second subperiod defined over the second cycle ranges from 2005 to 2011 (Table 2.2).

Table 2.1 Volatility break dates in phase 1

Germany	12-Jun-02	16-May-03	27-Oct-03			
Austria	23-Mar-00					
Belgium	10-Jun-02	20-May-03	3-Jun-04			
France	31-May-02	29-Oct-02	10-Mar-03	9-Apr-03	10-Oct-03	
UK	10-Jun-02	1-Nov-02	11-Jul-03			
Oslo	5-Dec-02					
Stockholm	7-Apr-03	20-Aug-04				
Spain	9-Jul-03					
Australia	28-Apr-03					
Taiwan	9-Mar-00	14-Feb-01	28-Aug-03	16-Mar-04	23-Aug-04	
Hong Kong	15-Oct-98	14-Nov-01	23-Jun-04			
Indonesia	28-Oct-99	2-Jun-04				
Malaysia	12-Aug-99					
Japan	16-Dec-03					
India	27-Apr-01					
Seoul	25-Apr-00	1-Nov-02				
Singapore	13-Feb-98	26-Aug-98	19-Feb-99	1-Mar-02	18-Nov-03	27-Apr-04
Brazil	26-May-99					
Canada	20-Apr-01	8-Jul-02	17-Dec-02			
Argentina	15-Jul-99	29-Jun-01	15-Jul-02	17-Jun-04		
Mexico	4-Jan-01	26-Nov-02				
Cairo	24-Nov-99	27-Nov-00	26-Sep-01			
Tel aviv	21-Jan-04					
DJ30	2-Jul-02	18-Oct-02	1-Apr-03	24-Jul-03		
NASDAQ	24-Aug-98	9-Mar-00	20-Apr-01	1-Apr-03	17-Aug-04	
S&P	13-Jun-02	16-Oct-02	1-Apr-03	30-Sep-03		

Volatility breaks during phase 1

The number of break dates has been the maximum in the Singapore stock market (six breaks altogether) followed by the markets of France, Taiwan and the NASDAQ (five breaks). The other two indexes of the US market (namely, S&P and Dow Jones) and the Argentinean market are characterized by four breaks. The markets of Germany, Belgium, UK, Hong Kong, Canada and Cairo have experienced three volatility breaks each. Stockholm, Indonesia, Seoul, Mexico and Tel Aviv experienced two volatility breaks in their stock markets. The remaining eight markets, namely, Austria, Oslo, Spain, Australia, Malaysia, Japan, India and Brazil experienced a single break in volatility over the study period. Thus, phase 1 has remained a period of excessive volatility change for only a few markets.

The first volatility break date occurred during 1998. This was, however, not a common break date. The stock markets of Singapore, Hong Kong and US (NASDAQ only) experienced breaks in volatility in 1998, but not simultaneously. The second break date for Singapore and the first break date for NASDAQ, however, are very close to each other.

Table 2.2 Volatility break dates in phase 2

Germany	11-Jan-08	2-Oct-08	5-Dec-08	14-Jul-09	23-Jul-10
Austria	25-Apr-06	2-Sep-08	5-Dec-08	23-Jun-09	30-Jun-10
Belgium	10-May-06				
France	16-Jul-07	17-Sep-08	5-Dec-08		
UK	16-Jul-07	11-Sep-08	5-Dec-08	20-May-09	
Oslo	3-Oct-05				
Stockholm	10-May-06	2-Sep-08	8-Dec-08	12-May-09	
Australia	18-Mar-05	2-May-06			
Taiwan	24-Jul-07	28-Aug-08	12-Dec-08	23-Jun-09	5-Jul-10
HongKong	30-Mar-06				
Indonesia	25-Jul-07	4-Jun-10			
Japan	27-Dec-07	8-Apr-09			
New Zealand	13-Dec-07	16-Feb-10	30-Sep-10		
India	5-Oct-07	17-Jul-09			
China	6-Dec-06	18-Nov-09			
Singapore	4-May-06	24-Jul-07	2-Sep-08	18-May-09	21-Aug-09
Canada	30-Sep-05	20-Jul-07	5-Sep-08	28-Nov-08	20-Mar-09 14-Aug-09 6-Nov-09
Argentina	2-Sep-08	28-Nov-08	14-Jul-09		
Mexico	30-Dec-05	11-Sep-08	28-Nov-08	20-May-09	31-May-10
Tel aviv	9-Jun-05				
DJ30	6-Jul-07	11-Sep-08	1-Dec-08	29-May-09	
NASDAQ	20-Jul-07	11-Sep-08	5-Dec-08	29-May-09	
S&P	27-Jul-06				

The three Asian markets (namely, Indonesia, Malaysia and Singapore), two markets of Latin America (namely, Brazil and Argentina) and Cairo stock market experienced a volatility break during 1999. The breaks, however, are neither simultaneous nor following any specific pattern. The volatility break dates found during 1998 and 1999 are thus not common break dates in the global market.

The volatility breaks during the year of 2000 were significant only in the markets of Austria, Taiwan, Seoul, Cairo and NASDAQ. The markets of Taiwan and the US experienced, for the first time since 1998, a volatility break on the same date (namely 9 March 2000). The other dates, however, do not coincide.

The stock markets of Taiwan, Hong Kong, India, Argentina, Mexico, Cairo and the US (NASDAQ only) experienced breaks in volatility during 2001. The dates however, do not coincide.

