Chapter 2

Regime shifts and financial contagion in global equity market: A guide to the literature

2.1 Introduction

The purpose of this chapter is to review the current state of knowledge and issues related to the theory and empirical evidence on regime shifts and financial contagion in the context of global equity markets. Regime shifts and financial contagion are closely connected and widely used concepts in the area of financial economics, particularly in the context of asset allocation and risk management. A good understanding of the origins and drivers of regime shifts and financial contagion is important for investors and policymakers. The existing literature on this subject documents strong and positive informational linkages between sensitivity of local stock market to common shocks and the degree of market integration. However, studies have shown that in case of stock market, the identification of regime shifts is crucial as it enables the investors and regulators particularly with regards to asset allocation for the former and stock market regulation for the latter (Bredin and Hyde 2008; Bulla et al. 2011). In this respect, numerous studies have tried to analyze the role of regime shifts from asset allocation and risk management perspectives by examining the regime switching, volatility, market synchronization and Sharpe ratio (see Guidolin and Timmermann 2005; Guidolin 2011, 2012; Seidl 2012). In the literature, there are two regimes which are widely discussed and analyzed viz., bullish and bearish (Stephen and St-Amour 2000; Gonzalez et al 2005; Guidolin and Timmermann 2005; Candelon and Metiu 2009). In the words of Hardy (2001), Candelon and Metiu (2009) and Grobys (2012) a bull regime shows the periods of generalized upward trend (positive returns with significantly low volatility) and bear regime corresponds to periods of generalized downward trend (negative returns with
considerably high volatility).\textsuperscript{4} A clear understanding of these regimes is very important for both investors and market regulators from investment decision and policy viewpoint. For example, an understanding of bear and bull regime is helpful in forming investment strategies especially when the uncertainty in the stock market is relatively high (Perez-Quiros and Timmermann 2000). On the other side, the analysis of regime shifts in stock market is also very crucial for market regulator because it can have destabilizing effects on the real economy (Estrella and Mishkin 1998; Chauvet and Potter 2000; Rigobon and Sack 2003; Bohl et al. 2007, Ang et al. 2006; Guidolin 2011).

Apart from regime shifts, the analysis of cross market correlations is also of great significance with regard to the cross-country portfolio diversification and risk management. In the literature, several studies have examined the process of time-varying cross market correlations especially at the time when the economy is facing the severe downturn in its real economic activities caused by the rapid transmission of shocks originating from neighboring or far distant country (Hatemi-J and Hacker, 2005; Phylaktis and Ravazzolo, 2005; Cappiello et al., 2006; Aloui et al, 2011; Marçal et al., 2011; Samarakoon, 2011). A significant increase in cross market correlations during the turbulent period is referred as contagion which in general term defined as the spread of financial shocks from one country to others (Forbes and Rigobon, 2002; Chiang et al., 2007; Dooley and Hutchison, 2009; Syllignakis and Kouretas, 2011). The existing studies on financial contagion indicates that the stock markets in crisis-hit countries normally indicate higher levels of interdependence, resulting in quick spread of financial shocks across markets within a short period of time (Pericoli and Sbracia, 2003). The investigation of financial contagion is of great significance because of its damaging impact on global economy in relations to the strategic asset allocation, formulation of public policies including both monetary as well as fiscal, asset pricing, financial risk

\textsuperscript{4}Candelon and Metiu (2009) provide excellent overview on the origin of the term bull and bull under various dimensions.
management and multilateral organizations (see Kaminsky and Reinhardt, 1999; Forbes and Rigobon, 2002; Longstaff, 2010, among others).

In the wake of recent global financial crisis in USA in 2008 and subsequent Eurozone upheavals in 2009, the examination of regime shifts and financial contagion across economies has become a fertile research terrain and has once again revived the interest of researchers and concerned stakeholders in the stock market to re-examine the role of regime shifts and financial contagion in asset allocation and risk management. In the literature, several studies have examined the regime switching behavior of various economic and financial assets using several nonlinear econometric methods such as smooth transition autoregressive (STAR) model, self-exciting threshold autoregressive (SETAR) model and regime switching model. Among all these models, regime switching model appears to be more promising because of its ability to identify the different unobserved states in a financial series endogenously. In simple way, regime switching model refers to a situation in which stock returns are treated as stochastic process and estimated parameters are viewed as the outcome of a discrete-state Markov process. For example, expected returns in the stock market may be subject to occasional, discrete shifts caused by sudden jump in the data. In a seminal work, Hamilton (1989) developed this model as a method for modeling non-stationary time-series to study the cyclical behavior. Since then, the model has been widely applied to capture the cyclical pattern in various economic and financial data. In the context of stock market, Turner et al, (1989) were the first to apply this model to capture the nonlinear properties in stock returns series. Empirically, studies have shown special interest in applying Markov regime switching model as it is able to answer following issues with respect to regime switching in stock return. Is it possible to differentiate between identified regimes in stock market returns? Can these regimes be explained in terms of its mean and variance switching? How frequent are regime switches and when do they occur? How these regimes can be

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5Hamilton (1989) used Markov regime switching model to examine the cyclical behaviour of US GNP series. The model estimated was able to reveal the exact turning points similar to the NBER’s dating of US business cycles. NBER stands for National Bureau of Economic Research.
used for asset allocation and risk management? The answers to these questions give the researchers a new set of stylized facts about stock market returns. An appraisal of existing literature suggests that the studies on the application of regime switching model in stock market returns have been divided into two categories. The first stream focuses on the application of Markov switching model to analyse the movement of mean as well as variance. Studies by Turner et al, (1989), Hamilton and Susmel (1993), Norden and Schaller (1997), Nishiyima (1998), Maheu and McCurdy (2000), Guidolin and Timmermann (2006) among others are important in this stream. Studies in the second stream focus upon the utilization of regimes identified from the Markov switching model in asset allocation and risk management. In this respect, a brief list of some prominent studies includes Ang and Bekaert (2002), Guidolin and Timmermann (2005), Perez-Quiros and Timmermann (2001) and Whitelaw (2001), Guidolin and Timmermann (2008), Gonzalez et al. (2005), Lunde and Timmermann (2004), Pagan and Sossounov (2003), Guidolin and Timmermann, (2008), Kole et al, (2010), Grobys (2011), Ramos et al, (2011), and Dai et al, (2012). Although, the literature on the contagion is still in its evolving stage, a close survey of literature indicates that a large number of studies have investigated various dimensions of contagion spread by taking into account different set of countries/asset class etc. Since contagion is strongly linked with cross market co-movement, the methods of estimation also deal with cross market correlations explicitly. In this light, the regression based adjusted correlation method developed by Forbes and Rigobon (2002) is widely popular. However, earlier studies have also applied conventional time-series models such as Vector Autoregression (VAR), cointegration, Granger causality and ARCH types models. In recent years, some authors have shown interest in applying a new set of techniques to study co-movement phenomenon, in this regard the prominent methods used for contagion analysis are Dynamic conditional correlation (DCC-GARCH), Co-breaking analysis, Local correlation analysis, Markov switching VAR and Wavelet method to estimate the contagion. A detailed review of the existing empirical literature suggests that at least two issues related to contagion still remain unsettled. First issue deals with the analysis of spread of contagion during
different crises periods. In this analysis, the major issue which the investigator faces is the identification of anecdotal events related with the sample crisis period, some studies prefer to rely on news sources or any form of qualitative information while some studies propose different set of statistical methods to identify the exact date of crisis. The second issue deals with the correlation based method of analyzing contagion which has been questioned by many authors with regard to heteroskedasticity biases in correlation analysis during turbulent period. However, prominent studies on contagion analysis are as follows: Hamao et al. (1990), Theodossiou and Lee (1993), Bekaert (1995), Bekaert and Harvey (1995), Longin and Solnik (1995), Meric and Meric (1997), Goetzmann et al, (2001), Chen et al, (2002), Kim et al, (2005), Yang (2005), Phylaktis and Ravazzolo (2005), Cappiello, et al, (2006), Chiang et al, (2007).

Over the past three decades, a large number of studies have examined and analyzed the occurrence of regime shifts and contagion in commodity, real economy and sectors across globe and within an economy, different currency rates, credit default swap (CDS), sovereign yield and stock market returns covering several crises periods. There are many interesting findings of these studies and the theoretical and empirical outcomes have been widely used for portfolio diversification and risk management. To keep the literature review more precise and focused on study’s objectives, this chapter attempts to review and discuss some selected theoretical as well as empirical studies which are considered to be directly related with the overall scope of the present study. However, Norden and Schaller (1997), Rigobon (2002), Kim et al. (2003), Forbes and Rigobon (2002), Dungey et al. (2003), Pericoli and Sbracia (2003), Caporale et al. (2005), Guidolin and Timmerman (2005), Didier et al. (2008), Talbott(2009), Guidolin and Hyde (2009), Liu (2010), Bulla et al. (2010), Guidolin and Ria (2010), Guidolin and Rinaldi (2010), Kolb (2011), Guidolin (2012) outline comprehensive survey of literature covering various aspects of regime shifts and financial contagion in stock market returns and other asset class. In what follows, a precise account of some selected studies is presented to provide a brief review of theoretical as well as empirical studies that have appeared in the
literature of regime shifts and financial contagion in stock market returns of developed as well as emerging economies in the recent past.

