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Contagion, volatility persistence and volatility spill-overs: The case of energy markets during the European financial crisis

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ABSTRACT

The aim of this paper is to investigate if and to what extent events in financially troubled EU markets (Greece, Ireland and Portugal) affected energy prices during the EU financial crisis. More specifically, (i) we test for contagion effects of bond prices on energy/commodity prices, (ii) we examine whether the nature of energy price volatility is affected and (iii) we investigate whether bond volatility from the financially distressed EU markets spills over to energy/commodity return volatility. Our results indicate the existence of significant contagion effects; notable changes in the nature of energy/commodity volatility during the EU financial crisis; and spill-over effects. The results are robust to the use of short-term yields instead of long-term bond price changes, and to the inclusion of Spain and Italy in the sample.

1. Introduction

The global financial crisis and the consequent rise of commodity prices in all sectors have led researchers and policy makers to analyse the dynamics of market volatility; however, this has seen mixed results and the impact of the crisis on commodity market characteristics and the attributes of dynamic volatility remain largely unknown (Shalini and Prasanna, 2016). This paper aims to contribute to the debate by investigating if and to what extent events in the financially troubled EU markets affected energy prices during the European crisis. It should be noted that previous evidence indicates that commodity futures returns are negatively correlated with stocks and bonds (see, among others, Gorton and Rouwenhorst, 2006); more recent reports suggest that correlations between equity and commodity returns increase sharply during a time of extraordinary economic and financial turbulence, meaning that the benefits provided by commodities to passive equity investors may be weaker (Büyükşahin et al., 2010).

More specifically, we ask three important questions. First, are there contagion effects between energy/commodity prices and the bond markets of the EU countries that received bailout packages? To answer this, we assume that informational events related to the EU crisis are reflected on bond yields. We follow a procedure similar to Longstaff (2010), who applied a vector autoregression (VAR) framework to empirically examine the pricing of asset-backed collateralised debt obligations (CDOs) and their contagion effects on other markets during the subprime crisis. Longstaff argued that this methodology allows for the direct examination of whether cross-market linkages during the 2007 subprime crisis differed from those during the periods before and after. We apply the same methodology, except that in our study the event window is the EU financial crisis and the contagion vector is the EU markets that have received financial aid packages.

The second question is whether the nature of energy price volatility was altered during the EU crisis. An understanding of volatility and how it is transmitted is important in determining the cost of capital, assessing investment and leverage decisions, and computing the optimal hedge ratio and portfolio weights (Jin et al., 2012). Karali and Ramirez (2014) found that volatility in energy markets changes substantially in response to major events. It is therefore logical to hypothesise that during a major crisis, energy price volatility is increased; however, our focus is on structural changes in volatility rather than changes in volatility per se. We employ GARCH-type models to envisage price volatility before, during and after the crisis before examining whether the nature of volatility has changed.

Third, we investigate whether bond volatility caused by EU markets during the crisis spills over and affects energy/commodity return volatility. This is motivated by the findings of Mink and De Haan

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(2013), who reported that news about the Greek bailout even affected banks that had no relationship to Greece or other highly indebted euro countries. In addition, El Hedi Arouri et al. (2011) identified significant volatility spill-over effects between oil and sector stock returns (see also Tamakoshi, 2011; Missio and Watzka, 2011). According to Nazlioglu et al. (2015), a volatility spill-over analysis provides interesting comparisons of how energy and financial markets respond to risk perceptions. In addition, the volatility transmission mechanism provides insights that are useful for pricing, value at risk, portfolio optimisation, optimal hedging and other applications in finance (Awartani and Maghyereh, 2013). In terms of volatility spill-overs, it is also of key importance to identify how negative or positive shocks transmit to other assets, as changes in the volatility of one commodity are likely to trigger reactions in others (Barunik et al., 2015).

It may be observed that the relationship between commodities and financial markets has received substantial attention over the past few decades, with many authors questioning whether commodities move in sync with traditional financial assets, with mixed results. For instance, Zapata et al. (2012) determined a negative correlation between stocks and commodities, while Gorton and Rouwenhorst (2006) also concluded that commodity futures returns are negatively correlated with stocks and bonds, in contrast to Huang et al. (1996) who found no correlation between oil futures returns and stock market returns, indicating that oil futures contracts are a good vehicle for diversifying stock portfolios. In addition, Gronwald et al. (2011) pinpointed no statistically significant correlations between financial variables and commodities such as returns of emission allowances.

Conversely, Silvennoinen and Thorp (2013) argued that financial variables drive changes in volatility and correlation between stocks, bonds and commodity futures returns, while Henderson et al. (2015) reported a positive relationship between abnormal futures returns and proxies for the size of the issuers' hedge trades during the financial crisis. Hammoudeh et al. (2014) identified a positive correlation between commodity markets and the stock markets in China, while Aboura and Chevallier (2015) pointed to evidence of return and volatility spill-overs between commodity and financial markets. Finally, Büyükşahin et al. (2010) found that correlations between equity and commodity returns increase sharply during a time of extraordinary economic and financial turbulence and concluded that the benefits provided by commodities to passive equity investors become weaker, especially when they are needed most.

