8. THE CONTAGION EFFECTS ON REAL ECONOMY: EMERGING MARKETS DURING THE RECENT CRISES

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Abstract

In this paper, we analyze financial contagion in the emerging markets both at the aggregate and disaggregate levels during the global financial crisis (GFC) and the European sovereign debt crisis (ESDC). By using a market model derived from Bakaert et al. (2005) and Baur (2012), we investigate the possible propagation channels of financial contagion as follows: i) aggregate stock market contagion, ii) financial sector contagion, iii) real economy sector contagion from the financial system of the crisis-originating country and iv) idiosyncratic contagion effects to the real economy sectors transmitted through the emerging financial market. At the aggregate level, our results document contagion incidences only during the ESDC. At the sector level, the energy, the materials and the industrial sectors are exposed to financial contagion from the European financial market in the episode of the ESDC. With regard to the idiosyncratic contagion effects, the real economy sectors are heterogeneous in the sense that they display co-movements at varying magnitudes during both of the crises. However, the healthcare sector is found to be vulnerable to financial system shocks within the emerging markets during both turmoil episodes. In this context, our results are of particular importance for the international investors in order to design a well-diversified portfolio, as well as for the authorities to maintain global financial stability and to prevent and mitigate the financial contagion.

Keywords: financial contagion, emerging stock markets, market model, regime switching, crises

JEL Classification: C22, G01, G15

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I. Introduction

The first decade of the 21st century peremptorily witnessed one of the most severe financial crises in the world history. Not much longer after the global financial crisis (hereafter GFC) of 2007-2009, the world was hit again by a new turmoil, the European sovereign debt crisis (hereafter ESDC) of 2010-2011. These two severe events have affected a great many countries, regions and sectors with diminishing wealth effects. Thus, scholars have started analyzing the impacts of these recent crises on the cross-market linkages at times of market distress, in an effort to explore whether the increased co-movements are related to interdependence or financial contagion.

Forbes and Rigobon (2002) construe contagion as a significant increase in the cross-market correlations after a shock in one of the markets. Kenourgios and Dimitriou (2015) discuss that the increased co-movements between different markets during crises surface from the shifts in risk appetite or risk aversion, rather than the shifts in the economic fundamentals, such as exchange rates and trade linkages. Hence, if contagion becomes a common feature of the global financial markets, then international diversification becomes useless at adverse market conditions.

In fact, the studies aiming to assess the contagion between different equity markets are quite in number; however, almost all of these academic works focus on the aggregate equity market contagion. More recently, an interest in analyzing the contagion of the real economy sectors has emerged (Phylaktis and Xia, 2009; Baur, 2012; Kenourgios and Dimitriou, 2014). Sector level interactions are worth-appraising, since the return dynamics of the sectors are not identical. Some of the real economy sectors are more susceptible to shocks because of their industrial structures, while the others are more resistant. Besides, the emerging markets have attracted the attention of researchers with their much higher growth potentials than the developed economies[3], as well as with the diversification benefits for the international investors. The empirical evidence shows that the linkages among the developed and emerging markets are weaker than those among the developed ones (Driessen and Laeven, 2007; Gupta and Donleavy, 2009). In this respect, contemporary research gravitates towards the financial contagion phenomenon in the emerging stock markets.

Furthermore, the identification of the length of the crises is also a major issue, since this would directly modify the results of any study on the topic (Baur, 2012). In the literature, the beginning and the ending dates of the crises periods are commonly set on anecdotal evidence (Dungey *et al*., 2005). However, some researchers apply regime-switching models to determine the crises periods endogenously (Boyer *et al*., 2006; Rodriguez, 2007). The Bank of International Settlements reports (2009) identify the GFC as starting in the third quarter of 2007 and ending by the fourth quarter of 2009[4]. Mostly, August

[3] According to the IMF World Economic Outlook Reports for 2014 and 2015, the expected economic growth rate is 5.1% and 5.4%, respectively, in the emerging economies, while it is 2.2% and 2.3%, respectively, in the advanced economies.

[4] There are four phases defined during the GFC. The first phase is the "initial financial turmoil", which continues from the third quarter of 2007 to mid-September 2008, followed by the second phase (which is described as "sharp financial deterioration") until the end of 2008; the third phase, "macroeconomic deterioration", ends in the first quarter of 2009 and the fourth phase, "stabilization and tentative signs of recovery" lasts by the end of 2009.

2007 is taken as the beginning of the GFC (Taylor and Williams, 2008) and March 2009 as the ending date. Ahmad *et al*. (2013) argue that the ESDC is considered as a byproduct of the GFC, with its dramatic impact on particularly the GIPSI (Greece, Ireland, Portugal, Spain and Italy) economies. The ESDC was flamed up by the announcement of the Greek government on its embarrassment of sovereign debt obligations in late 2009. In a sudden wave, Italy, Ireland, Portugal and Spain were also coerced by the crisis. The ESDC has forged ahead from several directions concurrently; firstly, the European banking system has faced severe difficulties due to the close ties with the US banks; secondly, the real estate markets have been adversely affected; and thirdly, some of the EU countries that have not abided by the principles of the Maastricht Treaty, have uncontrollably piled up deficits and borrowing levels over years, which in turn have triggered the sovereign debt crisis.[5]

In line with the aforementioned discussion, we focus on the contagion effects of the GFC and the ESDC on the emerging markets both at the aggregate and disaggregate levels. We test for the different channels of financial contagion: i) aggregate stock market contagion, ii) financial sector contagion, iii) real economy sector contagion from the financial system of the crisis-originating country iv) idiosyncratic contagion effects to the real economy sectors which spread through the emerging financial market. Moreover, a regime-switching model is employed to endogenously specify the length of the crises. We assume that the crises have originated in the finance sector and estimate the excess volatility of the US and the Eurozone financial sectors under two regimes, namely a low volatility and a high volatility regime. Our results of the regime-switching models match the ad-hoc specifications of the starting and the ending dates of the GFC and the ESDC.