This chapter is organized as follows. After this introduction, section 2 reviews the studies on regime shifts and volatility in stock market returns using Markov regime switching model in developed and emerging markets. Section 3 focuses on studies related with the application of regime shifts and volatility switching in stock markets in asset allocation and risk management. Section 4 discusses the financial contagion literature concentrated on developed and emerging markets, both at the empirical and theoretical level and some key areas for further research. Section 5 ends with summary and research gap in the literature.

2.2 Theoretical and empirical studies on regime shifts and volatility in stock market return

**Turner, Startz, and Charles (1989)** modeled and examined the switching behavior of stock market returns using Markov regime switching (MRS) model. The study estimated three different specifications of MRS model on monthly returns data of Standard and Poor’s composite index of USA for the sample period from January, 1946 to December, 1987. The study utilized 91 days Treasury bill rate to calculate the excess returns. The estimated model divided the sample series into two variance states viz., high and low. While, estimating two different specification of Markov regime switching model viz., switching in only mean and switching in only variance. The study found inverse relationship between excess mean returns and volatility, implying that high variance state may bring lot of surprise for investors and perception about the market may change when there is catastrophic increase in stock market volatility. However, the main findings of this study is that it highlights the role of regime shifts in modeling volatility in stock market return and also provides important direction for investors to time the buy and sell strategies. Finally, the study concluded that the non-linear properties of stock market
return can be discerned by using regime switching model as it captures the switches in unobserved regime endogenously.

In a similar attempt, Chu, Santoni and Liu (1996) studied the variations of volatility in stock market return of USA using monthly data for the period from July 1962 to December 1993. Applying MRS on the value-weighted New York Stock Exchange, the study identified six regimes. It is noteworthy that this was the first study which stressed on the possibility of existence of more than two regimes in stock market returns. The empirical results of the study indicated that the volatility is higher when returns are above or below the normal level, indicating the existence of non-linear behavior. One of the main contributions of this study is that it tried to resolve the issue of identifying exact number of states in data. The study used information criteria to identify six regimes. The findings of this study is by and large are in agreement with Turner et al, (1989). Another striking observation of this study is the role of time-varying volatility in identifying the major turning points in the data, as this may be helpful for regulators to examine the sudden ups and downs in the volatility series and may curb the market when it appears to be highly volatile. The study further provided many directions for future researchers to study the phenomenon of regime switching in stock market returns. However, the limitation of this study is that it modeled only the regime switches in second moments whereas first moment also plays crucial role in analyzing the levels of volatility in stock market returns.

Norden and Schaller (1996) empirically investigated the regime switching behavior of stock market returns using MRS model to identify the switches in stock market returns of US stock market for the sample period from January 1929 to December 1989. It was the first study which justified the use of MRS model in stock market returns. According to this study, the regime switching in stock market returns is strongly linked with macroeconomic scenarios and any adverse movement in economic activity may impact the regime switching behavior of stock market considerably. Highlighting the role of
regime shifts, the study outlined major advantages of MRS model to enable the researchers in analyzing these regimes mainly in reducing the informational asymmetry and time the stock market from risk management perspective. The study extended Markov regime switching model to incorporate the univariate and bivariate cases. Like Turner et al., (1996), the study is also based on excess return. Using Markov switching mean-variance model, the study confirmed the existence of regimes in returns. One of the major contributions of this study is that it added the multivariate dimension in MRS modeling by using price-dividend ratio as an explanatory variable to ascertain the predictive power of stock market returns with regime-switching. The study’s results further indicated strong evidence of predictability after accounting for state-dependent switching, indicating further the use of Markov regime switching model in exhibiting the risk-return relationship.

Maheu and McCurdy (2000) investigated the duration dependence as a source of nonlinearity in stock market cycles. The study extended the model of Durland and McCurdy (1994) by incorporating duration-dependent hazard function as a conditioning variable in both the mean and variance equations. The main purpose of this extension was to capture the ARCH effects and also to capture the changes in the duration dependence of conditional mean and variance. Using the extended model, the study identified two regimes of bull and bear on the monthly data of stock index of USA for the period 1802 to 1995, obtained from Centre for Research in Security Prices (CRSP) and from the study of Schwert (1990). As expected, the study reported high returns with low volatility which they referred as bull regime and low returns and high volatility as bear state, confirming further the applicability of Markov first order based model in identifying the number of regimes in stock market returns. Unlike earlier studies of Turner et al. (1989) and Chu et al. (1996), the study did not explicitly capture the different perceptions of investors. But in terms of modeling specification, the study contributed substantially to the existing literature by providing an important direction for applying Markov regime switching model on large sample data.
Maheu, McCurdy and Song (2009) empirically investigated the bull and bear regimes for the daily returns of 123 years on value weighted index of NYSE, AMEX and NASDAQ and applied various structures of MRS model to identify the regime shifts. The findings of this study are broadly in favor of application of Markov switching model in identifying regime switching in stock market returns which are in agreement with above mentioned single country studies. However, the most striking contribution of this study is that it enables researchers to undertake study in this field even using the daily data. In earlier studies, there were lots of apprehensions about the use of high frequency data in MRS estimation because it was perceived that the use of high frequency data may obscure the central results of the model due to more noise in the data. However, the study provides explicitly several justifications with regard to the use of high frequency data in the estimation of MRS model.

It may here be noted that all the above mentioned studies focus on different modeling specifications to capture the nonlinear properties of first as well as second moments present in the data by augmenting the existing models of Hamilton’s regime switching and Durland and McCurdy (1994). The empirical results of these studies confirm the nonlinear relationship between returns and volatility under different regimes and also the possible asymmetries with regard to volatility persistence. Similar to the findings of Mandelbrot (1963), these studies also conclude that the volatility of stock returns varies over time. After the emergence of literature on regime shifts and volatility in stock market returns, several studies have examined such properties in multi-country context. The main purpose of these studies is to highlight the role of these regimes in investment policy and regulation of stock market.

In the context of European stock markets, Morana and Beltratti (2002) using daily data for the period 1988 to 2000, applied three different specifications of regime switching models to examine the impact of strong monetary integration along with introduction of
Euro currency on the volatility of five European markets viz., France, Germany, Spain, Italy and UK and USA. In order to test for whether variance has been lowered after the introduction of Euro in European stock markets, at first step, the study conducted a test of equality of unconditional variances by using GARCH model. In the second step, MRS model was used to fit the data even better than GARCH model. Based on the estimated results, the study reported in favor of applying MS model in examining the volatility patterns of sample markets. As the study found that after comparison, the dynamics of the conditional volatility estimated using MS model were far better than the conventional GARCH model. The finally concluded that the introduction of Euro has reduced the volatility in the examined sample markets.

**Billio and Pelizzon (2003)** empirically investigated whether the euro, globalization, deregulation and financial crises, have affected the process of the world market index and whether the introduction of the euro has changed the stochastic process of the idiosyncratic factor risk of the leading European country, Germany, and some other European countries such as France, Italy, Spain and the UK. Furthermore, the study also tried to analyze the linkage between the leading market (Germany) and other sample European countries. Using weekly returns on stock indices of five European countries (Germany, France, Italy, Spain, and the UK) and a value-weighted world index, the study applied the Switching Regime Beta Model (SRBM) (Billio and Pelizzon, 2000) on excess return. The study further assumed that the sample markets are driven by a stochastic process with two states, a low volatility and a high volatility state. Based on the estimated results, the study found that in the last 5 years the world index volatility has increased as has the idiosyncratic German risk factor. Further, the study concluded that the volatility spillovers from both the world index and the German market have increased after EMU for most European stock markets. The most striking feature of this study is that it highlights the role of regime shifts in capturing the volatility in different markets. Another significant contribution of this study is that it uses the multivariate regime switching model to take into account the correlation between different markets.
**Hess (2003)** empirically examined the regime switching behavior of Switzerland stock market by using the monthly data for the sample period of January, 1973 to December, 1998. In line with Morana and Beltratti (2002), the study also reported the appropriateness of regime switching model to analyze and describe the regime switching behavior of examined stock market return. The study further analyzed the in-and-out sample properties of MRS model and concluded its poor performance of forecasted results. It may here be noted that after Schaller and Norden (1997), it was first systematic empirical exercise that highlighted the role of MRS model in capturing the time-varying volatility. Finally, the study reported that the application of MRS model setup needs to be done carefully. The findings of this study imply that the MRS model can be used to account for dynamic and nonlinear changes in the stock market return distribution.

**Bialkowski (2004)** empirically investigated the time series behavior of stock market returns of three CEEC countries viz., Hungary, Czech Republic, and Poland along with France, Germany and UK, using monthly data for the period of 1995–2002. The study further compared the results of three Central Eastern European Countries (CEEC) markets with other three markets. Applying an extended model of MRS model with mixture of normal distributions, the study reported the existence of two or three volatility states. The results of model comparison indicated that the Markov switching mixture of normal distributions has given more robust results than the single normal distribution. The study concluded in favor of applying MRS model with different specifications compared to conventional volatility models. Besides this, from policy perspective, the study reported that the change from the normal to the crisis regime leads to the significant increase in volatility on the emerging markets. By comparing the volatilities of both CEEC and Western Europe, the study found that the markets of later is more stable than former.
Moore and Wang (2007) applied MRS in variance model to detect the occurrence of number of volatility regimes in the stock markets of European Union (EU) member states viz., Czech Republic, Hungary, Poland, Slovenia and Slovakia for the 1994-2006. The MRS model identified two or three regimes in the volatility of sample markets. The results of MRS model uniquely characterized the volatility switching pattern of sample markets. In case of emerging European markets, the study reported that the volatility in stock market increased during transition phases and it has reduced significantly after joining the EU. Finally, the study concluded that the entry to the EU appears to be associated with a reduction of volatility in unstable emerging markets. The Asian and Russian financial crises are closely associated with the high probability of a high volatility regime. The findings of the study imply that state based models are able to identify the non-linear properties of stock markets which can be helpful for investors as well as policy makers.

