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What can wavelets unveil about the vulnerabilities of monetary integration? A tale of Eurozone stock markets

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ABSTRACT

The study has two main objectives: (i) to investigate whether there is pure contagion or fundamental-based contagion/interdependence among the Eurozone equity markets (Germany, France, Italy, Spain and Netherlands), attributable to the shocks stemming from nine major crises around the world (ii) to investigate the evolution of market integration, whether mainly short-run or long-run. Wavelet decompositions, in both its discrete and continuous forms, are employed to unveil the multi-horizon nature of co-movements, volatility and lead–lag relationships. This is to unveil the path of linkages and the behavior underlying the transmission mechanism of financial shocks across major Eurozone stock markets. Evidence also supports the presence of common shocks whereby equity markets in Eurozone are significantly affected by episodic crisis events globally. Prior to the recent subprime crisis, contagion effects have generated short-term shocks that may potentially involve, among other factors, excessive channels. In stark contrast, the most recent US subprime crisis and EMU sovereign debt crisis reveal the evidence of fundamental-based contagion. We also find the increasing short-run and long-run stock market integration, driven by several stages of the establishment of EMU. Policy implications for regulators and investors are discussed in the context of continued monetary integration.

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1. Introduction

The remarkable US born subprime crisis of 2007–09 that considerably hit the markets all over the world has raised a critical question on the capacity of the global financial system to maintain its financial stability in a meaningful way. The major consequence for Eurozone countries has been the injection of the first large emergency loan in August 2007 by European Central Bank in response to remarkable pressures in the interbank market. The global crisis eventually was transformed into sovereign debt crisis, which started initially from Greece in autumn 2009, followed by the first Greek rescue package in March 2010, and spread further to Portugal, Spain, Italy and Ireland.

Some studies pointed out a major role of contagion among Eurozone member countries, driven by the market pricing behavior (Arghyrou and Kontonikas, 2012). The context of contagion in financial markets has been discussed by Grammatikos and Vermeulen (2012) with respect to an increasing dependency of stock market indices in Eurozone countries. In particular, the severity of the contagion within the region has been due to several key factors such as the less attention of financial markets to the fiscal position of a country, the increasing cost and the market reaction to fiscal loosening (Bernoth and Erdogan, 2012;

Bernoth et al., 2012), the recent evolution of economic and financial landscape, including cross-border equity investments, that became more integrated after reaching the final stage of EMU (for example, see Lane, 2006; Lane and Milesi-Ferretti, 2008; Coeurdacier and Martin, 2009; De Santis and Gerard, 2006).

Many prior studies attempted to explain the nature of transmission mechanism across borders during several major financial crises. Dornbusch et al. (2002) and Kaminsky and Reinhart (2000) mentioned the two distinctive characteristics between pure and fundamental-based contagion. While the former is defined as an excessive transmission of shocks beyond any idiosyncratic disturbances and fundamental linkages (Bae et al., 2003; Eichengreen et al., 1996; Forbes and Rigobon, 2002), the latter is transmitted by way of financial market integration and trade linkages or interdependence (Calvo and Reinhart, 1996; N'Diaye et al., 2010; Zhang, 2008). The strong debate of empirical findings centers on the evidence of these two channels.

Given the presence of contagion effects in Eurozone countries, along with the different nature of their transmission channels, our study attempts to address this issue in the context of equity markets. There are three primary factors that govern the motivation of this empirical study. (i) The first is to detect the evidence of contagion not only in the period of the recent subprime crisis but also during the earlier major crises. The finding may demonstrate how the impact of one crisis differs from that of the other crises. (ii) The second is to identify whether

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each crisis reveals the evidence of fundamental-based or pure contagion. We further examine the lead–lag relationship in order to capture the dynamics of transmission. (iii) The third is to investigate the evolution of market integration, whether mainly short-run or long-run since well-integrated equity markets tend to have a higher exposure to external shocks. We analyze stock indices in Eurozone markets, namely, Germany (DAX 30), France (CAC 40), Italy (FTSEMIB), Spain (IBEX 35), and Netherlands (AEX). The three former countries are the founders of European Union and arguably the most important members of European Monetary Union. The length of our daily observations is 32 years starting with 1980 in order to capture all possible major crises around the world.

As to the methodology, we examine co-movement and lead–lag relationship among the equity indices. There are two main reasons for using co-movement to address our research objectives. Firstly, many prior studies identified the evidence of contagion by observing the changing correlations across different markets during crises periods (Candelon et al., 2008; Chakrabarti and Roll, 2002; and so on). Secondly, the phases of financial integration also can be reflected through the increased cross-country correlations (Goetzmann et al., 2002; Bekaert et al., 2005; Bekaert and Harvey, 1995; Baele, 2005; and so on).

Our study is different from most of the prior studies in that we emphasize the multi-horizon nature of co-movement. We perform multi-timescale analysis using wavelet decompositions as one of the latest techniques in finance to decompose any observed variable on scale-by-scale basis. The decomposition may capture both time series and frequency domain simultaneously. This may provide an ability to distinguish between higher frequencies and lower frequencies. The concept is similar to the prior studies by Bodart and Candelon (2009), Orlov (2009), and Behmad (2013) that examined contagion by associating high and low frequencies with contagion and interdependence. In addition, to observe the phases of stock market integration, our study uses wavelet coherence with a rolling-window in the multi-horizon nature to evaluate the changing co-movement across the different equity markets.