In this study, we address the following research questions: 1) Do contagion effects of the GFC and the ESDC vary on the emerging markets at the aggregate and disaggregate levels? 2) Are the financial sector shocks transmitted to the real economy sectors? 3) Do emerging market sectors display differences in their responses to the global shocks? Previous research mostly emphasizes the contagion of the GFC and a very few investigates the contagion of the ESDC, without accounting for the effects of these two downturn periods in the same study. Our study fills this gap in the literature to elaborate the effects of both of these two recent crises on the emerging markets and their real economy sectors.

The plan of the paper is as follows: Part 2 presents the related literature. Part 3 discusses the methodology and the data features. In Part 4, we identify the crises period endogenously within the context of Markov Switching Dynamic Regression (MSDR). Part 5 documents the results from the empirical models and, finally, Part 6 concludes.

II. Literature Review

Finance academics have spent an immense effort to study the linkages between financial markets for the last couple of decades. Their endeavor results in the empirical evidence of increased co-movements, financial integration and contagion incidences

[5] See Ahmad *et al*. (2013), Blundell-Wignall and Patrick (2011), and Missio and Watzka (2011).

(Bertero and Mayer, 1990; Pericoli and Sbracia, 2003; Kaltenhauser, 2003; Goetzmann *et al*., 2005; Berben and Jansen, 2005; Capiello *et al*., 2006; Dooley and Hutchison, 2009; Aloui *et al*., 2011; Bein and Tuna, 2015), which is argued to be the outcome of the so-called globalization with the economic and political systems faired into a huge global network.

The empirical studies of financial contagion proceed in two branches at the aggregate and disaggregate levels. The most recent work on the aggregate level contagion concentrates upon the two latest crises (GFC and ESDC), but particularly on the GFC. Hemche *et al*. (2014) analyze the shift contagion[6] with the US for ten developed and emerging markets (Argentina, China, Egypt, France, Italy, Japan, Mexico, Morocco, Tunisia and the UK) during the GFC. They document contagion[7] for Argentina, France, Italy, Mexico and the UK. Horta *et al*. (2008) investigate the contagion effect of the US subprime crisis on the G7 countries along with Portugal and attest significant levels of contagion for Canada, France, Italy, Japan and the UK. Ahmad *et al*. (2013) study the financial contagion in the BRIICKS economies (Brazil, Russia, India, Indonesia, China, South Korea and South Africa) during the Eurozone debt crisis, where they consider the US, the UK, Japan and the GIPSI (Greece, Ireland, Portugal, Spain and Italy) countries as a source of contagion. They substantiate evidence of the contagion effects from the GIPSI countries to the BRIICKS equity markets.

At the industry level, researchers document mixed results on the financial contagion. Kaltenhauser (2002) illustrates sector heterogeneity, while Carrieri *et al*. (2004) delineate that market-level integration does not avert industry-level diversification benefits. As discussed by Kenourgios and Dimitriou (2015), the asymmetric sector contagion may constitute hedging options for investors. Furthermore, the industry-specific concentration of different economies varies greatly, where the diversity is much higher in the developed economies as compared to the emerging ones. Along these lines, the weights of the sectors in different economies may alter the effect and the degree of the contagious flows between markets.[8] As a matter of fact, parsing the dynamics of market linkages for an efficient monitoring of both the costs and the benefits on the real economy sectors is significant for policymakers, institutional investors and portfolio managers.

Baur (2012) examines the spread of the GFC from the financial sector to the real-economy on a sample of 25 countries and ten sectors from each country. He shows strong contagion among all stock markets, along with strong contagious effects of the financial sector. However, he reports mixed results for the real economy sectors, implying that some of the sectors (healthcare, telecommunications and technology) have been immune to the shocks stemming from the crisis, thus, nestling diversification benefits for investors. Kenourgios and Dimitriou (2014) study the contagion effects of the GFC to the real economy on nine sectors of the US and developed Europe for a

[6] Shift contagion is defined as an increase in the co-movements between the markets during the crisis period as compared to normal times, as the result of the greater shock transmission at adverse times.

[7] They conduct the contagion test as described by Forbes and Rigobon (2002).

[8] The sector weights in the aggregate stock market indices for different countries may disentangle industry-specific factors from country-specific factors in shock transmissions.

sample period from 2004 to 2009. They report contagion for both the US and developed Europe at the aggregate level, while the financial sector contagion is found only in the case of the US. In their work, the real economy sectors are all prone to contagious effects in the US; however, the developed Europe sectors generally provide diversification benefits for investors.

Shortly after another study, Kenourgios and Dimitriou (2015) analyze the contagion of the GFC on ten sectors (consumer goods, consumer services, energy, financials, healthcare, industrials, materials, technology, telecommunications and utilities) in six developed and emerging regions (Developed Europe, Developed Pacific, Emerging Asia, Emerging Europe, Emerging Latin America and the US) during the different phases of the global crisis. Their results confirm those of Baur (2012), in the sense that Developed Pacific is the only region which is totally immune to the global meltdown at both the aggregate and sector levels. Moreover, their empirical findings depict that across all the other regions affected from the contagion flow of the GFC, the least affected sector is the utilities, while the most affected is the energy. Phylaktis and Xia (2009) investigate 10 sectors in 29 economies from Europe, Asia and Latin America between 1990 and 2004, by applying the model proposed by Bekaert *et al*. (2005). They find heterogeneous contagion at the sector level and report the importance of the financial sector in transmitting the shocks to propagate a crisis. Bekaert *et al*. (2014) study the contagion effects of the GFC in 10 sectors across 55 countries. The authors document strong contagious flows from domestic equity markets to domestic sector portfolios, and relatively weaker contagious effects of the US and the global financial sector. At the sector level, they state positive contagion from the US for the basic materials, the industrials, the energy and the utilities; and domestic contagion for all the sectors, with the only exception of technology.