Ismail and Isa (2008) empirically investigated the appropriateness of non-linear models in identifying the implicit jumps and breaks in financial time-series data. The study focused on how occurrence of regime shifts in different asset class may help the investors to reap the benefit of risk minimization. Further the study also compared the regime shifts in mean and variance among examined assets and tried to discern the different volatility patterns. Using two state MRS model on four indices of Malaysian stock markets viz., Bursa Malaysia namely the Composite Index, the Industrial Index, the Financial Index and the Property index between 1974 and 2003 (except for Composite Index between 1977 and 2003). The study dated the different timings of regime shifts and was able to link it with historical events such as the 1974 oil price shock, the 1987 stock market crash and the financial crisis in 1997. The findings of this study imply that the regime shifts in different indices may be used to characterize the level of volatility and timing of investment. Statistically, the model reported very interesting results in terms of nonlinearity in examined indices.
Wang and Theobald (2008) studied the impact of regime shifts in variance on stock market volatility by employing the MRS with switching only in variance model on six East Asian emerging markets i.e., Indonesia, Korea, Malaysia, Philippines, Taiwan and Thailand, for the period 1970 to 2004. At first step, the study highlighted the role of regime shifts on historical events related with economic and financial liberalization in examined countries. In the next step, using MRS model, the study found that the markets of Malaysia, Philippines and Taiwan were characterized by two regimes, while, the markets of Indonesia, Korea and Thailand were characterized by three regimes over the sample period. The empirical evidence further suggested the mixed impact of financial liberalization on stock market volatility. Their findings suggest that the MRS based identified regimes can further be linked with the real events in an economy and may also provide an important direction to put a check on the level of volatility in stock market of sample countries. The study has several implications from the point of view of investors because like Moore and Wang (2007), the study also provided deep insights about time-varying volatility that can be used to predict the volatility of different regimes. Especially, in emerging market context, the study provided several directions to pursue research in the light of regime switching in mean as well as variance. This is mainly because the simultaneous switching of mean and variance may allow a researcher to explore further the possibility of linking the volatility with positive payoffs from investment. However, the limitation of the study is that it does not substantiate the results of MRS in variance model with Switching ARCH (SWARCH) model of Hamilton and Susmel (1994).

Liu, Margaritis and Wang (2012) used two-state MRS model on weekly stock market returns and trading volume of S&P 500 index for the period from January, 1983 to November, 2007. The main objective of this study was to examine the explanatory and predictive power of price range and trading volume for return volatility. Empirical results indicated the negative relation between equity market returns and volatility even after keeping the time-varying determinants of conditional volatility within each regime as
constant. The study further reported that the price change has strong impact on high volatility state compared to low volatility, implying that the impact of price range in a stock market can also be captured with the application of MRS model.

2.3 Theoretical and empirical studies on the role of regime shifts and volatility in asset allocation and risk management

In an attempt to analyze the volatility in different stock market returns similar to Autoregressive Conditional Heteroscedacity (ARCH) process, Susmel (2000) applied the Switching Autoregressive Conditional Heteroscedasticity (SWARCH) model developed by Hamilton and Susmel (1994). The model was applied on eight stock market series of weekly returns viz., USA, Canada, the UK, Germany, Japan and Australia and the two international stock market indices compiled by Morgan Stanley Capital International (MSCI), to capture the time-varying volatility of when structural changes are allowed in international stock markets. An exponential SWARCH model was fitted. Evidence is found for switching volatility for the US, Canada, the UK, and Japan. Applying SWARCH model, the study found that ARCH and asymmetric effects were lower when a switching regime structure is allowed. The switching model was further used to date volatility states in international stock markets. After the comparison of these dates with real events, the study concluded that the domestic volatility states tend to be independent of foreign volatility states, with the exception of Japan, UK, US and Canada.

Ang and Bekaert (2002) used the MRS model with different specifications of mean and variance on US, UK and German stock markets for the period 1970-1997 (monthly data) to examine the role of regime shifts in international portfolio diversification. Following Das and Uppal (2001) who highlighted the perfectly correlated jumps across markets, the study also tried to exhibit the portfolio diversification opportunities especially when the market is in bearish regime. One of the major highlights of this study is that it attempts to identify the bull and bear market states quite efficiently and interpretation of results is also quite robust. At first stage, the study highlighted the problems associated with general asset allocation by analyzing some important descriptive and unconditional
correlations. In the second stage, the study identified the regime shifts in the stock market returns of sample countries using MRS model. Lastly, the study used a conditionally risk-free asset under two scenarios. In first scenario, the study examined the benchmark model with a constant risk-free rate and under second scenario, the MRS model was applied to allow the short-term rates to switch regimes and predict asset returns. Highlighting the implications, the study found that the role of regime shifts is immense in finding out lucrative risk diversification opportunities especially at the time when market is more volatile. The study has several contributions to the existing literature. Firstly, it was the first attempt to examine the role of MRS model in portfolio diversification. Secondly, the study tried to examine as how correlation between international equity market returns tends to increase in highly volatile bearish markets. What are the implications of these bearish regimes on strategic asset allocation? The study finally concluded that the highly volatile bear market can also provide immense opportunity for international diversification.

**Graflund and Nilsson (2003)** empirically tried to answer the question related with portfolio selection and intertemporal hedging within a Markovian regime-switching framework. The investment set in this study consisted of diversified home-market portfolio and the risk-free asset mainly the treasury bill. The study assumed that the regime-switching process makes the stock returns to switch between regimes with different mean and volatility, thus creating a non-IID stock return behaviour, confirming further the use of regime switching model in checking the nonlinearity in the data. To investigate the importance of investment horizon, given the stock return process, the study formed a optimal portfolios for investors with investment horizons ranging from 1 month to 10 years. The analysis was performed conditional on the current regime, which was used to investigate the importance of regimes in the sense that portfolio allocations were allowed to differ as a function of the current state of the world. The study discussed similarities and differences between the four largest stock markets in the world, the USA, Japan, the UK and Germany. Applying MRS model, the study found that the identified
regime has strong influence on the portfolio decision which can further be interpreted as one of the factors that governs the portfolio decision. The study also concluded that the question of intertemporal hedging is a more complex issue than is hinted in the previous literature, since demand for intertemporal hedging is present in some regimes, but not in others.

**Brooks and Katsaris (2005)** made one of the first systematic attempts to examine whether a three-regime model that allowed for dormant, explosive and collapsing speculative behaviour can be utilized for portfolio diversification and risk management in case of US stock market. The study extended the existing models of speculative behaviour by including a third regime that allowed a bubble to grow at a steady rate, and proposed abnormal volume as new indicator for bubble collapse. The study also investigated the financial usefulness of the three-regime model and suggested a trading rule which can provide better portfolio diversification opportunities by contradicting the model of regime based asset allocation strategy given by Norden and Schaller (1999). The study attempted to do this by incorporating a third regime in which the bubble grew at the fundamental rate of return. Additionally, the study showed that other variables, such as abnormally high volume, can be used in the Norden and Schaller framework to model the probability of a bubble collapse more effectively. The empirical analysis was conducted using monthly observations of S&P 500 for the period from January 1888 to January 2003. In order to calculate fundamental values and real gross returns, the study retrieved the data from Shiller (2000). Using MRS model, the study found that the speculative behaviour model has significant explanatory power for the next month’s returns. More specifically, as the bubble grows in size and yields higher returns, the probability of being in the explosive regime in the next time period increases, and thus the expectation of bubble growth is adjusted to compensate for the now higher probability of a bubble collapse. In the explosive state, the size of the bubble deviation and the measure of abnormal volume help in identifying the probability of observing a bubble collapse. The study further reported that the probability of observing an extreme
negative return, of at least two standard deviations below the historical mean of returns, increased significantly when a positive bubble is present and abnormal volume is high. The study also examined the timing ability of the bubble models by comparing the returns of the speculative bubble model trading rules with the returns on 10,000 randomly generated trading rules that have the same average proportion of the sample period invested in equities. The study concluded that the three-regime model can consistently lead to higher Sharpe ratio than the Norden and Schaller (1999), the randomly generated trading rules, and the buy and hold strategy, although some of this superiority fades when the study takes into account the market frictions such as transactions costs and other trading based strategies.

Guidolin and Timmerman (2005) empirically investigated the role of bull and bear regimes in UK stock and bond returns and analyzed their economic implications from the perspective of an investor’s portfolio allocation on the monthly data for the period from January, 1976 to December, 2000. Applying MRS model, the study found that the perceived state probability has a large effect on the optimal asset allocation, particularly at short investment horizons. If ignored, it may have adverse implications on portfolio holdings. The study further concluded that the predictability in the return distribution linked to the presence of bull and bear states has a significant effect on investors’ strategic asset allocation. The study found strong evidence of underlying economic regimes in the process driving UK stock and bond returns and considered their economic implications. According to the results of the study, the presence of regimes gives rise to a wide variety of investment shapes linking optimal asset holdings to the investment horizon and generates very sensible patterns in the optimal asset allocation. Further, the empirical results suggested a three-state specification with a transitory high-volatility regime with negative mean returns, a highly persistent, ‘normal’ state with mean returns and volatility levels close to historical averages and a persistent high-return ‘bull’ state capture important features of UK stock and bond returns. Predictability from the dividend yield by no means subsumes the effects of predictability due to the presence of...
underlying states in asset returns. The findings of this study imply that the economic
difference between the three-state model and a model that assumes no predictability is by
comparing the optimal portfolio holdings associated with these models at the end of the
sample. Further, the regime probability has large effect on the optimal asset allocation,
particularly at short investment horizons and presence of return distribution linked to the
detection of bull and bear states has significant effect on investors’ strategic asset
allocation. The findings further confirmed the application of MRS model in the
formulation of asset allocation strategies.

