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Volatility spillover between oil and agricultural commodity markets

Saban Nazlioglu [a,1], Cumhur Erdem [b,2], Ugur Soytas [c,*]

[a] Department of Econometrics, Pamukkale University, Denizli, Turkey
[b] Department of Economics, Gazi Osmanpasa University, Tokat, Turkey
[c] Department of Business Administration, Middle East Technical University, Ankara, Turkey

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ABSTRACT

This study examines volatility transmission between oil and selected agricultural commodity prices (wheat, corn, soybeans, and sugar). We apply the newly developed causality in variance test and impulse response functions to daily data from 01 January 1986 to 21 March 2011. In order to identify the impact of the food price crisis, the data are divided into two sub-periods: the pre-crisis period (01 January 1986 to 31 December 2005) and the post-crisis period (01 January 2006–21 March 2011). The variance causality test shows that while there is no risk transmission between oil and agricultural commodity markets in the pre-crisis period, oil market volatility spills on the agricultural markets —with the exception of sugar —in the post-crisis period. The impulse response analysis also indicates that a shock to oil price volatility is transmitted to agricultural markets only in the post-crisis period. This paper thereby shows that the dynamics of volatility transmission changes significantly following the food price crisis. After the crisis, risk transmission emerges as another dimension of the dynamic interrelationships between energy and agricultural markets.

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1. Introduction

The interest in commodity prices is not a recent phenomenon. However, the global financial crisis and large fluctuations in commodity prices have renewed interest on the dynamic relationship between them. The increasing trend in commodity prices over the last 10 years, which is sometimes attributed to the leading role of the upward trend in crude oil, was followed by a sharp decline when the global financial crisis hit (Cevik and Sedik, 2011). Spot price of WTI crude oil increased from $25.56 per barrel in January 1986 to over $138.68 in July 2008. Then following a downward trend it declined down to as low as $38.95 per barrel by the end of December 2008, before resuming another upward trend and reaching $102.36 per barrel on 21 March, 2011, the last day in our dataset. The wide fluctuations in the price of this important commodity raised some questions. One such question is whether the fluctuations in oil market lead to similar behavior in other commodity markets. And if so, what is the structure of this link? The answers to these questions are important for investors, traders and policy makers.

Cashin and Pattillo (2000) and Cashin and McDermott (2001) point out the importance of empirical behavior of commodity prices and emphasize the relevancy of commodity price cycles for policy purposes. They explain that about 25% of world merchandise trade is on commodities and for some countries commodity exports is an essential source of earnings. Therefore, not only commodity price shocks, but also varying degrees of fluctuations pose serious policy challenges. Cashin and McDermott (2001) find that over 140 years there has been a decline in real commodity prices by 1.3% without much evidence of a break in this downward trend, but a rise in the volatility. They argue that policy implications of the increase in volatility are more important than concerns about the long-run downward trend. This is because sharp movements in commodity prices have serious impacts on terms of trade, real incomes and fiscal positions of countries that depend on commodities.

The adverse effects of increasing world oil prices and possible mitigation policies have been the center of interest for manufacturer and consumer group levels in many sectors as well as governments of oil dependent economies. Like other sectors, agricultural commodity markets are also affected by fluctuations in oil prices at various levels. Especially with the introduction of biofuels, effects of oil markets on agricultural commodity markets are believed to intensify. Increase in the number and intensity of biofuel mandates also contributes to the link between agricultural and energy prices. It can be argued that biofuel policies linking agricultural and energy markets led to the food price crisis in 2006.[3] Furthermore, financialization of the commodity markets seems to have increased the degree of integration between energy and agricultural commodity markets.

Bioethanol (primarily from corn) and biodiesel (primarily from soybeans) are considered to be technological substitutes for conventional

* Corresponding author. Tel.: +90 312 210 2048; fax: +90 312 210 7962.
E-mail addresses: snazlioglu@pau.edu.tr (S. Nazlioglu), cumhur_erdem@yahoo.com (C. Erdem), soytas@metu.edu.tr (U. Soytas).
[1] Tel.: +90 258 296 2742; fax: +90 258 296 2626.
[2] Tel.: +90 356 252 2361; fax: +90 356 252 1673.

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fuels such as diesel and gasoline (Chang and Su, 2010). Since production of these biofuels is heavily dependent on supply of agricultural commodities, it is expected that there is a tight market integration between energy and agricultural markets (Schmidhuber, 2007), and this market integration is likely to be the most important change to occur in agriculture in decades (Tyner and Taheripour, 2008). As production of biofuels continues to rise, demand for these commodities is expected to increase which causes food prices to increase. Both crude oil and agricultural commodity prices displayed exceptional volatility throughout most of 2008 (Du et al., 2011). A high and positive price correlation between crude oil and corn at 0.80 for the period of 2006–2008 was observed (Tyner, 2008). Mitchell (2008) stated that one of the most important factors that cause food prices to increase in the 2006–2008 period is the large increase in US and EU biofuels production. He also added that around 70% of the increase in international food prices was attributed to biofuels and the related consequences of low grain stocks, large land use shifts, speculative activity, and export bans. Yang et al. (2008) stated that respectively, 38% and 22% of the increases in the international corn and wheat prices can be attributed to biofuels in the 2005–2008 period.