III. Methodology and Data Analysis

III.1. Empirical Model

Based on a market model proposed by Bekaert *et al*. (2005) and following Baur (2012), we estimate contagion from one market to another as follows:

$$r_{m,i,t} = \alpha + \beta r_{c,t} + e_{m,i,t} \tag{1}$$

$$e_{m,i,t} = \theta_0 + \theta_1 e_{m^*,t} + \theta_1 e_{m^*,t} D_{crisis t} + \eta_{i,t} \tag{2}$$

where: $r_{m,i,t}$ is the return of stock market index i (aggregate emerging market index in our case) at time t, $r_{c,t}$ represents the return of the stock index of the crisis-originating country. A second-pass regression in equation (2) uses $e_{m,i,t}$ from equation (1) as the dependent variable to identify the effect of unanticipated shocks from the crisis-originating market m^* ($e_{m^*,i,t}$) on the unanticipated return component ($e_{m,i}$) in market *i.* The dummy variable D_{crisis} is equal to one in case of a crisis and zero otherwise. The coefficient θ_1 quantifies interdependence and θ_2 measures the contagion effects. If θ_2 is found to be positive and statistically significant, contagion incidences are present.

However, contagion effects detected through equations (1) and (2) are sensitive to the first-pass regression.[9] Besides, the parameters estimated in equation (2) do not measure the impact of a change in the systematic component $r_{c,t}$. For this reason, the model in equations (1) and (2) derives the changes in the co-movement of the filtered or idiosyncratic shocks.

Due to the aforementioned problems associated with the model given in equations (1) and (2), we conduct an alternative model to measure the change in the co-movement in tranquil and turbulent times and to test for contagion. The model to measure aggregate equity market contagion is specified as:

$$r_{m,i,t} = \alpha + \beta_1 r_{c,t} + \beta_2 r_{c,t} D_{crisis,t} + e_{m,i,t} \tag{3}$$

where: $r_{m,i,t}$ is the return of the stock market index *i* at time *t*, $r_{c,t}$ represents the return of the stock index of the crisis-originating country. The dummy variable D_{crisis} is equal to one for the crisis period and zero otherwise. The model in equation (3) can be extended to quantify disaggregate (sector) market contagion as follows:

$$\begin{aligned} r_{s,i,t} &= \alpha + \beta_1 r_{fin,c,t} + \beta_2 r_{fin,c,t} D_{crisis,t} + e_{s,i,t} \\ h_{s,i,t} &= c + \psi e^2_{s,i,t-1} + \delta e^2_{s,i,t-1} I\left(e_{s,i,t-1} < 0\right) + \xi h_{s,i,t-1} \\ e_{s,i,t-1} &= \sqrt{h_{s,i,t}}\, z_{s,i,t} \\ z_{s,i,t} &\sim N(0,1) \end{aligned} \tag{4}$$

where: $r_{s,i,t}$ represents the return of the sector returns under investigation and $r_{fin,c,t}$ is the return of the financial index of country *i* which triggers the crisis. We use the financial index of the crisis-originating country since the two analyzed crises, the GFC and the ESDC, originated in the US and the European financial markets. The models in equations (3) and (4) are specified to measure a change in the transmission of the systematic shocks during both the crisis and normal periods. The parameter β_1 captures the degree of interdependence in normal times. If β_2 is found to be positive and statistically significant, contagion exists. In the case of a negative coefficient estimate of β_2, there is no evidence of contagion. We estimate the model within a GARCH framework, since it is a well-known property that stock returns display conditional heteroskedasticity. An extension of the GARCH model, namely GJR GARCH model of Glosten *et al*. (1993) is specified to account for possible asymmetric impacts of positive and negative shocks on the volatility of the markets.

Extending equation (4), we test for four types of contagion: i) aggregate stock market contagion, ii) financial sector contagion, iii) real economy sector contagion from the financial system of the crisis country and iv) idiosyncratic contagion effects to the real economy sectors spreading through the emerging financial market index. In order to test for different contagion types, we augment equation (4) as:

[9] Baur (2012) and Kenourgios and Dimitriou (2014) discuss that controlling equation (1) for financial and macroeconomic indicators that change during the crisis may cause an estimate of "unexpected" shocks which is not really unexpected. This leads to biased estimates of contagion.

$$r_{s,i,t} = \alpha + \beta_1 r_{fin,c,t} + \beta_2 r_{fin,c,t} D_{crisis,t} + \gamma_1 r_{fin,i,t} + \gamma_2 r_{fin,i,t} D_{crisis,t} + e_{s,i,t} \quad (5)$$

where: γ_1 measures the level of co-movement between the emerging financial index and the real economy sectors under examination, while γ_2 captures the real economy sector contagion from the emerging financial sector. The equation may also be employed to estimate the changes in the level of co-movements between a specific sector and the financial index of the crisis-originating country, as well as that of the emerging markets. Following Baur (2012), we test for different channels of contagion with the four hypotheses listed below:

Test 1 (Aggregate Stock Market Contagion) Increased co-movement of the emerging market composite index with the aggregate stock index of the crisis-originating country in the crisis period as compared to the non-crisis period. The source of the contagion is assumed to be the US composite index and the EU index during the GFC and the ESDC, respectively.

Test 2 (Financial Sector Contagion) Increased co-movement of the emerging financial sector index with the financial index of the crisis-originating region in the crisis period as compared to the non-crisis period. The source of the contagion is assumed to be the US financial index and the EU financial index during the GFC and the ESDC, respectively.