Guidolin and Timmerman (2006) in their empirical attempt tried to examine the the
joint distribution of US stock and bond returns under regime switching framework for the
period from January 1954 to December 1999. The study applied different versions of
MRS model on excess return of the CRSP index.\textsuperscript{6} Dividend yield was also used in the
analysis and was computed as dividends on a value-weighted portfolio of stocks over the
previous 12-month period divided by the current stock price. On of the most important
contributions of this study is that like Brooks and Katsaris (2005), this study also tries to
capture the regime dependent dynamics in sample index by applying more complicated
four-state model with regimes characterized as crash, slow growth, bull and recovery
states. Based on the estimated results, the study reported that although there are well-
defined regimes in the marginal distributions of both stock and bond returns, there is very
little coherence between these regimes. This complicates models for the joint dynamics
of stock and bond returns and suggests that a richer model with several states is required.
The study further found the evidence that the standard linear models do not capture
essential features of this distribution and that four regimes are required to capture the
time-variation in the mean, variance and correlation between large and small firms’ stock
returns and long-term bond returns. Two regimes capture periods with high volatility and
low persistence and two regimes are intermediate states with higher persistence.

\textsuperscript{6}To obtain excess returns, the study subtracts the 30-day T-bill rate from CRSP’s index returns.
**Baele and Inghelbrecht (2008)** investigated whether globalization, regional integration, and the introduction of the euro have made local European (and non-European) stock markets more exposed to global and regional shocks. In order to do this, the study developed structural regime switching volatility spillover model that decomposes total volatility at the regional, country, and global industry level in a systematic and an idiosyncratic component. To correctly separate systematic and idiosyncratic risk, the study allowed the exposures to global and regional market shocks to vary with both structural changes and temporary fluctuations in the economic environment. The study used the very large dataset which consisted of 21 developed equity markets, of which 14 European. The study estimated the dynamic factor model on a set of 4 regions, 21 countries, and 18 global industries over the period 1973-2007 (weekly data). Based on the estimated results, the study systematically found that the globalization and integration have led to a gradual convergence of country to industry betas, especially in Europe. Further, the study reported that Europe as a region is more exposed to global market shocks, suggesting that Europe as a whole is strongly integrated with world equity markets. The exposures of local European equity market shocks to both global and regional shocks have increased structurally over time. Surprisingly, the study reported only minor differences between euro area and other European markets and found structural increases in market betas for Non-European countries. Finally, the study concluded that while the benefits of geographical diversification have gradually decreased with globalization and integration, they are still substantial, to the extent that geographical diversification yields still larger risk reduction benefits than industry diversification.

**Li (2009)** in an entirely new set-up empirically investigated the co-movement between the US and Emerging Markets (EM) under various volatility regimes by proposing a model in which four-state correlations under multivariate Markov switching framework can be analyzed. Using weekly (Wednesday to Wednesday) stock index returns for the US stock markets compiled by Morgan Stanley Capital International (MSCI) and five
EM market indices maintained by MSCI: (1) MSCI EM Asia, (2) MSCI EM Europe, (3) MSCI EM Europe Middle East, (4) MSCI EM Far East and (5) MSCI EM Latin America for the sample period from February, 1988 to May, 2007, the study applied the Markov-switching ARCH (MVSARCH) model in which variance/correlations for stock returns is controlled by a state-varying mechanism. The empirical results of this study indicate that the US-EM market correlations increase relatively more when both the US and EM markets simultaneously experience a high variance condition. Moreover, the situation of both the US and EM stock markets at a high volatility state is associated with a minimum risk reduction benefit and a maximum cross-market correlation. Finally, the study concluded that the state-varying portfolio loadings established by the MVSARCH model can effectively enhance the asset allocation effectiveness.

With respect to developed markets, Guidolin and Ria (2010) used Markov switching vector autoregressive (MSVAR) model to examine the non-linear patterns in the joint distribution of asset returns. The study tried to empirically analyze the presence of regimes in means, variances, and correlations of asset returns under Markowitz mean-variance frontier framework. In particular, their study showed both theoretically and through an application to international equity portfolio diversification that substantial differences exist between bull and bear regime-specific frontiers, both in statistical and economic terms. Using MSCI investable indices for five countries/macro-regions viz., North America, Japan, Europe excluding UK, Pacific excluding Japan and UK, the study reported that it is possible to characterize the mean-variance frontiers and optimal portfolio strategies in bull periods, in bear periods, and in periods where high uncertainty exists on the nature of the current regime.

In emerging market context, the study of Ramos, Vermunt and Dias (2011) tried to address simultaneously the issue of observed heterogeneity between emerging markets as well as the existence of regimes. The study applied the augmented model of MRS as Heterogeneous Regime-Switching Model (HRSM) which took into account the

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unobserved heterogeneity by a model-based clustering of the markets. Under this framework, HRSM allows distinguishing sample emerging stock markets indexes with respect to their likelihood of switching between bear and bull markets. The study used the daily data from July 1994 to July 2007 of 18 emerging markets viz., Argentina, Brazil, Chile, China, Czech Republic, Hungary, India, Israel, Malaysia, Mexico, Pakistan, Peru, Philippines, Poland, Russia, South Africa, Taiwan and Thailand. One of the important objectives of this study is to confirm whether emerging markets can be considered as homogeneous asset class or not. After dividing the sample markets into different clusters, the empirical results indicated frequent swings between the two regimes with different levels of persistence. The study also analyzed the level of stock market synchronization across sample countries and reported the regime synchronicity for certain pairs of markets. They further find the empirical evidence against the treatment of emerging markets as homogeneous asset class. Their findings further suggested that the asset allocation strategy must take into account the synchronization properties of emerging markets before taking any investment decision.

2.4 Theoretical and empirical studies on financial contagion in emerging and developed markets

Meric and Meric (1997) empirically investigated the impact of equity market crash of 1987 on major European stock exchanges by analyzing the changes in the comovements among 12 largest equity markets in European region. Using monthly equity market indices of twelve European countries viz., Austria, Belgium, Denmark, France, Germany, Italy, the Netherlands, Norway, Spain, Sweden, Switzerland and the United Kingdom, the model applied factor analysis based regression method to examine the changes in comovements among sample markets. In this process, the study further divided the full sample period into three different sub-samples to perform the pre and post factor. The sub-sample periods were decided as February 1975 to May 1981 (period 1), June 1981 to September 1987 (period 2), November 1987 to February 1994 (period 3). Based on the empirical results, the study found significant changes in the comovements of sample
stock markets after the crash. The low correlation among examined stock markets, indicated further a strong case of portfolio diversification. The study’s findings further indicated that correlations among the twelve largest European equity markets and the U.S. equity market increased substantially, leaving limited scope of further asset allocation and risk management.

Using weekly stock market return data of Asian and Latin American countries viz., Argentina, Brazil, Chile, Hong Kong and Mexico during the 1990s, Edwards and Susmel (2001) empirically investigated the behaviour of volatility through time. The study tried to exhibit whether periods of high volatility in one market are correlated with periods of high volatility in other markets. Using univariate and bivariate switching volatility models developed by Hamilton and Susmel (1994) as SWARCH, the study found important breaks in the time-varying volatility and was able to identify the periods of high volatility. The most striking result of this study is its analysis of co-dependence of volatility regimes. Unlike previous studies, this study does not rely on the correlation coefficients. After analyzing the persistence of volatility regimes it appeared that the high volatility episodes are in general short lived and persists for two to twelve weeks. The study further reported the strong comovement across sample countries especially the Mercosur countries, confirming the strong case of contagion. The results of bivariate SWARCH further indicated the case of strong comovement especially among Latin American markets. Among Asian markets, Hong Kong, which the study considered as emblematic representative of the Asian financial crisis of 1997, did not show non-linear state dependence with Chile and Brazil. The finding of this study implies that the second moment condition sometime contradicts the results obtained directly from correlation and other comovement measures. The study further tries the augment the interest of researcher in SWARCH model in contagion and comovement analysis.

Since contagion is dependent upon the movement of second moments mainly volatility based correlations, Forbes and Rigobon (2002) in their study tried to highlight the
demarits of heteroscedasticity biases in contagion analysis. Unlike previous studies which emphasized on the role of correlation is examining contagion effect, this study tried to build-up an argument in favour of possible heteroscedasticity biases in the correlation analysis of contagion. Taking the daily data from January, 1996 to October, 1997 on 28 stock market indices which comprised of emerging and mature markets, the study mainly focused on outlining a new methodology to estimate the contagion phenomenon. According to the study, contagion is a phenomenon directly linked with consistent rise in correlation during crisis period and hence it is dependent on market volatility. At first stage, the study tried to develop theoretical model to argue that the contagion is not only a comovement phenomenon but it also possesses the characteristics of extreme comovement during a downturn period, while at later stage, the study tried to exhibit the improvement in results caused by heteroscedasticity biases. Using Vector Autoregression (VAR) and adjusted correlation coefficient methods, the study concluded that if the cross market correlations increase during turbulent period, this is interpreted as evidence of contagion. The most striking outcome of this study is that it stresses upon the turmoil period under consideration as well as correlation co-efficient conditional on market volatility. Analyzing the crisis period, the study found no evidence of contagion during 1997 East Asian crisis, 1994 Mexican Peso devaluation and 1987 US stock market crash.