The rising food prices during the recent years have raised the question of whether oil markets have any explanatory power on the recent upward movements in agricultural food prices. The food-energy nexus has become a controversial issue. Many researchers indicate that increasing oil prices is the main factor behind the recent major demand shock experienced by agricultural markets (e.g. Abbott et al., 2008; Baffes, 2007; Chang and Su, 2010; Collins, 2008; Mitchell, 2008; Rosegrant et al., 2008; Yang et al., 2008). In contrast, some researches indicate that there is no direct relationship between oil and agricultural commodity prices. For example, Zhang et al. (2010) argued that oil price increases do not have direct impacts on agricultural commodity prices. Pindyck and Rotemberg (1990) examined the co-movement of wheat, cotton, copper, gold, crude oil, lumber and cocoa prices and found that the cross-price elasticities of demand and supply are zero. Gilbert (2010) stated that there is no direct causal relationship between oil and agricultural prices and the correlation between oil and agricultural prices is due to demand growth and monetary and financial developments. His findings do not offer support for restrictions on the use of food commodities as biofuel production. According to the Council of Economic Advisors only around 3% retail food price increase can be attributed to the ethanol production in 2007 (Lazear, 2008).

In addition to the increase in production of biofuels, another factor that boosts agricultural prices is the active interests of global investors, traders, and speculators in agricultural commodity markets. Recently, players in global financial markets view commodity markets as alternative investment areas for hedging and portfolio diversification purposes (Baffes and Haniotis, 2010; Sari et al., 2011). In other words, agricultural commodities are being regarded as financial assets (Alom et al., 2011). Therefore, intuitively, commodity markets may be subject to similar dynamics as financial markets. Globalization and increased integration of world markets have accelerated the "financialization of commodities." Apparently, sound investment decisions and policy options call for a better understanding of the recent dynamics of commodity markets. Therefore, global investors and governments need to analyze the dynamics of price and risk transmissions among commodity markets. "Financialization of commodities" has added a new dimension to the determinants of commodity price hikes (Baffes and Haniotis, 2010; Sari et al., 2011). The financial contagion literature notes the increased correlation across international financial markets during a crisis. A similar phenomenon is observed between commodity markets. Baffes and Haniotis (2010) point out the expectation of a stronger link between energy and non-energy commodity prices, especially food markets.

The literature on energy and agricultural market linkages shows that price transmission between oil and agricultural commodity prices is extensively analyzed for different time frameworks, using different econometric techniques, and for various countries.[4] However, as indicated above, the relationship between oil and agricultural commodity prices is complicated and suggests the need to take energy-agricultural markets integration into account. In that respect, the recent tendency in the literature on the energy-food nexus is to focus on the volatility spillover between oil and agricultural commodities. It is now well known that energy and agricultural markets are recently characterized by more volatile dynamics that call for deeper analyses of volatility transmission between these markets.

The goal of this paper is to identify whether volatility in oil prices have any explanatory impact on the volatility in agricultural commodity prices. We concentrate on identifying the structure of the volatility transmission mechanism between oil and the selected agricultural commodities (wheat, corn, soybeans, and sugar) that are the main crops used as inputs in production of biofuels and are the key agricultural products for food in the world. The newly developed causality in variance test and impulse response functions are applied to the data covering the period 01 January 1986–21 March 2011. To investigate the impact of the 2006–2008 food price crisis on volatility transmission mechanism between energy and agricultural markets, the empirical analysis is conducted for two sub-periods (the pre-crisis period from 01 January 1986 to 31 December 2005, and the post-crisis period 01 January 2006–21 March 2011). The empirical results provide evidence on volatility spillover from oil prices to agricultural commodity prices in the post-crisis period, implying that agricultural commodity markets have become more integrated with energy markets after the crisis.

A considerable body of research exists on the linkages between crude oil and agricultural commodity prices. Our study differs from other studies by employing a newly developed causality in variance test. To the best of our knowledge, within the energy-food nexus this is the first study to carry out the causality in variance test developed by Hafner and Herwartz (2006) which is superior to test developed by Cheung and Ng (1996). This paper also utilizes impulse response functions in order to identify temporal volatility transmission dynamics between energy and agricultural markets.

The paper is organized as follows: The literature is reviewed in Section 2. Econometrics methods are outlined in Section 3, followed by data definition in Section 4. Interpretation of and discussion on empirical results are droved in Section 5. Finally, Section 6 is devoted to a brief summary of this paper and policy implications.

2. Literature review

There is a vast literature on the link between oil and agricultural prices but the nature of this causal link remains unclear. There is an increased interest in volatility spillover or risk transfer between oil and agricultural commodity prices. However, this literature seems to be still scarce and calls for more attention to the dynamics of the risk transmission. In the literature, a distinction can be made among three key linkages between oil and agricultural prices: (i) oil as a production cost; (ii) biofuels; and (iii) co-movement with agricultural commodities due to investment fund activity.[5] Table 1 presents a chronological summary of the literature in terms of method types, commodity, data and key findings.

The relationship between oil and agricultural prices in terms of oil as a production cost in agriculture was examined by Baffes (2007, 2010), Harri and Hudson (2009), Chang and Su (2010), Alghalith (2010), Du et al. (2011), Alom et al. (2011). Baffes (2007) analyzed how crude oil prices spill on the prices of 35 internationally traded primary commodities and found that the pass-through of crude oil

[4] We refer interested readers to Nazlioglu and Soytas (2011), Nazlioglu (2011), Nazlioglu and Soytas (2012) for the literature reviews on the studies that examine price transmission between oil and agricultural prices.

[5] We thank an anonymous referee for suggesting this classification.

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