Test 3 (Real Economy Sector Contagion from the Financial System of Crisis Country) Increased co-movement of an emerging market real economy sector index with the financial index of the crisis country. The source of the contagion is assumed to be the US financial index and the EU financial index during the GFC and the ESDC, respectively.

Test 4 (Idiosyncratic Contagion Effects to the Real Economy Sectors Spreading through the Emerging Financial Market) Increased co-movement of an emerging market real economy sector index with the emerging market financial index. The source of the contagion is assumed to be the emerging market financial index during both the GFC and the ESDC. We assume that the shocks to the financial sector of the emerging markets indirectly spread to the real economy sectors.

The null hypothesis (H_0) and alternative hypothesis (H_1) for tests 1, 2 and 3 can be listed as: $\beta_2 \leq 0$ (no contagion); $\beta_2 > 0$ (contagion)

For test 4, the null and alternative hypotheses are given by: $\gamma_2 \leq 0$ (no contagion); $\gamma_2 > 0$ (contagion)

III.2. Stochastic Properties of the Data

In this analysis, we use Morgan Stanley Capital Investment (MSCI) indices for all of the aggregate and disaggregate markets. Specifically, we focus on the contagion exposure of the emerging markets during both the GFC and the ESDC; hence, along with the composite indices, the financial sector indices for the US and Europe are also used.[10]

[10] Emerging countries include: Brazil, Chile, China, Colombia, the Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Malaysia, Mexico, Peru, Philippines, Poland, Russia,

The sectors under investigation are the consumer discretionary, the consumer staples, the energy, the financials, the healthcare, the industrials, the information technologies, the materials, the telecommunication services and the utilities. The time span of the data is from January 1, 2001, to December 23, 2013, and the data is retrieved from Bloomberg. We use the weekly returns for the econometric analysis. The summary statistics are reported in Table 1.

Table 1

Summary Statistics

	Mean	Std. Dev.	Skewness	Kurtosis	Jarque-Bera
Cons. Disc.	0.240752	3.41557	-0.78214	10.35738	1595.969***
Cons. Stap.	0.234714	2.58994	-1.35059	13.64878	3404.545***
Emerging index	0.155318	3.269588	-0.8534	9.993976	1462.006***
Energy	0.200127	4.152239	-0.65038	10.10667	1472.383***
Financials	0.150706	3.479962	-0.86508	8.491096	934.982***
Healthcare	0.214396	2.638204	-0.49267	4.378851	81.01731***
Industrials	0.14299	3.599505	-1.13252	10.88137	1896.909***
Information Tech.	0.11213	3.980801	-0.07249	5.421127	165.9461***
Materials	0.179624	4.061717	-0.67159	9.67502	1307.739***
Telecom.	0.098413	2.973813	-0.65785	9.708035	1318.141***
US Index	0.053133	2.596637	-0.87755	10.40813	1634.976***
US Financials	-0.03611	4.031182	-0.16268	14.55527	3769.486***
Utilities	0.152171	3.010371	-1.47586	14.34151	3874.202***
EU Financials	-0.10773	4.019043	-0.93522	11.08893	1944.38***
EU index	-0.01911	2.809847	-1.14438	13.03417	2987.91***

Notes. (***) denotes the statistical significant at the 1% level.

The statistics in Table 1 show the outperformance of the emerging markets both at the aggregate and the sectoral levels. The MSCI emerging market index yields a mean return of 0.15 for the sample period, whereas the MSCI US index has an average return of only 0.05 and the MSCI Europe stock index displays a mean return of -0.01. The riskiest is the emerging market composite index measured by the standard deviation, followed by Europe and then the US. The financial sector indices for the US, Europe and the emerging markets exhibit captivating traits in terms of risk-return profile; the emerging market financial portfolio records an average return of 0.15, almost equal to the MSCI emerging composite index; on the other hand, the financial sectors of the US and Europe display negative mean returns for the study period, -0.03 and –0.10, respectively. Moreover, the emerging markets financial sector displays the lowest risk in terms of standard deviation as compared to the US and Europe. For the emerging markets real sectors, the mean returns vary between 0.09 for telecommunications and 0.24 for consumer staples, indicating heterogeneity across sector returns.

As it is typical for financial data, the non-normality of the return distribution is observed by the means of skewness, kurtosis statistics and Jarque-Bera (JB) normality tests. All of the MSCI indices exhibit negative skewness and excess kurtosis (>3), and we reject

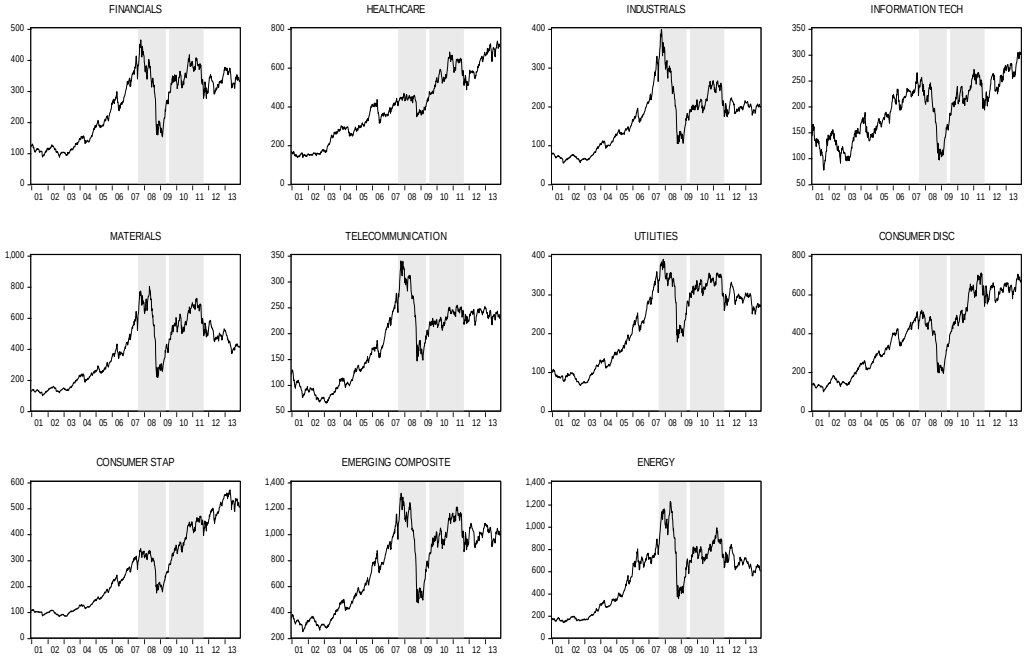
Qatar, South Africa, Taiwan, Thailand, Turkey and the United Arab Emirates. Countries in Europe include: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, the Netherlands, Norway, Portugal, Spain, Sweden, Switzerland and the UK.