Chen, Firth and Rui (2002) empirically investigated the stock market linkages among six Latin American countries’ stock markets. Using the monthly data of these six markets viz., Argentina, Brazil, Chile, Colombia, Mexico and Venenzuela, for the period 1995 to 2000, the study reported very high incidence of interdependence during Asian crisis, indicating very limited diversification opportunities in these markets. Econometrically, the study applied the techniques of cointegration and vector error correction model to exhibit the market interdependence among sample countries. One of the major contributions of this study is that it examined the phenomenon of market interdependence at the time when these markets were really in bad shape and there were many apprehensions about strong case of contagion from Asian financial crisis.
In a more robust way to measure the contagion effect between assets, Baur (2003) theoretically and empirically tried to add new dimension in the analysis of contagion. The study argued that the correlation based test of contagion suffers from heteroscedasticity biases because it ignores the time-varying nature of correlation movement with frequent ups and downs in the magnitude of correlation, hence, the contagion analysis based on such test may obscure the analysis. The study proposed new factor based regression analysis to eliminate the shortcomings of these tests and differentiated between mean contagion and volatility contagion in an asymmetric way. For the analysis of spillover, the study relied on Exponential Generalized Autoregressive Conditional Heteroscedasticity (EGARCH) model. Taking the daily data of eleven stock markets viz., China, Hong Kong, India, Indonesia, Japan, South Korea, Malaysia, Phillipines, Singapore, Taiwan and Thailand for the period April, 1997 to October, 2001, the study found strong evidence of contagion during Asian crisis. The most important contribution of this study is that it developed the concepts of mean and volatility contagion which is still widely used in empirical analysis to examine the contagion effect. The factor based regression model is also one of the important contributions of this study especially in the area of contagion analysis.

Using daily data for the period January, 1985 to December, 1996, the study by Connolly and Wang (2003) empirically examined the comovement in three prominent international equity markets viz., USA, UK and Japan. The study tried to differentiate whether the observed comovement is due to economic fundamentals or simply contagion. In order to do this, the study also examined the impact of macro news on a comprehensive dataset of macroeconomic news announcements made in the USA, UK and Japan during the sample period. Using linear and nonlinear regressions, Glosten–Jagannathan–Runkle (GJR) asymmetric GARCH volatility model to account for the asymmetric volatility clustering, the study found that the macro news has limited impact for any economically sizeable part of the return comovement for the sample markets.
Collins and Biepke (2003) investigated the contagion phenomenon in African stock market context. The study is based on the daily data of eight African countries viz., Egypt, Kenya, Mauritius, Morocco, Namibia, Nigeria, South Africa, Zimbabwe and Hong Kong (as proxy of Asian financial crisis) for the period from January 1997 to November 1997. To study the contagion during Asian crisis period, the study divided the full sample period into tranquil and crisis period as January 2, 1997 to October 17, 1997 and October 20, 1997 to November 28, 1997, respectively. The study is mainly focussed on whether any of the sample African stock markets are highly cointegrated with emerging markets in Asian region or not. If so, it might create a problem of contagion during any abnormal events probably during crisis period. Using Forbes and Rigobon (2002) method of regression based correlation analysis and Corsetti et al. (2002) methods of common factor based regression analysis, the study found strong evidence of limited evidence of contagion between African stock markets and Hong Kong (as a proxy for Asian crisis).

Khalid and Kawai (2003) empirically investigated the interlinkages among three significant financial indicators viz., exchange rates, stock price indices and interest rates of nine East Asian countries viz., Hong Kong, Indonesia, Japan, Malaysia, The Phillipines, Singapore, South Korea, Taiwana and Thailand for the period from July 1, 1997 to June 30, 1998. The study used the daily data to examine such relationship and relied on VAR and Granger causality for empirical results. Considering Asian financial crisis (1997) as source of contagion, the study could not found any evidence of contagion among sample markets and given financial indicators.

Hatemi-J and Hacker (2005) in their theoretical and empirical attempt tried to suggest a more robust test of contagion based on asymptotic distribution. The study tried to built up a theoretical model for contagion in which the lack of slope-coefficient change between two time periods is tested. Following Forbes and Rigobon (2002), the study relied on standard t-statistics and its asymptotic distribution. Further, the size and properties of this
test was tested through Monte Carlo simulations. Using daily data of the period 1997 and relying on the above mentioned semi-theoretical model, the study found strong evidence of contagion from the Thailand’s stock market to the Indonesian equity market. The study divided the sample period as low volatility period from 1 January to 30 June, and the high volatility period from 1 July to 31 December. The most striking result of this study is that its results appeared to be more robust than ARCH effects. However, the contagion results were more or less in line with previous literature.

In the context of European stock markets, Sarwa and Bohl (2005) investigated the contagion phenomenon to European stock markets associated with major financial shocks occurred during 1997 to 2002. Perhaps one of the reasons why this study was undertaken because during this period, all the Latin American markets were quite vulnerable and due to colonial linkages, Europe relied heavily on Latin American economies. The study applied the method of heteroscedasticity-adjusted correlation coefficients to discriminate between contagion, interdependence and breaks in stock markets’ relationships. The study used the stock market returns of 17 stock markets viz., Czech Republic, Hungary, Poland, Russia, France, Germany, United Kingdom, Greece, Ireland, Portugal, Spain, Argentina, Brazil, Hong Kong, Korea, Turkey, the U.S. The study covered all major financial markets in Europe and analyzed the impact of seven different financial crises periods viz., Crises in East Asia (1997), Russia (1998), Brazil (1999), Turkey (2000), Argentina (2001) and the U.S. (2001, 2002) on European stock markets to find out any possible contagion. Following Forbes and Rigobon (2002) and Corsetti et al. (2002), the study found the limited evidence of contagion during examined crises periods between source and destination countries. However, the study further reported that the European markets are not impacted strongly during analyzed crises periods and most of these markets provide the strong evidence of interdependence which is very much contradictory and in disagreement with existing literature. Theoretically, the study is not very much appealing except the fact that the study has clearly divided the crisis and stable periods.
Caparole, Cipollini and Spagnolo (2005) empirically examined the impact of Asian crisis (1997) on East Asian economies. The magnitude of this impact was investigated in the form of contagion. Using the weekly data for eight East Asian countries viz., Indonesia, South Korea, Malaysia, Taiwan, Singapore, Hong Kong, the Philippines and Thailand over the period January, 1990 to July, 1998 and following Forbes and Rigobon (2002) and Corsetti et al, (2005) method of correlation based contagion, the study reported very strong evidence of contagion during sample crisis period. However, on methodological front, the study provided theoretical explanation to control for three types of biases arising from heteroskedasticity, endogeneity and omitted variable. In order to control such biases the study developed a theoretical model by using GARCH and factor based regression analysis suggested by Forbes and Rigobon (2002). The most striking result of this study is that it confirms the existence of contagion during Asian crisis and provides strong explanation in this favor. Another major contribution is in terms of endogenous structural breaks corresponding to the beginning of the contagion period. The selection of crisis and stable periods are more or less in line with previous literature and provides sufficient explanation based on historical developments.

Using a new and innovative approach, Rodriguez (2007) studied the dependence between stock market returns of countries in Asia and Latin America during the Asian and Mexican crises by applying Copula with switching parameter. As exhibited in the study, the main reason of using this approach was to capture the correlation breakdown and characterization of nonlinearity and tail dependence. This method also helped in avoiding discretion in the identification of the contagious episodes and extreme events during the sample period. In the literature, “copulas are used to construct flexible multivariate distributions exhibiting rich patterns of tail behaviour, capturing the extreme breaks in the form of tail independence to tail dependence”. This method helps the investigators to avoid any informational asymmetry in the data. The study applied the augmented version of Copula model by incorporating the state based volatility model as SWARCH. The study used the daily data (in US dollars) of stock indices from five Asian
countries viz., Thailand, Malaysia, Indonesia, Korea and Philippines and four Latin American countries viz., Mexico, Argentina, Brazil and Chile for the period from January, 1996 to June, 1998. Based on the estimated results, the study found low dependence among sample series from state-varying volatility. However, the changes in dependence during high variance regimes were appeared to be stronger and statistically significant in most cases, confirming the occurrence of contagion. Further, the study’s results indicated the increased informational asymmetry caused by increased tail dependence with high volatility in case of Asian countries. While, in case of Mexico to Brazil, the study exhibited increased dependence with symmetry and tail independence. The most striking finding of this study is that it added a new dimension to measure and analyze the contagion phenomenon in the framework of tail dependence using Copula approach. Further, the study analyzed impact of Mexican crisis on Latin American countries which could be a significant contribution in the field of contagion literature particularly in emerging market context.

