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Crude oil price and food price volatility: A conceptual analysis

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Abstract

In this paper we explain the volatility of food prices, the sources and consequences of volatility. We develop a conceptual model linking oil price and food price volatility. We also attempt to assess previous empirical studies and identify any gaps in the literature that will serve as guide for future empirical studies.

Keywords: Oil price; Food price; Volatility; Conceptual Analysis

1 Introduction

Oil is used to power agricultural machines, processing machines, and to transport inputs such as fertilizer, pesticides and final goods to the ultimate consumer. Increases in the price of oil therefore add serious pressure on the cost of these operations. Higher prices of oil may trigger inflation in the economy; increase cost of input, transport cost and subsequently reduce investment [9].

There have been large increases in crude oil prices. Several hypotheses were advanced when world oil prices (e.g. the West Texas Intermediate) started their inexorable climb from 2003–04 onwards, then skyrocketed from \$92 a barrel in January 2008 to cross the \$140 a barrel mark in June, finally hitting a record high of \$147 a barrel on July 11, 2008, before collapsing to less than \$40 a barrel [22]. Oil prices began to rise in 2009 from a low point of about \$40 a barrel in January to around \$70 a barrel in July [22] and stands at \$96.54 as at August 2014 according to the US Energy Information Agency data base, one begins to wonder whether the world is in for another oil price spike in the near term similar to that witnessed in early 2008. Higher crude oil prices stimulate the demand for bio fuel since agricultural food is used as feed stock for bio fuel which in turn may lead to higher food prices and volatility. This could possibly imply that there is a direct shock transmission from crude oil to food prices.

2 Food Price Volatility

Food price instability refers to variation in the price of food over time. It also could be referred to as excessive fluctuations in commodity price either in situations of high price or low which creates uncertainty for farmers [7].

Jacks *et al.* (2009) [5] defined volatility as the standard deviation of price changes over a given period. According to Huchet-Bourdon (2011) [21] “volatility is defined as the variation (amplitude and frequency) of commodity price changes around their mean value”. Volatility is defined as rates of price variation over a successive period of time; it is determined by the speed, magnitude and change in direction of the rate of variation in prices [7] Volatility is not a

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directly observable quantity, like a price, but has to be estimated. Sudden, large and unexpected price increases are known as surges.

According to FAO, IFAD, IMF, OECD, UNCTAD, WFP, World Bank, WTO, IFPRI and UMHTF. (2011) [9], “Not all price variations are problematic, such as when prices move along a smooth and well-established trend reflecting market fundamentals or when they exhibit a typical and well known seasonal pattern. But variations in prices become problematic when they are large and cannot be anticipated and, as a result, create a level of uncertainty which increases risks for producers, traders, consumers and governments and may lead to sub-optimal decisions [9].

High prices are not new in African market. In fact, price variability is at the core of very existence of markets. However, since 2007, the degree of price volatility and the number of countries affected have been very high. This is why food volatility in the context of higher food price has generated considerable anxiety and caused real problems in many countries [15].

Period of high prices favours the producer; he is willing to increase production because he makes more profit. While on the other hand, the consumer suffers because the family budget for food will increase. On the contrary food price volatility affects both the producer and the consumer but the effect on the consumer is small [17]. It can affect production decisions, because investment has to be made before prices and yields are known. The FAO, IFAD, IMF, OECD, UNCTAD, WFP, World Bank, WTO, IFPRI and UMHTF. (2011) [9], noted that volatility becomes an issue for concern and for possible policy response when it induces risk-adverse behaviour that leads to inefficient investment decisions and when it creates problems that are beyond the capacity of producers, consumers, or nations to cope. This implies that when volatility is minimized, it will not be a problem rather when it becomes extreme, frequent and creates uncertainty.