the null hypothesis of normality with the JB statistics. Hence, all the returns manifest leptokurtic behavior with skewed heavy-tails.[11]

The raw index series are plotted in Figure 1, where the shaded area represents the crises period identified from the regime switching models explained in the next section. The plots provide evidence of record low levels following the collapse of Lehman Brothers on September 15, 2008. From the figure, it is obvious that the significant decline in the index values coincide with the second phase of "sharp financial market deterioration", which is in line with Kenourgios and Dimitriou (2015). The index values stay at these low levels for a couple of months and experience a gradual increase immediately after the deepest wave. As one may see from the graphs, the ESDC has no major impact on the MSCI emerging market composite and sector indices, where the markets follow a recovery stage.

Figure 1

Price Plots of the Emerging Market Real Economy Sectors



11 We also investigate whether the series under investigation are suitable for further modeling with conventional tests in time series analysis, such as Ljung-Box serial correlation, ARCH LM and unit root tests. The results points out that the series have significant autocorrelation on both raw and squared values, as well as ARCH effects. The unit- root statistics (ADF, PP and KPSS) indicate the absence of unit-root in the return series. Therefore, the preliminary tests suggest the use of GARCH models and the suitability of the return series for further modeling procedures.

IV. Endogenous Identification of the Crises Period

For the contagion analyses, it is vital to correctly identify the dates of turmoil, as in our case the models conducted to test for contagion can be very sensitive to the choice of the crisis dates. Baur (2012, p.2682) states that "even studies that avoid discretion in the definition of the crisis period use discretion in the choice of the econometric model to estimate the location of the crisis period in time". Following Kenourgios and Dimitriou (2015) and Ahmad *et al*. (2013), we rely on the Markov Switching Dynamic Regression (MSDR) model to endogenously specify the lengths of the crises as a statistical approach, rather than relying on only economic and financial news reported by the central banks or announced by the media. The MSDR model of Hamilton (1989) accounts for endogenous structural breaks and, hence, allows the data to specify the starting and the ending dates of the crises.

We apply the MSDR to the financial sector indices of the US and Europe, since both the GFC and ESDC originated in their fragile financial systems. Hence, the financial markets can be treated as a source of contagion for both of these crises. Hamilton's MSDR model (1989) can be written as follows:

$$y_t = \begin{cases} \alpha_0 + \beta y_{t-1} + \eta_t, & s_t = 0 \\ \alpha_0 + \alpha_1 + \beta y_{t-1} + \eta_t & s_t = 1 \end{cases} \tag{6}$$

where: y_t is the stock return of the financial index and η_t are *i.i.d* random variables with zero mean and σ^2_η variance. s_t represents unobservable state variable, which follows a first-order Markov chain and determines the switching between the "low" and the "high" regimes.

$$P = \begin{bmatrix} IP(s_t = 0 | s_{t-1} = 0) & IP(s_t = 1 | s_{t-1} = 0) \\ IP(s_t = 0 | s_{t-1} = 1) & IP(s_t = 1 | s_{t-1} = 1) \end{bmatrix} = \begin{bmatrix} p_{00} & p_{01} \\ p_{10} & p_{11} \end{bmatrix} \tag{7}$$

Where:

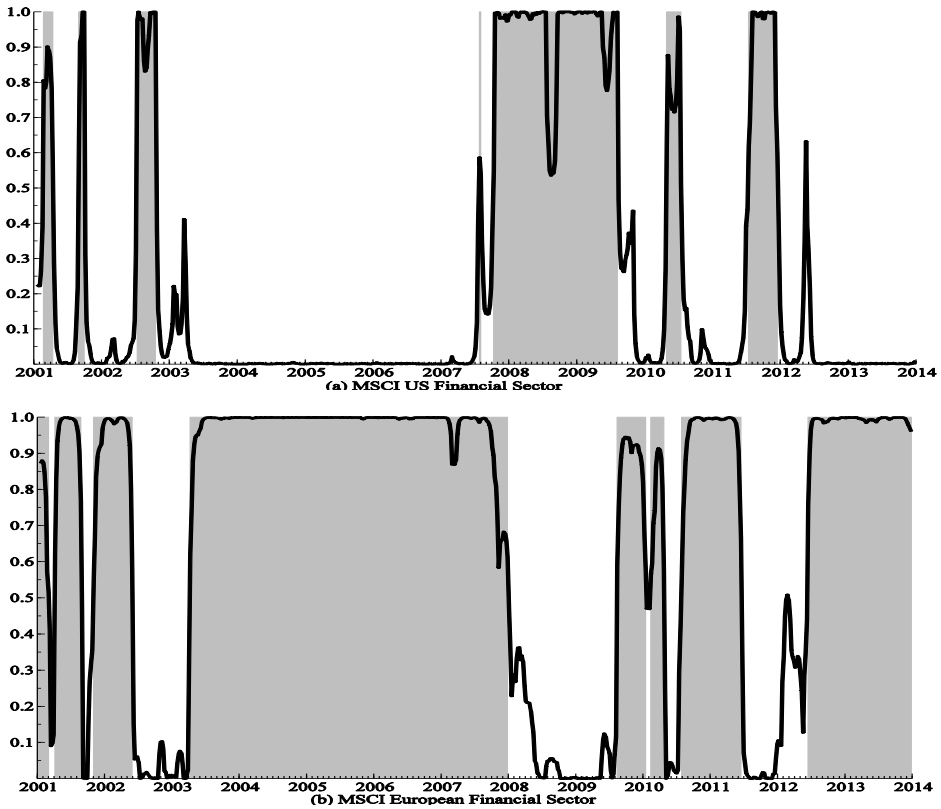
p_{ij} stands for the transition probabilities of $s_t = j$ given that $s_{t-1} = i$ and $p_{i0} + p_{i1} = 1$.