In countinuation with above mentioned studies, using dynamic conditional correlation (DCC-GARCH) model, Chiang, Jeon and Li (2007) empirically examined the cross market correlations between crisis country during Asian crisis and eight other important Asian markets. While, examining the correlations to confirm the contagion by using Forbes and Rigobon (2002) method, the study highlighted following methodological drawbacks in the contagion analysis. First, the heteroscedasticity bias in the correlation analysis, because contagion phenomenon is strongly linked when volatility is high and this may have damaging impact on the correlation results. Second, the unavailability of reliable data on financial indicators in case of emerging markets as it sometimes create obstacles in pursuing the contagion research. Third, the role of time-varying cross market correlations must be given priority because it highlights the nature of change in correlation during examined crisis period. As the study suggested this may require a different set of modelling which the literature must explore. Fourth, the study highlighted the role of identification of crucial turning points as the exact identification of start date
always play vital role in analyzing contagion. Using daily data of nine Asian stock markets for the period of 1990 to 2003, the study reported significant increase in correlation during sample period, confirming the strong case of contagion. However, the study also utilized the dynamic conditional correlations to classify the Asian crisis period into different phases and based on qualitative sources of information, the study classified the Asian crisis period into two phases. In the last phase of empirical analysis, the study also shown the impact of credit rating changes on mean as well as variance. The study has significant contribution in the field of contagion literature as it outlines new dimension of utilizing more qualitative information in contagion analysis.

In a similar attempt, Sojli (2007) tried to examine the contagion in emerging markets during Russian crisis (1998). The study majorly focussed on emerging markets in Europe due to geographic proximity. The study considered three emerging markets of Europe viz., Estonia, Czech Republic and Slovenia to examine the crisis spread on these economies. The most striking part of this study is that it examines the contagion using two types of correlation models. First the adjusted correlation model given by Forbes and Rigobon (2002). And second the full information model developed by Favero and Giavazzi (2002). As the study highlights, the main purpose of using these models is to try and analyze the unbiased contagion results as these two models capture the significant changes in correlation and also of interdependence and external shocks, making it more viable for contagion analysis. Using daily data in domestic currency terms for the period 1997 to 1998, the study reported the evidence of high interdependence during Russian crisis and reports no evidence of contagion.

Considering contagion as macroeconomic phenomenon, Khan and Park (2009) examined the contagion effect during Asian crisis using macroeconomic variables viz., trade balance, interest rate, price level, exchange rate, and weighted average of USA, Britain and Japan and macroeconomic variables of Thailand, Indonesia and South Korea. The study used the monthly data of January 1994 to December 1999. Using Kalman filter
technique, the study found strong evidence of herding contagion during Asian crisis. The most striking outcome of this study is that this study attempts to add new avenue of research in the literature by introducing the state space modelling in contagion literature. At the same time, the study can also be criticized because it ignored the qualitative dimension of aggregating information about contagion. Relying solely on statistical criteria may be misleading and therefore some studies in the literature always recommend to verify the statistically analyzed results with qualitative inferences. However, the study contributes significantly to the contagion literature particularly in the context of Asian financial crisis.

Drawing on the inference of Khan and Park (2009), Baur and Fry (2009) empirically investigated the contagion effect of Asian financial crisis on a large basket of countries viz., China, Hong Kong, India, Indonesia, Japan, Korea, Malaysia, the Phillipines, Singapore, Taiwan and Thailand. The study also utilized two global composite indices viz., MSCI World, MSCI Emerging markets Free Asian Indices. The study used the daily data for the period of April 30, 1997 to October 22, 2003. Using panel data regression with fixed time effects and mixture of GARCH model, the study found strong evidence of interdependence and not contagion during examined Asian crisis period. The most striking contribution made by this study is that it applies the panel data techniques in analyzing the sample markets and also uses the volatility model to contain the heteroscedasticity inflated correlation results.

Duley and Hutchison (2009) empirically examined the impact of US subprime under different dimensions on emerging markets. One of the significant features of this study is that it also tested the decoupling and recoupling hypotheses during the examine crisis period. As at that time, it was rumoured that the emerging economies are immune to the US subprime crisis as these economies were still striving to achieve high rate of growth. Keeping these issues into account, the study at first stage used the data of credit default swap (CDS) and event study analysis to confirm whether with the change in CDS spread
impacted the emerging markets or not. The analysis was performed to capture the impact of various sources of news announcements during turmoil period of August 2008. Using the daily data of January 1, 2007 to February, 2009 on CDS for five emerging markets in Latin America (Argentina, Brazil, Chile, Colombia, and Mexico), three in Asia (China, South Korea and Malaysia), four in Central Europe (Czech Republic, Poland and Hungary) and three from other regions (Russia, South Africa and Turkey), the results of event study analysis further confirmed that the news related with CDS spread has significant impact on emerging markets. In order to confirm that these empirical claims were true, the study also analyzed the cross market correlations between price changes in the S&P 500 and those of sample emerging markets, the results indicated significant increase in correlation after August 2008, in nine of eleven selected sample emerging markets, confirming the strong impact of US financial and real news on emerging markets. In the second stage of analysis, the study relied on conventional time-series tools to examine the linkages between US equity markets and sample emerging markets, using VAR method, the study reported strong linkages since fall 2008 when the US financial crisis was at its peak. At last stage of analysis, using Granger causality and different regression estimates, the study found strong evidence of decoupling-recoupling hypothesis. The study finally concluded that at the beginning of subprime crisis, the emerging markets appeared to be insulated during early 2007 to summer 2008 and after that subprime crisis had strong impact on these markets and there was no scope to decouple.

The study of Ahlgren and Antell (2010) empirically investigated the comovements between emerging and developed markets covering several crises periods. The most striking features of this study is that it applies the method of Co-breaking developed by Hendry and Massmann (2007). The method of co-breaking outlines new changes in the analysis by way of identifying the breaks across linear combination of variables. Similar to cointegration analysis, this method also looks at the combination of variables exhibiting the break at the same time. In the words of Ahlgren and Antell (2010)
“Cobreaking is defined as the cancellation of breaks across linear combinations of variables. More specifically, if two or more stationary time series have a break in their conditional mean but some linear combination does not have the break, then the series are said to be cobreaking”. Co-breaking is generally applied to the analysis of comovement because it captures the immediate comovements of information from one market to another. During crisis period, this analysis is considered to be important as it helps the investigators to examine the instantaneous spread of a crisis from one market to another. The study used two sets of monthly data. In the first set study used the data of January 1988 to August 2006 for Germany, Japan, UK and USA and MSCI global index. The second set contained emerging markets viz., Hong Kong, Korea, Mexico, and in addition the US along with MSCI before 1988. The estimation of co-breaking is performed in this manner. At first stage, VAR model was estimated to confirm the interdependence among study variables. For this purpose, four dummy type values were generated to denote the crisis events. In the second stage, the study applied the concept of co-breaking on the residual obtained from VAR. Based on the results, the study concluded that there is no co-breaking between developed and emerging markets and also there is no evidence of contagion during Russian crisis (1998), Asian crisis (1997) and Mexican crisis (1994). Hence, the study contradicted many of the aforementioned studies by applying the co-breaking method. The study contributes significantly to the contagion literature because it proposes the application of new method in the contagion analysis similar to endogenous structural break test.

Yiu, Ho and Choi (2010) using contemporary econometric technique tried to exhibit the contagion effect of Asian financial crisis (1997) and US financial crisis (2008) on a group of countries in the Executives’ Meeting of East Asia-Pacific (EMEAP). The acronym is considered as strong abbreviation in global economy as it includes most of the Asian tiger nations. Based on the study, the acronym consists of 11 mature and emerging nation’s viz., Australia, China, Hong Kong (of China), Indonesia, Japan, Korea, Malaysia, New Zealand, the Philippines, Singapore and Thailand. Though the sample size of this study is
weekly data for the period from February 1993 to March 2009, the empirical methodology is little innovative. At first stage the study constructed single latent factor that could explain the major variation in the returns data of sample markets. At later stage, the study applied asymmetric DCC model to analyze the time-varying conditional volatility and correlations between US equity market and the Asian factor and four selected economies. The main advantages of Asymmetric DCC model is that it allows the residual estimated at first stage of DCC-GARCH (Engle, 2002) to capture the asymmetric impact of positive as well as negative residuals on the dynamics of the conditional correlations. The empirical methodology works in more or less same manner as found in case of conventional volatility model of EGARCH. The estimated results of Asymmetric GARCH model confirmed the contagion effect between USA and other sample markets. However, the study did not report the evidence of contagion in case of individual countries during the Asian financial crisis. Further, the study found strong evidence of asymmetry in each contagion cases by confirming the impacts of bad and good news on time-varying correlations. In continuation, the study also classified the crisis period using different dummies into the regression equation of dynamic correlations and found insignificant results of these dummies. Based on this result, the study concluded that the Asian financial crisis reveals that the crisis originated locally in the region. The findings imply that with the help of cross market correlations, a contagion phenomenon is possible to discern. However, the limitation of this study is that it ignores the importance qualitative information in the model.

Inci, Li and McCarthy (2011) in a comprehensive study on analyzing the phenomenon of financial contagion applied local correlation analysis to investigate the contagion effects between spot and futures prices of developed markets during subprime crisis (2008). The most striking features of this study are: first, the study uses the futures and spot prices data which is new to the literature an most previous studies have examined the crisis period on simple stock market returns. Second, the study applies the semi-

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The Asian factor was constructed using the principle component analysis.
parametric econometric method developed by Bradley and Taqqu (2005) to investigate the contagion of US crisis on other mature markets. According to the study “the technique of local correlation makes use of local polynomial regression, and allows for the examination of the reaction in one sovereign market to then change in financial returns in other sovereign markets for both small and large return deviations”. The study used the daily data for the period March, 1985 to August, 2008 of five developed markets viz., USA, Britain, Germany, Japan and Hong Kong spot equity indices and index futures. Before analysis, the study raises several issues with regard to existing methods of contagion and contradicts correlation based methods of measuring contagion as developed by Forbes and Rigobon (2002). One major observation that the study makes about the size of the sample period that the small sample size always effects the central results of contagion analysis. However, the results of the study reported strong evidence of contagion from US stock market to that of Germany and Britain. By addressing the differences of opening hours, the study also found contagion from US spot equity market to that of Japan and Hong Kong, this appeared to be in contrast with the study of (Bradley and Taqqu, 2005). The most interesting observations of this study is that it found no contagion from US futures to other futures markets, while, in case of spot market, no reverse contagion was found from any of the sample markets to US index futures markets.