3 Inherent Volatility of Agricultural Commodity Market

Most agricultural prices are characterized by some degree of volatility. According to [21] “price volatility is a fundamental feature of agricultural markets and probably one of the main sources of risk in international agricultural trade”. In the short term, because there is a mismatch between timing of supply (which is seasonal) and timing of demand (which is much less seasonal), agricultural commodities must be stored, and storage will not be profitable unless prices vary during the course of the year. Over the longer term, if the increase in food production is not keeping pace with demand growth, it is important that prices increase. This will provide incentives for farmers to increase supply and for the private sector to increase research and development and will provide signals for the public sector to increase spending on public goods that support agricultural production and markets [7].

The FAO, IFAD, IMF, OECD, UNCTAD, WFP, World Bank, WTO, IFPRI and UMHTF [9] on food price volatility identified three major factors that are responsible for the inherent volatility nature of agricultural commodities. First, agricultural outputs vary from time to time due to vagaries of weather and pest incidence. Second, demand elasticities are relatively small with respect to price and supply elasticities are low in the short run. In addition, in order to get supply and demand back to balance after a shock, prices have to vary rather strongly. This means that demand and supply are relatively inelastic in the short run as such any shock in demand or supply will tend to generate higher or more volatility or variability. Thirdly, because agricultural production has a time lag, supply cannot respond much to price changes in the short term, though it can do so much more once the production cycle is completed. The resulting lagged supply response to price changes can cause cyclical adjustments (such as the often referenced “hog cycle”) that add an extra degree of variability [21].

4 Sources of Price Volatility

According to [14], price volatility in developing countries has two main sources: international source of volatility from world markets and domestic sources of volatility. Studies conducted prior to recent international price rises indicate that international price variability explains a very small share of domestic price variability in developing countries, meaning that domestic price volatility is mainly of domestic origin [6]. Imported volatility occurs as a result of the extent of international trade available in the country. Daviron *et al.* (2008) as cited by [15] examined the pattern of the transmission of the changes in international food prices to national markets in four African countries with fully liberalized cereals markets (Senegal, Mali, Niger, and Madagascar) before the food crisis. He identified that the dynamics of markets for local coarse grains (millet and sorghum) in the Sahel were found to be completely disconnected from the international food prices.

In developing countries, the factors that intensify price volatility are high cost of production, and erratic government policies which makes marketing system very risky and thus discourage private ownership of stocks [15]

HPLC (2011) [15] also identified some structural conditions of the markets in developing countries that contribute to high cost of price and volatility which includes the subsistence nature of farming in these countries. Production is majorly for self, having a small portion for market. Also, poor developed marketing infrastructures and institution and lack of marketing information for major actor contribute immensely to domestic price volatility. There is also demand and supply shift where by farmers who were net sellers during normal or good harvest become net buyers during bad years. Poor policies such as unstable trade policies contribute to domestic price volatility in developing countries. Microeconomic instability which characterized these countries also contributes to their domestic price volatility.

Studies have shown that even though there is imported source of volatility from the world market, it is domestic price volatility and inflation that possess a severe treat to the vulnerable poor people of these countries. For instance, Hoyos and Medvedev (2009) cited in [9] found that on average, only 18 per cent of the increase in international price during the crises of 2007-2008 was transmitted to domestic markets. This implies that the behaviour of international market has limited impact on the movement of domestic prices in the short term. According to Mousseau (2009) as cited by [15], “rising food prices in global markets represent a serious threat to vulnerable people in developing countries; it is domestic food price inflation and volatility that determine the poverty and food security impact of international food crises”.

HLPE (2011) [15] reported that international food price rises have been unevenly transmitted to domestic prices in developing countries. In most countries transmission was delayed but increases in domestic food prices persisted after international food prices dropped. This contributes to the fact that the source of volatility is not only from international source. In many poor countries, particularly in Africa, this volatility from the international market exacerbated chronic domestic volatility in local food prices. The report also identified that the consequences of international food price volatility on food security differs both across and within countries depending on the degree of transmission of world food price hikes in domestic markets. Also, the effectiveness of policy measures adopted to insulate the domestic markets from the international markets, determines the degree of transmission across developing countries [15].

