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Co-movement of major energy, agricultural, and food commodity price returns: A time-series assessment☆

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ABSTRACT

Using monthly data between 1970 and 2013, we provide a comprehensive analysis of the extent of co-movement (measured by correlation coefficients) among the nominal price returns of 11 major energy, agricultural, and food commodities. We study the degree and the time evolution of unconditional and conditional correlations using a uniform-spacings estimation and testing approach, multivariate dynamic conditional correlation models, and a rolling regression procedure. We find that (1) the price returns of energy and agricultural commodities are highly correlated; (2) the overall level of co-movement among commodities increased in recent years, especially between energy and agricultural commodities, and in particular in the cases of maize and soybean oil, which are important inputs in the production of biofuels; and (3) the stock market volatility is positively associated with the co-movement of price returns across markets, especially after 2007.

1. Introduction

Commodity prices and their fluctuations have received substantial attention among academics and policy makers over the past decades. A stylized fact of commodity prices that is frequently discussed is their apparent co-movement and the possible drivers of this synchronized behavior. In their influential study, Pindyck and Rotemberg (1990) show, for example, that the prices of a broad set of seemingly unrelated commodities — i.e. for which the cross-price elasticities of demand and supply are close to zero — move together even after controlling for macroeconomic and market conditions.

The general interest in the analysis of commodity prices is also motivated by the potentially large welfare and policy implications. In fact, the presence of synchronized changes in the behavior of different commodity prices may cast doubts on the competitiveness and efficiency of commodity markets. Commodity traders may react, for instance, to herd behaviors instead of market fundamentals, thus missing arbitrage and hedging opportunities. Similarly, traders and exporting countries could face substantial challenges in balancing their portfolios and could therefore be exposed to high income volatility. In the case of agricultural commodities, farmers growing multiple crops may experience strong income fluctuations due to synchronized changes in prices, with likely significant effects on food security. In addition, a simultaneous increase in several commodity prices may generate inflation pressures on highly dependent commodity-import countries.

In this paper, we use a multivariate empirical approach to assess the extent and time evolution of the co-movement (measured by correlation coefficients) of nominal price returns both within and across agricultural, energy- and food-related commodities. First, using monthly data between January 1970 and May 2013, we study the extent of cross-section correlation and the time-varying properties of pairwise unconditional and conditional correlations among 11 energy, agricultural, and food price returns. In practice, (1) we adopt a uniform-spacings methodology developed by Ng (2006) to test for the presence of and to evaluate the extent of unconditional co-movement (unconditional correlation) in commodity price returns;

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and (2) based on Sheppard and Engle (2001) and Engle (2002), we estimate multivariate dynamic conditional correlation (DCC) models to analyze the time-varying conditional correlations between commodity price returns. Second, we study the effects on unconditional co-movement of a set of possible determinants. In particular, we use a linear regression analysis to investigate whether bivariate rolling unconditional correlations are statistically associated with specific macroeconomic and financial factors.

Our empirical results show that the nominal price returns of related commodities are generally highly correlated. In fact, several of these commodities likely exhibit cross-price elasticities of demand and supply that are not close to zero. The uniform-spacings methodology indicates the presence of strong and positive correlations within cereal crops, between cereal crops and soybean oil (a reference agricultural commodity), and within energy commodities. However, we also detect a recent increase in the degree of co-movement between energy and agricultural commodity price returns, particularly maize (another agricultural commodity commonly used as a reference) and soybean oil, which are both important inputs in the production of biofuels. The evolution of the estimated dynamic conditional correlations further suggests the presence, in the past few years, of high levels of co-movement between the returns of energy commodities and the returns of maize and soybean oil. It also shows that this co-movement increased in recent years. This finding is likely evidence of the emergence of stronger interlinkages between energy and agricultural markets in the past few years, possibly determined by the expansion of the biofuel industry. The concluding linear regression analysis shows that many correlations within and across energy and agricultural markets are, in general, positively associated with the behavior of financial markets (measured by the volatility of stock market returns), particularly after 2007. However, co-movement does not seem to be statistically associated with other macroeconomic and/or financial conditions, such as the volatility of short-term nominal interest rate variations and the volatility of exchange rate returns.

The remainder of the paper is organized as follows. Section 2 briefly reviews the related literature on the topic and outlines the contribution of the study to this literature. Section 3 describes the data and the statistical properties of the price returns included in the analysis. Section 4 presents and discusses the empirical results. Section 5 concludes.