Aloui, Aissa and Nguyen (2011) in their innovative modelling attempt combined the multivariate copula model with extreme value theory to analyze not only the tail dependence but also the possible informational asymmetry in the sample series. The study starts with simple argument in favour of possible biasedness with correlation based modelling and tried to add the dimension of extreme interdependence in the contagion analysis. Though, the methodology of this study is by and large similar to the study of Jondeau and Rockinger (2006), still the study contributes significantly to the existing literature on financial contagion. The study analyzed the data of stock markets of BRIC (Brazil, Russia, India and China) countries along with USA for the sample period of 2004
to 2009. The objective of this study is to empirically investigate the extreme financial interdependence of some selected emerging markets with the US and found out their dependence at extreme levels conditionally dependent on the possibility of extreme financial events (e.g., financial turbulence, and crisis). The model which the study used in empirical analysis is called extreme value theory as well as generalized autoregressive conditional heteroscedasticity (EVC-GARCH) model. According to this study “in this nested setting, the GARCH models with possibly skewed and fat tailed return innovations are applied to filter the stock market returns and to draw their marginal distributions, while the multivariate dependence structure between markets is modeled by parametric family of extreme value copulas which are perfectly suitable for non-normal distributions and nonlinear dependencies”. Hence, the model not only allowed to capture the tail dependence but also the asymmetric tail dependence. When calibrating several well-known copulas based on the marginal distributions of the filtered returns from the EVC-GARCH model, the study found evidence of extreme comovement of all market pairs both in the left and right tails. The study further concluded that the Brazil and Russia exhibit high tail dependence with US than China and India.

In a large sample study on examining the contagion effect of US subprime on a large group of countries, the study of Samarakoon (2011) examined the transmission of shocks between US and foreign markets. The study also tried to investigate the differences in levels of contagion effect in overlapping and non-overlapping markets. For this, the study developed two separate models. One is called partially overlapping shock model and non-overlapping shock model, in both these models; a dummy variable based regression model is used to capture the interaction effect between US crisis dummy and country’s stock market return. The model was implemented on all 62 sample markets. This study used daily price indices for the USA, emerging, and frontier markets. The study estimated the contagion effect between US and sample markets in this manner:

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8 The study defined overlapping and non-overlapping based on the different opening hours of the markets in comparison with US stock market.
At first stage, autoregressive models were used to extract the unexpected returns for examining the time-varying properties. Then at second stage, the study used the cross market regression under VAR framework. In this, USA returns were related with other sample market’s returns. Based on the estimated results, the study found bi-directional asymmetric contagion effect in emerging markets with important regional variations. However, among sample markets, interdependence was exhibited by US shocks while contagion is shown by emerging markets returns. Finally the study concluded that there is strong contagion and interdependence between USA and emerging markets, while frontier markets are contagious. The most striking observation of this study is that it confirms the interdependence between emerging and mature markets shocks and provides direction for future research in examining this interdependence from portfolio diversification perspective. However, in case of frontier markets the results of the study appear to be contradictory as it provides strong evidence of interdependence with US economy. However, the study confirms the strong impact of recent US subprime on mature markets, implying that the shocks originating from US economy jolt the stock markets in emerging markets. Considering the large sample covered in this study, the study underpins several policy implications for vulnerable economies and especially for frontier markets on which the literature is very limited and may also provide an important direction in undertaking various rescue measures to insulate the economy from contagion effects in future.

Kenourgios, Samitas and Paltalidis (2011) examined contagion effect of five financial crises (the Asian Crisis in 1997, the Russian Crisis in 1998, the Technology Bubble Collapse in 2000, the Brazilian Stock Market Crash in 1997–1998 and the Brazilian Crisis in 2002) on four emerging equity markets, namely Brazil, Russia, India, China (BRIC) and two developed markets (U.S. and U.K.). The sample period is from January, 1995 till October, 2006. The study employed the multivariate regime-switching Gaussian copula model to analyze the second moment dynamics of stock market return series and to address the heteroskedasticity problem and correlation breakdowns as highlighted by
Forbes and Rigobon (2002). Further in order to take into account the possible asymmetry, the study also used the asymmetric generalized dynamic conditional correlation (AG-DCC) to investigate the non-linear correlation dynamics in cross market correlations. Based on the estimated results, the study confirmed the contagion effect from crisis country to other sample emerging markets. After analyzing the examined crises periods, the study concluded that the BRIC markets are more prone to contagion. Analyzing the asymmetry, the study also found strong evidence of asymmetry. The most striking finding of this study is that it combined the two nonlinear models efficiently. Unlike Aloui et al. (2012), this study relies more on identifying the breaks in correlation endogenously rather than based on prior information. However, the study contributes to the existing literature significantly highlighting the role of nonlinear models in contagion analysis.

In order to examine the short-run inter-relationships Syllignakis and Kouretas (2011) used the multivariate DCC–GARCH model to investigate possible contagion effects between the stock market returns of the US, Germany and Russia and those of the Czech Republic, Estonia, Hungary, Poland, Romania, Slovakia and Slovenia, by using weekly stock return data for the period October 1997 to February 2009. Considering USA, Germany and Russia as sources of potential contagion, the study at first stage of its empirical analysis, introduced each source country as a mean in GARCH model, to confirm whether these markets are having any significant impact on the vulnerable countries or not. Most of the results estimated confirmed the significant role of these three markets on Central and Eastern European (CEE) emerging countries’ stock markets. In the second step, the study estimated the dynamic conditional correlations to examine whether the t-stats of adjusted correlation is significant or not. After doing this, the study also analyzed the comovement and herding behavior by introducing the volatility of CEE countries as explanatory variable in the correlation based regression, the study results further confirmed the strong herding behavior in CEE’s stock markets. However, considering the examined crises periods, the study found strong evidence of contagion
effects between USA and CEE markets during recent financial turmoil period. On the contrary, in cases of the Asian and Russian crises and the dot com bubble, the study did not report the occurrence of any contagion between the same set of markets. The finding of this study has strong implications on possible contagion between Russia and USA on CEE countries. The study contributed significantly to the contagion literature in emerging European stock market context.

Marcal, Pereira, Martin and Nakamura (2011) empirically investigated financial contagion and interdependence among the Asia and Latin America financial crisis during the 1990s. Using daily stock price of Argentina, Brazil, South Korea, US, Singapore, Malaysia, Mexico and Japan for the period 1 January 1994 to 31 December 2003 and multivariate Generalized Autoregressive Conditional Heteroscedasticity (GARCH) model, the study found strong case of regional contagion in both Latin America and in Asia. The study further highlighted the role of macroeconomic variables in contagion analysis. The main drawback of this study is that it does not explicitly work on identifying the exact crisis period by using some statistical criteria. However, the findings of this study contradicts many important studies, confirming the fact that the results of contagion analysis play vital role in confirming the occurrence of contagion.

In a comprehensive study on analyzing the impact of global financial crisis on major economies of the world, Baur (2012) empirically investigated the spread of crisis risk from financial sector to the real economy by examining 10 sectors in 25 major developed and emerging stock markets. The study is mainly focussed on analyzing the stock market contagion on the aggregate, sectoral, global, and domestic level. The study analyzed these hypotheses in this way. At first stage, the study utilized all the available sources of information about the specific impact of the crisis in developed and emerging countries. At second stage, the study identified the dates of economic crisis using the methods of excess volatility and also by using the regime switching model. After this, the study chose the time-window which is common to both methodologies. In the last step, the
study used GARCH based models to test for contagion. Based on the estimated results, the study showed that during global financial crisis period, the shocks were mainly triggered from financial sector stocks as the contagion effects appeared to be stronger in case of financial sector. Whereas, contagion effect in other sectors viz., Consumer Goods, Industrials, Telecommunications and Technology appeared to be mixed. The findings of the study illustrate that the crisis of 2007–2009 is truly global in the sense that no region, country and sector has been immune to the crisis. The study contributes significantly to the literature in two ways: firstly, the study tries to analyze the contagion effect of global financial crisis sectorwise across 25 countries which is unique to the best of our knowledge/understanding of the related literature. Secondly, the study developed a novel methodology to identify the start date of the crisis by using all the relevant qualitative information analyzing news related with crisis events and also apply statistical techniques to identify the crisis date endogenously. This is something newly incorporated in the existing literature.

