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Exogenous impacts on the links between energy and agricultural commodity markets

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ABSTRACT

The main purpose of this paper is to identify the effects of exogenous factors, which have been somewhat controversial, on the price links between the energy and agricultural commodity markets. Our study differs from other studies by employing multivariate normal mixture models to capture the structural properties of the price dependencies in the underlying states. This paper investigates price dependencies from both quantitative and structural perspectives. By analyzing the overall dependencies and structural heterogeneity in the empirical results, we conclude that the global financial crisis is the most influential shock on the price links between energy and agricultural commodities. Because price links are vulnerable to financial shocks, our results also suggest introducing state-based analysis to risk management and portfolio diversification across the energy and agriculture markets during times of turmoil.

1. Introduction

With the importance of agriculture prices in the economy increasing over the past decades, price links between energy and agriculture futures have attracted considerable attention from global investors (Apergis et al., 2014; Jebabli et al., 2014). A number of empirical studies document that these price links are affected by exogenous factors, such as the financialization of commodities, biofuel policies, food crises and the global financial crisis (see Baffes and Haniotis, 2010; Kristoufek et al., 2014; Nazlioglu et al., 2013). However, there is still no consensus about the consistency of energy and agricultural commodity prices. Because the possibility of multiple states plays an important role in investigating dependence among financial assets (Gray, 1996; Hamilton, 1988), considering dependence in the underlying states is a potential misconception in existing studies of energy and agriculture links.

Therefore, the goal of this paper is to identify the impacts of these exogenous shocks on the dependence structure of energy and agricultural commodity prices. The dependence structure here does more than describe dependencies during different critical periods; instead, it emphasizes investigating the correlations among the levels of their underlying states. To achieve this goal, we utilized multivariate normal mixture models, which have been used by Ang and Bekaert (2002), to accommodate the structure of dependence between energy and agriculture commodity prices during different sub-periods of the last decade.

The main contribution of this paper consists of two parts. First, we show that a mixture of multivariate normal distributions provides the underlying structural features of the correlations, whereas other models of dependence, such as copula or multivariate GARCH models, do not. Consistent with Gray (1996) and Ang and Bekaert (2002), the evidence confirms the existence of multiple states and suggests that the state-based structure is likely an important dimension when considering price links between financial assets. In addition, our method of calculating the overall correlation relaxes the linearity inherent in Pearson's method while remaining tractable and easy to estimate.

Second, we analyze our results from both quantitative and structural perspectives. The empirical results show that abrupt changes in the

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overall correlations and significant structural heterogeneity in the underlying states coexist only during the financial crisis and suggest that the global financial crisis is the most influential exogenous shock to energy agriculture dependence. In addition, supportive evidence is also found in the dependence features of the tails. For future studies, it is of interest to investigate dependence by introducing underlying states to determine whether investors can benefit from portfolio diversification between the energy and agriculture markets during times of turmoil.

The rest of this paper proceeds as follows. Section 2 presents a brief review of the major studies in the related body of literature. Section 3 presents the models. Section 4 describes the data and provides some preliminary analysis. Section 5 reports and discusses the empirical results. We provide conclusions from the investigation in Section 6.

2. Literature review

There are a number of papers studying the correlation between energy and agricultural commodity prices in the light of the energy substitutions promoted by biofuel policies. Many countries around the world are involved in the growing use and production of biofuels, such as bioethanol and biodiesel, as technological substitutes for conventional fuels (Chang & Su, 2010). Because this massive production of energy, mainly of liquid fuels, is heavily dependent on supplies of agricultural resources, it is expected that energy prices will play a more important role in driving agricultural commodity prices (Tyner & Taheripour, 2008; Tyner, 2010) and thus tightly link agricultural and energy markets (Schmidhuber, 2007). To foster the biofuel industry, governments have implemented legislation and provided rebates to incentivize the use, import, and production of biofuel. With a mandatory blending policies, enhanced demand for biofuel crops is found to positively affect dependence between the energy and agricultural markets (Banse et al., 2008; Janda et al., 2012; Mallory et al., 2012), especially the correlations between biofuel markets and their related commodity markets (Kristoufek et al., 2014; Vacha et al., 2013). Serra (2011) utilizes a copula-based GARCH model to analyze volatility spillovers between food and energy markets. Their results suggest strong volatility links among crude oil, ethanol and sugar prices in Brazil. Moreover, the prices for crude oil and agricultural commodities are interdependent, including commodities that are not directly used in bioenergy production (Ciaian & Kancs, 2011). In addition, OPEC announcements, which limit oil production, will also encourage the use of biofuel and influence the oil markets as well as oil–cereal relationships (Mensi et al., 2014).