2. Related literature

The literature on commodity prices, their fluctuations and relationship, and their interlinkages with the real economy is extensive (see, e.g., Beck, 2001, Cashin et al., 2002, Deaton, 1999, Enders and Holt, 2012, Karali and Power, 2013). Saadi (2011), who provides a recent review of commodity price dynamics in international markets, notes that the parallel upward and downward price movements is one of the most discussed stylized facts about commodity prices. Pindyck and Rotemberg (1990) further label the observed price co-movement of seemingly unrelated commodities as excess co-movement and attribute this phenomenon to multiple factors, such as herd behavior in financial markets and liquidity constraints. They also observe that latent variables representing unobserved forecasts of inflation and industrial production are significant explanations of commodity prices and that, even after allowing for these latent variables, there is still excess co-movement left over. Subsequent studies, however, have challenged these empirical findings and conjectures (e.g., Ai et al., 2006, Cashin et al., 1999, Deb et al., 1996). More recently, Alquist and Coibion (2013) examine from a theoretical perspective the drivers of co-movement among commodity prices and build a model that characterizes the sources of co-movement and its implications in terms of macroeconomic dynamics. The authors argue that commodity-related shocks have generally played a limited role in global business cycle fluctuations.

The recent increases in both the level and volatility of commodity prices have reignited the interest of researchers and policymakers in the behavior of commodity prices and their co-movement. According to Ivanic et al. (2011), the upsurge in commodity prices of 2007/2008 and 2010/2011 had an overall negative effect on the population — especially the poor, who spend a high fraction of their income on food consumption. Several studies have lately investigated the determinants of these price fluctuations. Frankel (2008) indicates that the real interest rate may be an important determinant of the prices of oil and other mineral and agricultural commodities. Svensson (2008) highlights the importance of taking into account aggregate supply-and-demand shifts to explain commodity price dynamics. Gilbert (2010) asserts that the recent commonality of rises and falls in the price of energy, metals, and food is unlikely to be coincidental and that it may well be the result of a common set of macroeconomic and financial factors driving prices across a wide range of commodities. Byrne et al. (2013) document a significant degree of price co-movement across 24 commodities and argue that such co-movement may be due to a common factor related to macroeconomic fundamentals, such as the real interest rate and stock market uncertainty.

Our contribution to the existing empirical literature on the topic develops along several dimensions. First, contrary to most previous studies, which mainly examine the co-movement of commodity price returns, focus on price levels and pay less attention to the interrelations in conditional volatility, we model the evolution of the interlinkages between commodity markets by also allowing for time variation in nominal price-specific conditional volatilities.[3] Allowing for time variation in mixed and non-mixed conditional second moments permits to provide a more accurate assessment of the dynamic relationships between commodity markets (Gallagher and Twomey, 1998).

Second, we extend our empirical investigation to a set of 11 major energy, agricultural, and food commodities with the goal of analyzing the extent of the correlation of their nominal price returns. The prices of agricultural commodities, for example, are expected to be correlated because such commodities are generally close substitutes in demand, have similar input costs, and share common market information. Yet, growing financial market integration and the development of agricultural futures markets might corroborated these interdependencies in recent years. Similarly, the interlinkages between energy and agricultural markets, typically associated with production and transportation costs, may have become stronger due to the recent development of the biofuel industry and the increasing demand for agricultural produce in the production of ethanol and biodiesel (Rajagopal and Silverman, 2007). The period over which we conduct our empirical analysis is sufficiently large to allow for a comprehensive characterization of the evolution of commodity price co-movement in terms of trends and structural changes, which could be associated with particular events in the commodity markets (see Fig. 1). The use of monthly data allows us to capture dynamics that would otherwise be hidden in lower-frequency data. At the same time, we avoid the use of higher frequency data, which could instead be characterized by a high noise-to-signal ratio.

[3] Du et al. (2011), Serra et al. (2011), and Gardebroek and Hernandez (2013) are among the few recent authors, who focus on the interactions between energy and agricultural products in particular markets by specifically exploring the behavior of conditional second moments (a Bayesian approach is adopted in the first study; BEKK models based on Engle and Kroner (1995) are employed in the other two studies). Baillie and Myers (1991), Haigh and Holt (2002), and Alizadeh et al. (2008) are important examples of how to use multivariate generalized autoregressive conditional heteroskedasticity (MGARCH) models to describe the dynamics of commodity price returns.