In an empirical attempt Gallegati (2012) applied wavelet-based method to examine the contagion effect of US subprime on Canada, Japan, UK, France, Italy, Germany, Hong Kong for the period June 2003 to December 2008. More specifically the study sets to examine whether sample markets faced the problem of contagion or interdependence during subprime crisis period? As the study highlights the use of frequency domain approach to capture the sudden or excessive jump in the sample series in contagion analysis. One of the characteristics of frequency domain is that it can filter the sample series into the components of different frequencies, some time it is noted as trend and cyclical components which can help the investigators immensely in distinguishing between contagion and interdependence with different frequency ranges (normally in stock market sense it is high and low observed in stock prices) as applied by Bodart and Candelon (2009). In the words of this study “Wavelet analysis is a filtering method that provides an interesting alternative to time series and frequency domain methods since it transforms the original data into different frequency components with a resolution
matched to its scale. This characteristic is particularly useful when dealing with signals that are non-stationary and exhibit changing frequencies over time, as in the case of financial market data”. Two main features of wavelet method make this study interesting. Firstly, its ability to decompose the sample series into time-scale components. Secondly, to provide an alternative representation of the variability and association structure of certain stochastic processes by applying the scaling rule. In summary, the study analyzed the financial time-series to find out the presence of any large jump using wavelet and scaling techniques under frequency domain framework. Based on the estimated results, the study found the strong evidence of contagion and interdependence between US stock market returns and rest of the sample countries though the results vary across scales except for Japan and Brazil. The study further concludes that the lower scales (high frequencies) are associated to contagion and high scales (lower frequencies) to interdependence. The results based on wavelet correlation analysis provide evidence of international contagion effects from the US during the subprime crisis, but also indicate that these contagion effects do not display their influence uniformly across scales, except for Japan and Brazil.

Kenourgios and Padhi (2012) using conventional econometric techniques of Johansen cointegration tests and vector error correction models examined the financial contagion of three crises periods linked with emerging markets during 1990s and global financial crisis of 2008. However, in order to analyze the dynamic conditional correlations by incorporating the informational asymmetry in the returns series, the study applied the asymmetric generalized dynamic conditional correlation (AG-DCC) model developed by Cappiello et al. (2006), a generalized model of DCC-GARCH model of Engle (2002). Using the data on equity and bond markets of Emerging Market Economies (EMEs) from various regions around the world, USA and 2 global stockmarkets, the results provided the evidence of strong contagion effect of the subprime crisis and the Russian crisis. During Argentine crisis the study found the evidence of decoupling. However, the results of conventional cointegration indicated
short and long-run dynamics for stock markets during Russian and Asian crises. The results of AG-DCC model indicated the existence of asymmetric contagion to emerging markets and globally only in case of Russian crisis and the US subprime crisis.

In European stock market context, Syllignakis and Kouretas (2010) tried to examine the long-term linkages between seven Central and Eastern European (CEE) emerging stock markets and two developed stock markets viz., the German and the US markets. In order to do this, the study used the recursive cointegration analysis. The major findings of this study are as follows: first, the empirical results of the study reveal that there are financial linkages between CEE markets and world markets and it has increased over the years especially after the accession of CEE countries into EU. Second, using Gonzalo and Granger (1995) methodology, the study further reported that the examined markets are weakly integrated. In a different dimension, the study found that the emerging stock markets of CEE have significant common permanent component except for Estonia, this derives this system of stock exchanges in the long-run. Third, the study indicated that the global financial crisis has caused slowdown in the convergence process of CEE countries with EU. Finally, the study concluded that the US subprime crisis has negative impact on CEE markets. However, the study has some drawbacks, as it attempts to underpin the broader framework of financial convergence by analyzing the integration process and ignoring the fact that these relationships may possess the nonlinear characteristics. Besides this, the consideration of US and Germany as global markets seems premature because Europe is also highly integrated with Russia which is always called as fuel tank of Europe. Despite these limitations, the study contributes significantly to the literature because it considers CEE markets which appear to have very limited literature especially on analyzing the contagion phenomenon.

Choe, Choi, Nam and Vahid (2012) proposed a new time-varying test of contagion during Asian financial crisis by using the daily stock returns data of 27 stock markets for the period January, 1996 to November, 1997. The sample countries were divided as
eleven national markets from Asia (including Hong Kong), ten markets from Europe, and six markets from North and South America. The important feature of the study points out that in this test there is no need to make adjustment in the correlation coefficients to avoid the heteroscedasticity related biases or any specific assumption on the relative importance of idiosyncratic variance to common factor variance, as found in the studies of Forbes and Rigobon (2002) and Corsetti et al. (2005). Another feature of this test which the study attempted to highlight is that it can capture the time-varying component of cross-market comovements and can also identify the intertemporal adjustments of risk-averse investors. In this time-varying correlation test, contagion is defined as a structural break in correlation dynamics during a crisis. The study also pointed out the role of structural breaks in time-varying correlation which appeared to be an outcome of an excessive cross market comovement beyond the level that can be explained by the risk-return relation. For this purpose, the study used the Weber’s (2010) structural dynamic conditional correlation (SDCC)–GARCH model. The estimated results from this model found contagion evidence under standard constant correlation test, none of the countries exhibited contagion evidence during 1997 Asian crisis for daily as well as two-day rolling average returns using the Weber’s approach. Finally, the study concluded that the high correlation during crisis period as contagion evidence by the constant correlation test is mostly due to cross-market co-movements induced by the inter-temporal risk-return adjustments by rational, risk-averse investors during the crisis period.

Tamakoshi and Hamori (2013) empirically analyzed the causality-in-variance and causality-in-mean between banking sector Credit Default Swap (CDS) index and the Greek sovereign CDS spread. Though, this study is not particularly focused on stock market but it has several implications on the smooth functioning of the stock market in the sample countries. According to the study causality-in-variance helps immensely in analyzing the process of information transmission between variables. The data used in this study is unique, as the variables included in the study are Eurozone banking sector CDS index prices and the spreads of the 5-year Greek sovereign CDS index prices over
those of Germany for the sample period of January 2008 to December 2011. Further, the sample period was divided into two sub-groups viz., pre and post crisis period. One of the most significant contributions of this study in the light of recent Eurozone crisis is that it identifies the anecdotal date of trigger of Greek crisis as November 17, 2009. On empirical front, the study used the model of Cross-Correlation Function (CCF) to analyze the causality-in-variance. Based on the estimated results, the study reported two major findings: firstly, before the sovereign debt crisis, there was significant unidirectional causality in mean and variance from bank CDS to the Greek sovereign CDS spreads. Secondly, the results after the debt crisis were appeared to be completely inverse and causality in variance found to be moving from Greek sovereign CDS to the bank CDS. The study indeed provided very significant results especially in the context of Eurozone crisis which is still a major problem for the global economy. However, the study contributes significantly to the contagion literature because it focusses upon the movement of risk using macroeconomic variables.

2.5 Summary and research gap in the literature

An appraisal of above mentioned studies reveals that although theoretical as well as empirical studies have produced somewhat mixed results, still some patterns in the existing literature on regime shifts and financial contagion are easily observable. First, it is well established that the state of the equity market can be captured in nonlinear way by applying set of econometric methods. The occurrence of these regimes can also be further utilized in asset allocation and risk management. Second, among all the available econometric methods of nonlinearity, the aforementioned studies emphasize more on the application of regime switching based model because of its ability to identify the major turning points, structural breaks and volatility switching endogenously. Third, while the issue of asset allocation and risk diversification remains a major concern in emerging markets, there is very limited literature to overcome this problem. Fourth, the studies of contagion phenomenon clearly indicate that the issue of contagion still requires improvement not only in terms of econometric analysis but also in the way the research
has been undertaken till now. Although, the literature has covered all the major crises happened in the past thirty years, most of these studies are concentrated on developed markets and more importantly the contagion on recent Eurozone crisis is very scanty.

In the light of above mentioned facts, it is apparent that there exist following research gaps in the related literature.

- Although there is huge wealth of literature on regime shifts and financial contagion in stock market returns of developed markets, there is comparatively limited literature on emerging markets.
- Numerous studies have applied the model of regime switching only in variance to examine the level of volatility from risk management perspective. There is very limited literature on utilizing these regimes from asset allocation and risk management in the context of emerging markets;
- Previous studies have majorly used the MRS model with only in mean or in variance, but as the literature suggests the simultaneous examination of both mean as well as variance in stock market returns provide better opportunity for investors as well as regulators in timing the market for taking investment positions or to curb the market from any unfortunate events;
- Previous literature on regime shifts and volatility in emerging markets have not examined whether a group of prospective emerging markets can be considered as single homogenous financial asset class or not? And this issue has received very less attention in the literature. The examination of this particular issue is very relevant especially after the financial crisis when the global economy has witnessed tectonic shift in the economic and political scenarios and the increased role of emerging markets in reviving the global economy.
- Surprisingly, the literature on regime and volatility is very scanty as a reappraisal studies reveal that there has been very limited attention paid on examining the regime shifts and volatility in European markets, particularly in the context of asset allocation and risk management;
• Further, the existing literature on European markets also indicates that the issue of market synchronization needs to be reinvestigated as there are several apprehensions raised against the outbreak of strong comovement among these markets.

• Most studies in the literature have analyzed different set of stock markets from asset allocation perspective based only on Sharpe ratio, the role of market synchronization in asset allocation and risk management is almost missing.

• Previous studies have majorly focused on the examination of time-varying correlation between markets during turmoil period. But the literature on identifying the exact start and end date of crisis is almost missing. This can be considered as one of the major gaps in literature;

• Previous literature has covered almost all the major crises events occurred in the past three decades. However, the literature on recent global financial crisis is still burgeoning and particularly on Eurozone debt crisis, there are very limited studies.

• The review of above mentioned studies also indicate that the absence of Eurozone crisis’s impact literature on European markets.

Building on these observations, the present study attempts to fill these gaps by providing some additional empirical evidence in the context of developed as well as mature markets. The present study will contribute substantially to the related literature by showing some new empirical evidence from the examination of regime shifts and financial contagion.