Figure 2 shows the smoothed high-volatility regime probabilities over the sample period. By applying the MSDR model on the returns of the US and the EU financial portfolios, we elaborate the following results: i) Figure 2 (graph a) displays that the endogenously specified crisis period during the "Great Recession" match the ad-hoc beginning and ending dates. According to the Bank of International Settlements' (BIS) report, the GFC continues through 2007 and 2009 in four phases, as described in the introduction. The starting date of the crisis is taken as July 28, 2007, and the ending date as March 23, 2009. ii) Unlike the GFC, defining the length of the ESDC is more complex from an economic approach, since the turmoil flamed up severe financial difficulties in a number of different countries subsequently. From Figure 2 (graph b), we observe that the economic events experienced during the ESDC all take place within the period detected

by the MSDR model. As a result, we use June 29, 2009, as the beginning date and July 25, 2011, as the ending date for further contagion tests. The dates from the MSDR incorporate the announcement of the huge Greek budget deficit and the dramatic increase in the sovereign risk in several European countries. Subsequently, many European countries requested a bail-out plan from the IMF (International Monetary Fund) and the ECB (European Central Bank).

Figure 2

Smoothed Regime Probabilities of the US and European Financial Sectors



V. Empirical Findings

In this section, we present the results of the econometric models (3 and 4) and substantiate the hypotheses of contagion. Table 2 depicts the empirical results for interdependence and contagion during the GFC and the ESDC. One may see that the emerging stock markets are interconnected with both the US and the EU equity portfolios, whereas the associated coefficients (β_1) are 0.859 and 0.007, respectively. This suggests that the emerging equity markets are more integrated with the US than

with Europe, as depicted by the magnitude of the interdependence parameters. As for the crisis related coefficients (β_2), we find the presence of contagion from the European market to the emerging markets portfolio during the ESDC, thus we fail to reject the null hypothesis of no contagion at the aggregate stock market level. The emerging markets seem to be immune to contagion from the US during the GFC; hence, the null hypothesis of no contagion (Hypothesis 1) cannot be rejected. These findings reveal that contagion may not prevail even in the case of higher interdependence, which is in line with Forbes and Rigobon (2002). However, since we use an aggregate emerging stock market index (MSCI), our findings do not suggest the isolation of each emerging economy from the contagious effects of the GFC. In this context, our result is plausible given the fact that the emerging economies are distinct with regard to their international trade characteristics and economic fundamentals.

Table 2

Aggregate Stock Market Contagion during the Crises

	α		β_1		β_2		Contagion
During GFC	0.1222	(0.1080)	0.8591***	(0.0000)	0.0021	(0.9850)	*No Contagion*
During ESDC	0.0016**	(0.0340)	0.0077***	(0.0000)	0.0017**	(0.0330)	*Contagion*

Notes. (***), (**) and (*) denote the statistical significant at the 1%, 5% and 10% levels. The numbers in parentheses are the p-values.

The results of the financial sector contagion during the GFC and the ESDC are documented in Table 3. The interdependence of the emerging markets financial sector with both the US and the EU financial indices is shown by the (β_1) coefficient, which is 0.575 for the US and 0.005 for the EU. The emerging market financial index is more inter-related with the US financial sector, whereas the linkage is quite weak with the Eurozone financial market. The contagion parameter (β_2) is statistically significant, but negative for the GFC, whereas it is positive and insignificant for the ESDC. Therefore, the second null hypothesis of no contagion cannot be rejected for either the GFC or the ESDC. The negative and statistically significant contagion coefficient in the case of the GFC may imply that the decreasing co-movement of the emerging markets financial sector with the US financial index results from the substantial deterioration of the US financial sector as compared to the emerging markets financial portfolio over the crisis period.[12] Despite the recent discussion that globalization has determined increased financial integration, which induces contagious flows at times of market distress, we document no contagion, but only interdependence between the emerging financial index and the US and the Eurozone finance sectors.

Table 3

Financial Sector Contagion

	α		β_1		β_2		Contagion
During GFC	0.1505	(0.1160)	0.5751***	(0.0000)	-0.1566*	(0.0530)	*No Contagion*
During ESDC	0.0022**	(0.0143)	0.0055***	(0.0000)	0.0005	(0.4771)	*No Contagion*

Notes. (***), (**) and (*) denote the statistical significant at the 1%, 5% and 10% levels. The numbers in parentheses are the p-values.