Food crises are also a matter of intense scholarly debate when the exogenous impacts on variations in energy and agriculture dependence are considered. Crises are commonly used as break points in many studies to investigate the relation between energy and agricultural commodity prices. Nazlioglu et al. (2013) study the volatility spillovers between the oil and agricultural commodity markets during both pre- and post-crisis periods using a causality in variance test and impulse response functions; they find that a shock to oil price volatility is transmitted to agricultural markets only during the post-crisis period. Wang et al. (2014) investigate the effects of oil price shocks on agricultural commodity prices using a structural VAR model. The empirical results show that the power of changes in oil prices to explain agricultural commodity price variations increase during the post-crisis period. Kristoufek et al. (2012, 2014) examine price transmission among biofuels, fuels, and food commodities, and the results show significantly strengthened transmission between ethanol (biodiesel) and corn (German diesel) during the food crisis. Vacha et al. (2013) study the time-frequency dynamics of the biofuels–fuels–food system using a wavelet coherence model. Their work also shows that the structure of correlations between ethanol (biodiesel) and corn (German diesel) changes remarkably and that biofuel prices react more rapidly to changes in their producing factors during the food crisis period. Reboredo (2012) considers the co-movement of food and oil prices using different copula model specifications with time-invariant and time-varying dependence structures. The results for weekly data from January 1998 to April 2011 show that extreme oil price spikes had no causal effects on agricultural price spikes.

Financial crises are considered another exogenous factor affecting the relationships among commodity markets, and Nazlioglu et al. (2013) find a dramatically increased correlation between oil and agricultural commodity returns during the financial crisis. The global financial crisis differs from other episodes of financial market stress since 1991, and this difference is reflected, in part, by an increase in cross-market correlations (Büyükşahin and Robe, 2014). The stream of literature addressing this phenomenon includes the work by Silvennoinen and Thorp (2013), who find significant increases in the correlations of oil returns and the majority of commodity futures only during the global financial crisis using DSTCC-GARCH models. Ji and Fan (2012) investigate the volatility effect from oil prices to non-energy commodity markets using a bivariate EGARCH model with time-varying correlations. The results indicate that the crude oil market has significant volatility spillover effects on non-energy commodity markets, and the overall level of correlation strengthened after the financial crisis. Wen et al. (2012) measure contagion between the energy and stock markets during the financial crisis using a time-varying copula approach. A significantly increasing dependence between the crude oil and stock markets after the failure of Lehman Brothers is observed thus supporting the existence of contagion, according to Forbes and Rigobon's (2002) definition, during the financial crisis.

The financialization of commodity markets and increased volatility of commodity prices have renewed interest in the relationships among commodity prices (Baffes and Haniotis, 2010; Sari et al., 2011). Tang and Xiong (2012) compare the increase in correlations between indexed and off-index commodities to identify the effects of index investment. Their analysis highlights the linkages among commodity markets as a result of the financialization process. Concurrent with the rapid growth of index investment in commodity markets, the prices of non-energy commodities became increasingly correlated with oil prices. Silvennoinen and Thorp (2013) find evidence that if commodity and conventional asset markets become more integrated due to financialization, the systematic component of commodity prices may increasingly dominate returns, increasing their correlation with other asset classes and creating more time-variation in correlation.

In summary, there are four key exogenous factors whose role has been somewhat controversial: financialization of commodities, biofuel policies, food crisis and the global financial crisis. The related studies enrich our understanding of the effects of exogenous shocks on energy agriculture correlations. In these studies, dynamic copulas and multivariate GARCH models are commonly employed to analyze the dependence between energy and agriculture assets. These models provide information about the overall level of dependence; few studies have examined the underlying dependence structure of these energy agriculture correlations. Our study differs from other studies by employing multivariate normal mixture models to analyze the structural features of the price links between energy and agricultural commodities.

3. The empirical model

This section begins with a discussion of the multivariate normal mixture models utilized in our empirical study. Hamilton (1988) introduces the possibility of multiple states in analyzing the structure of dependence of interest rates. Motivated by Hamilton (1988), the Federal Reserve monetary experiment from 1979 to 1982 has found that changes in operating procedures are likely to have affected the structure of dependence of the nominal interest rate. Therefore, a model allowing multiple states is needed in this paper to identify whether exogenous shocks impact the structure of price links between energy and agriculture commodities.

Mixture models, especially the normal mixture models, are widely used to analyze underlying states. Since the first attempt by Pearson