To anticipate the results, using a VAR methodology, we found significant contagion effects caused by daily bond price changes in the financially distressed European markets on energy/commodity during the EU financial crisis, but not before or after; a result consistent with the argument of Büyükşahin et al. (2010). Additionally, the relationship is negative, which is consistent with previous findings (Zapata et al., 2012; Gorton and Rouwenhorst, 2006, among others). Results from GARCH-type models – that is, a methodology that examines changes in the nature of volatility rather than changes in volatility per se – indicate significant changes in energy/commodity volatility during the crisis. Finally, we also report that bond volatility from Greece, Portugal and Ireland is significant in the GARCH-volatility of energy/commodity contracts during the crisis – that is, there have been significant volatility spill-over effects. Further tests, with Spain and Italy included in the sample and with short-term sovereign bond yields as proxies for bond market developments, confirm these results.

The rest of the paper is organised as follows: Section 2 presents the relevant recent literature, before Section 3 describes the data and main methodological tools used in the analysis. More specifically, Section 3.1 describes the data, Section 3.2 discusses the VAR methodology and explores the issue of contagion, Section 3.3 presents the modelling for volatility persistence and changes in the nature of volatility and Section 3.4 utilises the ARCH-GARCH family of models to explore volatility spill-overs. Section 4 presents the empirical results and Section 5 concludes the paper.

2. Literature review

Karali and Ramirez (2014) found a volatility spill-over effect between natural gas and crude oil, and between natural gas and heating oil, while accounting for important economic and weather events as well as key macroeconomic variables. Meanwhile, Aloui et al. (2013) employed the time-varying copula approach to investigate the conditional dependence between the Brent crude oil price and stock markets in the Central and Eastern European transition economies and identified a contagion effect between oil and stock markets. Wen et al. (2012) also applied the same approach to study the contagion effect between crude oil and US/Chinese stock markets during the recent financial crisis. They concluded that knowledge of said effect may motivate regulatory authorities to slow the rapid pace of financialisation and reduce the adverse volatility spill-over effect. Elsewhere, Awartani and Maghyereh (2013) analysed the dynamic spill-overs of returns and volatilities between oil and equities in the Gulf Cooperation Council Countries from 2004 to 2012 to find that they were bi-directional in nature. Chen and Hsu (2013) determined that oil price volatility decreases bilateral trade flows, while Barunik et al. (2015) delineated that no commodity dominates any other in terms of spill-over transmission and that asymmetries in directional spill-overs declined after the financial crisis. In another study, Antonakakis and Vergos (2013) examined yield spreads during the EU disaster to find that spill-overs mainly originate from financially troubled countries and, to a lesser extent, from the core EU nations.

Nazlioglu et al. (2013) examined volatility transmissions between energy and agricultural markets, before and after the commodity crisis in 2006, using GARCH models. Gardebroek and Hernandez (2013) also deployed the GARCH approach to analyse the level of interdependence and dynamics of volatility between oil, ethanol and corn prices in the United States between 1997 and 2011. Jin et al. (2012), meanwhile, analysed the volatility transmission effects among three crude oil markets using a VAR-BEKK model. They concluded that, although the crisis had a significant impact on crude oil markets across the globe, the extent of the devastation varied between markets. In another investigation by Nazlioglu et al. (2015), they conducted the first study to explicitly examine spill-overs between financial stress and world oil markets. Among other findings, they concluded that there is causal linkage between oil prices and financial stress in the post-crisis climate, and vice versa during the crisis, whereas the volatility transmission pattern displays similar dynamics in its pre- and post-crash states. Ciarreta and Zarraga (2015) also used GARCH models to present evidence of electricity market integration between Spain, Portugal, Austria, Germany, Switzerland and France from 2007 to 2012, using spill-overs and price convergence as indicators. Elsewhere, Shalini and Prasanna (2016) found that financialisation plays a key role in explaining commodity price volatility dynamics and that the impact of macroeconomic variables on commodity markets was significant during the period of stability but minimal during the crisis.

Hammoudeh et al. (2013) examined the interrelations among six different measures of risk in four oil-related sectors, and equity and bond/interest rate options markets, during the full 2004–2011 period and the 2009–2011 recovery subperiod. They found that the equity market is a consistent source of risk for all the above sectors and markets. Another team, Mensi et al. (2015), investigated the influence of structural changes on the asymmetry of volatility spill-overs, asset allocation and portfolio diversification between the USD/euro exchange market and major spot petroleum markets; they presented evidence of significant asymmetric volatility spill-overs. Park and Ratti (2008), meanwhile, examined the effect of oil price shocks on real stock returns in the US and 13 European countries over the period 1986–2005, using variables such as short-term interest rates, consumer prices and industrial production. They inferred that there is little evidence of asymmetric effects for the oil-importing European states (the exception, at a marginal level, being for Greece in a model with