The world financial system has a direct influence on non-financial firms, because these firms lend and borrow in the global context (Baur, 2012). Although this fact makes them

[12] See Baur (2012) and Kenourgios & Dimitriou (2014).

subject to any shocks arising from the global financial market, the real economy sectors are too distinct to be affected in the same direction and magnitude by shocks during the turbulent periods. Table 4A exhibits the estimates related to hypothesis 3, which tests for the presence of the US financial contagion in the emerging real economy sectors during the GFC.

Table 4A

Real Economy Sector Contagion from the US Financial Sector during the GFC

	β_1		β_2		Contagion
Cons. Disc.	0.0484*	(0.0833)	-0.0064	(0.8593)	*No Contagion*
Cons. Stap.	0.0588***	(0.0039)	-0.0296	(0.3523)	*No Contagion*
Energy	0.1944***	(0.0000)	-0.2205***	(0.0014)	*No Contagion*
Healthcare	0.0892**	(0.0169)	-0.1566**	(0.0190)	*No Contagion*
Industrials	0.0424*	(0.0763)	-0.1609***	(0.0004)	*No Contagion*
Information Tech.	-0.0186	(0.6637)	0.0335	(0.6623)	*No Contagion*
Materials	0.1327***	(0.0000)	-0.1707***	(0.0034)	*No Contagion*
Telecom.	0.1044***	(0.0000)	-0.0406	(0.3350)	*No Contagion*
Utilities	0.0126	(0.5843)	-0.0439	(0.2260)	*No Contagion*

Notes. (***), (**) and (*) denote the statistical significant at the 1%, 5% and 10% levels. The numbers in parentheses are *the* p-values.

The β_1 parameter, which denotes the interdependence of the emerging sectors with the US financial portfolio, is the highest for energy (0.194), followed by materials (0.132) and telecommunications (0.104). The utilities and information technologies are found to act independent from the US financial sector. The coefficients of β_2 representing the contagion from the US financial market to the emerging market sectors are statistically significant, but negative for energy, materials, industrials and healthcare. This finding indicates a decreasing co-movement between these sectors and the US financial index during the GFC. The related estimates for the remaining sectors are found to be statistically insignificant. Therefore, we demonstrate no contagion from the US financial index to nine of the sectors under investigation in the episode of the subprime meltdown, failing to reject the null of hypothesis 3. This result points out the aforementioned finding of Forbes and Rigobon (2002) that interdependence does not imply contagion for the real economy sectors.

Table 4B shows the parameter estimates for hypothesis 3, which also tests for the European financial contagion to the emerging market sectors. The interdependence coefficients γ_1 range from 0.892 for materials to 0.528 for healthcare portfolio. The crisis specific parameter γ_2 quantifies the change in the level of the co-movement between the EU financials portfolio and the emerging market sectors during the ESDC.

As one may see from the tabulated results, energy (0.300), materials (0.209) and industrials (0.342) are akin to contagion from the European financial market during the ESDC. The remaining six sector indices do not display any contagion effect. Hence, we reject the null of hypothesis 3 in the case of energy, materials and industrials. The above findings can be linked to the sector-specific features of energy, industrials and materials. The fact that the demand and supply mechanisms of these sectors are heavily affected

by the global economic outlook and the financial environment may account for them being more prone to the contagious shocks from the financial sector.

Table 4B

Real Economy Sector Contagion from the European Financial Sector during the ESDC

	γ_1		γ_2		Contagion
Cons. Disc.	0.8535***	(0.0000)	-0.0721*	(0.0834)	*No Contagion*
Cons. Stap.	0.5859***	(0.0000)	0.0824	(0.1069)	*No Contagion*
Energy	0.8185***	(0.0000)	0.3007***	(0.0011)	*Contagion*
Healthcare	0.5285***	(0.0000)	-0.2363***	(0.0022)	*No Contagion*
Industrials	0.8519***	(0.0000)	0.3429***	(0.0000)	*Contagion*
Information Tech.	0.8305***	(0.0000)	-0.1352	(0.1520)	*No Contagion*
Materials	0.8926***	(0.0000)	0.2096***	(0.0056)	*Contagion*
Telecom.	0.6567***	(0.0000)	0.0676	(0.3527)	*No Contagion*
Utilities	0.7224***	(0.0000)	0.0226	(0.7039)	*No Contagion*

Notes. (***), (**) and (*) denote the statistical significant at the 1%, 5% and 10% levels. The numbers in parentheses are the p-values.

Although most of the real economy sectors in the emerging markets do not display direct contagion incidences from the developed financial markets (the US and Europe), the crises may indirectly spread to these real economy sectors through the channel of the emerging financial market. Table 5A displays the coefficients associated with hypothesis 4, which tests for the idiosyncratic contagion of the emerging sectors. The parameters of the co-movement between the emerging market financial sector and the real economy sectors over the period of the GFC substantiate that most of the sectors are significantly inter-connected to the emerging financial index.

Table 5A

Real Economy Sector Contagion from the Emerging Market Financial Sector during the GFC

	β_1		β_2		Contagion
Cons. Disc.	0.0009***	(0.0000)	-0.0007	(0.1695)	*No Contagion*
Cons. Stap.	0.0006***	(0.0057)	-0.0004	(0.3442)	*No Contagion*
Energy	0.0011***	(0.0009)	0.0003	(0.6997)	*No Contagion*
Healthcare	0.0009***	(0.0086)	0.0011*	(0.0873)	*Contagion*
Industrials	0.0005***	(0.0088)	-0.0002	(0.6719)	*No Contagion*
Information Tech.	0.0001	(0.8531)	-0.0004	(0.6551)	*No Contagion*
Materials	0.0004	(0.1048)	0.0016***	(0.0063)	*Contagion*
Telecom.	0.0006**	(0.0273)	0.0005	(0.2467)	*No Contagion*
Utilities	0.0000	(0.8907)	0.0004	(0.4591)	*No Contagion*

Notes. (***), (**) and (*) denote the statistical significant at the 1%, 5% and 10% levels. The numbers in parentheses are the p-values.