The key finding of our study on the four concerned equity markets during 9 major crises tends to show evidence of a fundamental-based contagion being the immediate increase of co-movement that occurs at both higher as well as lower frequency bands. This has been in line with our cross wavelet power results showing that all index-pairs have experienced both common short-term and long-term shocks to volatility temporarily, signifying market turbulence related to fundamentals.

The paper is organized as follows. Section 2 presents some literature reviews associated with the issue of financial contagion and integration. Section 3 introduces wavelet decomposition analysis both discrete and continuous wavelet transform. Section 4 presents and discusses the empirical results. Section 5 provides some overarching interpretations, conclusions and policy implications.

2. Literature review

Our literature review is structured as follows. The first is to present the theoretical underpinnings on financial contagion and interdependence. The second is to show some empirical findings of contagion effects in Eurozone equity markets. The third is to present some established methods of measuring contagion.

2.1. Theoretical underpinnings of excessive and fundamental-based contagion

Dornbusch et al. (2002) and Kaminsky and Reinhart (2000) have mentioned the two distinctive characteristics between “fundamentals-based” and “pure” contagion.

The pure contagion or excessive linkage is defined as an excessive transmission of shocks from the crash in origin country into others

beyond any idiosyncratic disturbances and fundamental linkages (Bae et al., 2003; Eichengreen et al., 1996; Forbes and Rigobon, 2002). The sentiment shift of investors, unrelated to economic fundamentals (Dailami et al., 2008; Kumar and Persaud, 2002), may lead to a general reversal of funds and eventually trigger financial crises (Forbes and Rigobon, 2002; Kleimeier and Sander, 2003). The role of herd behavior may burst asset bubbles created by self-fulfilling expectations, moral hazard, or government guarantees, either implied or explicit (Krugman, 1998).

There are mainly three mechanisms of shock transmission. The first is the transmission of information from markets with more rapid price discovery, where the effect of news may spread investors' sentiment across borders (Kaminsky and Schmukler, 1999). Secondly, negative returns in one market may increase the risk premium in other markets, resulting in simultaneous drop of assets prices (Acharya and Pedersen, 2005; Longstaff, 2008; Vayanos, 2004). Thirdly, liquidity shock across countries plays an important role in contagion through a flight-to-quality (Allen and Gale, 2000; Brunnermeier and Pedersen, 2009).

On the other hand, the fundamental-based contagion is defined as a transmission of shocks by way of financial market integration and real linkages in non-crisis and crisis periods, thereby reflecting normal interdependence across borders (Calvo and Reinhart, 1996).

2.2. Exploring contagion in Eurozone financial markets

Many studies have evidenced financial contagion across border in crises periods in European markets. Chakrabarti and Roll (2002) find that European and East Asian countries are susceptible to volatility contagion during the 1997 Asian financial crisis. Both correlations and volatilities have increased from the pre-crisis to the crisis period, even though the percentage increases are larger in Asia. Climent and Meneu (2003) also document evidence of contagion during 1997 Asian crisis among the stock markets of three geographical areas (Europe, North America, and Latin America). The contagion effect may reveal the dynamic relationships between international equity markets. In another study, Serwa and Bohl (2005) investigate contagion effect to developed Western European markets and emerging stock markets in Central and Eastern Europe between 1997 and 2002 in relation to seven big financial shocks. Their finding shows modest evidence of significant instabilities in cross-market linkages after the crises, where the emerging European markets are not more contagious as compared to those in developed European markets. As to the 1998 Russian financial crisis, Dungey et al. (2006) study the impact of Russian bond default in August 1998 and the long-term capital management (LTCM) recapitalization announcement to bond markets across Asia, Europe and the Americas. They show that 17% of total volatility in bond spreads can be explained by contagion due to the Russian crisis.

Recent literature has focused the study on the remarkable periods of US born crisis and EMU sovereign debt crisis within European economy, with loan supply shocks have a substantial contribution to the evolution of the loan volume and real GDP growth in Eurozone members (Hristov et al., 2012). While there has been an unobserved common factor which drives the co-movement of government debt in Eurozone (Pan and Wang, 2012), Pozzi and Wolswijk (2012) find the convergence of the country-specific exposures to the common international risk factor across European countries, with no hindrance during the recent financial turmoil. Other studies attempt to discover the major role of credit risk spreads and CDS spreads during crisis. Oliveira et al. (2012) find that the factors which explain the credit risk spreads and the factors which drive the prices on the government bond markets are similar. Specifically, Calice et al. (2011) study a time varying influence and show that, for some countries like Greece, Portugal, and Ireland, the liquidity of the sovereign CDS market has substantially affected sovereign bond credit spreads. For euro area banks, Annaert et al. (2012) find that the CDS spreads arose along with the increasing credit risk, which mainly have been driven by individual CDS liquidity and

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