The stock markets of France, UK, Seoul, Singapore, Argentina, and the US (namely, DJ30 and S&P) experienced breaks in volatility during 2002. Of these markets, the French, the London and the two US markets experienced two breaks each during the year. Moreover, the break dates in the London market lag those in the French market by exactly one month in each case. The two US markets and Argentina experienced volatility breaks in July 2002, where as the US markets shared a break with the French market in October 2002. While S&P and UK experienced break in June 2002, Seoul and London experienced break in November 2002. The volatility breaks during 2002 are thus, more simultaneous in nature.

Thirteen markets experienced breaks during 2003. Of them the two US indexes and the German market experienced two breaks during the year. The French market experienced as many as three breaks over the time. The French market was the first to experience a volatility break in March. It experienced another break in quick succession during April 2003 along with the three US markets (where the break dates coincide) and the markets of Stockholm, and Australia. Two European markets of Germany and Belgium experienced breaks in May. UK, Spain and Dow Jones experienced break in July. It was only in August that any Asian market (namely Taiwan) could experience its break for the first time in 2003. Singapore and Japan remained the other two Asian markets to have any breaks during 2003. Thus, it was mainly the European and the US markets that went through volatility regimes during 2003. For these markets some breaks have been simultaneous or have occurred in quick succession.

The stock markets of the US (NASDAQ), Argentina, Singapore, Indonesia, Hong Kong, Taiwan, Stockholm and Belgium experienced volatility breaks during 2004. The breaks occurred during March 2004 and August 2004 and have been simultaneous in nature.

Tel Aviv stock market has been the only one to experience a volatility break during 2005.

The period of 1998 to 2005 was thus characterized by the presence of many volatility breaks in the global stock market. It is however, very difficult to trace out any pattern in these breaks. The breaks, in most of the cases have not been simultaneous or common to all the markets. Moreover, while the breaks are not global, there is hardly any regional pattern.

Volatility breaks during phase 2

The second phase (2005–2011) has been characterized by many volatility regimes in the global stock market. Out of the thirty markets selected as many as twenty three experienced volatility switches during this phase. The number of break dates has been the maximum (seven) in the Canadian market. The markets of Germany, Austria, Taiwan, Singapore and Mexico experienced five volatility breaks each over the period. Each of the markets of the UK, Stockholm and the US (Dow Jones and NASDAQ, respectively) has been characterized by four breaks in volatility. The markets of France, New Zealand and Argentina have experienced three volatility breaks each. While the stock markets of Australia, Indonesia, Japan, India and China each experienced two breaks, markets of Belgium, Oslo, Hong Kong, Tel Aviv and the US (S&P) were characterized by single volatility break date.

The break dates during 2005 were not global in true sense. The year of 2005 was mostly a period of tranquility in the global stock market. Only the five markets of Tel Aviv, Oslo, Canada, Mexico and Australia experienced volatility break in 2005. More interestingly, the first two markets have experienced no more volatility breaks during the second phase of study.

The year of 2006 was characterized by volatility breaks in the stock markets of Austria, Belgium, Stockholm, Australia, Hong Kong, China, Singapore and the US (namely, S&P). Of these markets, four experienced a break date in May 2006.

The volatility breaks in 2007, particularly in July 2007 have been global in true sense. Nine markets experienced a volatility break in July 2007, of which some break dates coincide. Some sort of lead-lag relationship might exist among the other break dates in the world market.

The nature of break dates during 2008 has been particularly interesting. The stock markets of Austria, France, UK, Stockholm, Singapore, Canada, Mexico and the US (except for S&P) experienced volatility breaks in September 2008. Of these markets, Austria, Stockholm and Singapore each had a break on 2 September. The markets of UK, Singapore, Mexico and the US experienced break on 11 September. Another break date occurred during November–December, 2008. Canada, Argentina and Mexico attained their respective volatility breaks on 28 November 2008. Germany, Austria, France, UK, and NASDAQ reached their break dates on 5 December 2008. Stockholm, Taiwan the US market (namely, DJ30) also attained their respective break dates in December 2008. Thus, the break dates during 2008 are once again global. Some regional pattern and some lead-lag movements (if not simultaneous) could be easily traced in the global market.

Some lead-lag and even simultaneous movements are once again visible during 2009. Markets passed through different volatility regimes during a period from March 2009 to November 2009. Markets of the UK, Stockholm, Singapore, Mexico and the US (namely DJ30 and NASDAQ) experienced volatility breaks during May 2009. Many markets experienced breaks in July and August 2009.

The markets of Mexico, New Zealand, Indonesia, Taiwan, Austria and Germany experienced breaks during 2010. Some lead-lag movements might once again be expected in the global stock market over this period.

The two phases compared

The nature of volatility breaks during the study period reveals something interesting. Over the two cycles considered in the study, the global markets have experienced significant volatility changes. Any stock market cycle defined around a significant crisis and its aftermath has been characterized by significant and vigorous volatility changes in the global stock markets. Moreover, the markets worst-hit by such crises have gone through series of volatility regimes within a very short span of time. The association between financial crises and volatility breaks, however, has been ambiguous. While significant financial market changes (including, of course, crises) have often been associated with volatility breaks, the mere presence of volatility breaks has not ever been sufficient to identify a peak or a trough in global stock market. Moreover, the extent and degree of such association has varied over cycles. During the first phase the association between volatility regime switch and financial crises has been quite weak. The associations were stronger over the second phase of study where financial market changes have almost taken the form of volatility regime switch. The analysis has further hinted

toward possible presence of some regional association and strong financial integration at the global level over the two cycles considered in the study, particularly during the second one that has been truly global in nature. It could now be of interest to analyze the nature of such associations in greater detail and to identify channels through which a regional crisis might spill over to the rest of the world and assume global dimension. Such an exploration, however, requires a study of latent structure in the global stock market and that is where we move next.

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