The (β_1) inter-dependence parameters are positive and statistically significant at the conventional levels for six of the emerging market real economy sectors. The highest (lowest) statistically significant coefficient is recorded for the energy (industrials). We document no interdependence between the US financial index and materials,

information technologies and utilities. A positive contagion coefficient (β_2) is found for the materials index at the 1% level and the healthcare index at the 10% level. The null of hypothesis 4, no contagion, cannot be rejected for the other seven sectors. Therefore, most of the economic sectors do not display any exposure to contagious flows from the emerging financial market, substantiating that international investors can still exploit the diversification benefits from investing in heterogeneous sector portfolios in the emerging markets.

As for hypothesis 4 in the case of the ESDC, our empirical findings in Table 5B demonstrate that the null of no contagion cannot be rejected for seven of the sectors. The positive and statistically significant coefficients (γ_2) representing contagion due to the exogenous shocks transmitted through the emerging financial sector are observed for healthcare (0.175) and consumer staples (0.091). These two sectors are subject to the contagion effects stemming from the idiosyncratic shocks during the ESDC, while the remaining seven sectors are immune to the contagious flows.

Table 5B

Real Economy Sector Contagion from the Emerging Market Financial Sector during the ESDC

	γ_1		γ_2		Contagion
Cons. Disc.	0.8071***	(0.0000)	0.0986	(0.1357)	*No Contagion*
Cons. Stap.	0.5823***	(0.0000)	0.0912*	(0.0774)	*Contagion*
Energy	0.8673***	(0.0000)	0.0213	(0.7952)	*No Contagion*
Healthcare	0.4142***	(0.0000)	0.1757**	(0.0164)	*Contagion*
Industrials	0.8700***	(0.0000)	0.0549	(0.3664)	*No Contagion*
Information Tech.	0.7759***	(0.0000)	0.0664	(0.5328)	*No Contagion*
Materials	0.9224***	(0.0000)	-0.0084	(0.9098)	*No Contagion*
Telecom.	0.7226***	(0.0000)	-0.1756***	(0.0003)	*No Contagion*
Utilities	0.7306***	(0.0000)	-0.0469	(0.3000)	*No Contagion*

Notes. (***), (**) and (*) denote the statistical significant at the 1%, 5% and 10% levels. The numbers in parentheses are the p-values.

Overall, our results suggest that none of the real economy sectors in the emerging markets were affected by the adverse shocks from the US financial sector in times of the GFC. This indicates that the emerging market sectors display no contagion incidences of the global financial meltdown, which implies that an investor could reap the possible diversification benefits by allocating across emerging market sectors during that period. However, the materials and the healthcare indices are subject to the idiosyncratic financial contagion effects during the GFC, which can be linked to the indirect shocks from the US financial market spilled over to the emerging financial sector. As for the ESDC, we provide evidence that the energy, the industrials and the materials indexes of the emerging markets are found to be vulnerable to the external shocks from the European financial market. The remaining six sectors display no contagion incidences during the ESDC. The results also depict the idiosyncratic contagion effects from the emerging financial index to healthcare and consumer staples during the same episode.

The emerging real economy sectors seem to be totally immune from the adverse shocks originated from the US financial sector throughout the GFC. Thus, according to our

findings, the emerging markets still possess diversification benefits both at the aggregate and disaggregate levels, despite the discussion that globalization and financial liberalization have increased the degree of financial integration among the local equity markets.

VI. Concluding Remarks

Given the fact that the global financial markets have experienced severe turbulences over the last decades, the international investors desire to build well-diversified portfolios in which individual assets are not highly inter-related. To this end, the real economy sectors can be taken as alternative diversification tools as regards their distinct industry-specific characteristics. Despite the large work on international financial contagion at the aggregate level, the studies related to the propagation channels of contagion flows at the industry level are sparse. The objective of this study is to contribute to the existing literature by analyzing sectoral contagion from a more comprehensive perspective.

In this paper, we test for four different channels of financial contagion, both at the aggregate and disaggregate levels. From the perspective of an asset pricing approach, we use a market model proposed by Bekaert *et al*. (2005) and later extended by Baur (2012). At the aggregate level, we elaborate the immunity of the emerging markets from the US during the GFC, contradicting the results of Syllignakis and Kouretas (2011), and Karanasos *et al*. (2015), as they provide evidence of contagion from the US equity market. On the other hand, our results reveal significant contagion effects from Europe during the episode of the ESDC, which are partially in line with Ahmad *et al*. (2014). As for the financial sector contagion, the empirical evidence suggests that the emerging markets are not vulnerable to the shocks from either the US or the European financial markets.

Related to the real economy sector contagion from the crisis-originating markets, we demonstrate no contagion incidences during the subprime crisis. However, three of the sectors, namely, energy, industrials and materials, are subject to contagious flows from the European financial index over the period of the sovereign debt crisis. A plausible explanation for this finding can lie in the nature of these two crises. The GFC, which has stemmed from the US sub-prime mortgage market, is described as a single country case in general, whereas the ESDC can be regarded as a multi-country case, due to the high level of government debt and simultaneous contractions in many European countries. Therefore, the propagation of the shocks leading to contagion incidences might be transmitted through many European countries to the emerging markets. Our results support the findings of Baur (2012). Furthermore, healthcare is the only sector that is affected by the contagious flows of the emerging financial market during both crisis episodes. The materials (consumer staples) index is also adversely affected by the emerging financial market shocks at times of the GFC (ESDC). In this respect, the results of idiosyncratic contagion from the emerging financial market substantiate the sector heterogeneity, which implies that there are significant diversification benefits in allocating portfolio investments across sectors.

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