According to [15], barrier to trade is an important cause of international price volatility. Trade barriers are designed to isolate domestic markets from international price fluctuations. As such, they reduce the number of consumers and producers participating in the quantitative adjustment between supply and demand. This implies that individual countries need to adopt policy measures to protect their local markets from international price volatility. Also, the level of international price transmission depends on whether a country is a net exporter or net importer of a given product or self-sufficient in its production. However, domestic volatility can also be transmitted to international market as well through market intervention policies such as trade restrictions adopted by an exporting country to stabilize their domestic market [7]. This will in turn cause supply shock in the international market thus causing price variability. For instance, the world food crises of 2007/2008 provide a good case study in this regard. According to FAO *et al.* (2011) [12] “While trade restrictions allowed some countries to prevent transmission of the price surge on world markets to their domestic prices, domestic stability was achieved at the cost of destabilizing the world market”.

Some specific factors that have potential influence on high prices and volatility include energy prices and biofuel, population trend, weather and climate, exchange rates, trade restrictions and speculations [9]. These are further explained below:

4.1 Energy prices and biofuels

Energy prices directly affect agricultural production and its commodity prices. This is because oil is used in powering machines during mechanization, processing, transportation of inputs such as fertilizer, pesticides and final products to the ultimate consumers. Increases in the prices of oil affect the cost of these operations which will in turn be translated to the prices paid by consumers [25]. According to Baffes and Dennis (2013) [18] “large increase in crude oil price stands out among numerous factors to explain most of the jumping food prices”. This conclusion was made after a comparative study of the commodity price with some of the drivers such as energy, exchange rates, interest rates, inflation, income and using a stock-to-use ratio to determine which driver had the most impact on food prices. United States Agriculture Secretary Tom Vilsack said that “if oil prices keep going up as they have recently, that could have a greater impact on food costs than what's associated with what's going on with the drought” [19].

There is also an increasing demand for biofuels production globally especially in the United States due to souring price of oil. This is as a result of technological advancement in the discovery of new uses of products. The production of biofuel

has a negative impact on food prices because of the use of food commodities such as maize, sugarcane and oil seeds as feedstock for its production [20]. Increase in the production of these crops has gone to the production of ethanol instead of food and animal feeds. According Toni (2013) [19], “Corn-based ethanol rose from 15 per cent of total U.S. corn production in 2006 to an estimated 40 per cent in 2012.

4.2 Population trends

The growth in the population especially in developing countries without corresponding increase in the agricultural production exacerbates the food situation in those regions, resulting to domestic price hikes and volatility [9].

4.3 Weather and climate change

Variability in weather is the most common source of volatility in agricultural price. Increased climate variability has become a major global challenge. For instance, the 1998 flood in Bangladesh created a shortfall of 2.2 million tons of rice productions leading to a price surge harming vulnerable [26]. Disasters like flood and drought when they occur are likely to affect production outputs. A shortage in food supply as against demand is known as supply shock. This supply shock if not provided for may create scarcity through speculation leading to hikes in food prices and variability in prices [19].

4.4 Exchange rates

Shocks in the nation’s currencies can affect the income of commodity food producers. The recent depreciation of the US dollar (USD) is a good illustration of this [24].

4.5 Trade restrictions

The imposition of tariffs and restrictions on import or exports can exacerbate the commodity price fluctuations [4]. Restriction in trade is a policy measure usually adopted by exporting countries to insulate their countries from international price volatility or to reduce domestic volatility. This is to insure surplus and stabilize price at domestic levels. Export restriction of wheat and rice by Argentina, Russia, Ukraine and India were the primary cause of the 2008 price surge [26].

4.6 Speculations

The effect of price speculation on volatility is still very controversial [4]. While some believe that it has significant affect others do not believe. It is important to note that speculation is important for the efficient functioning of markets because it brings liquidity into the market and helps farmers and other participants to offset their exposure to future price fluctuations in the physical commodity market [9]. However, excessive level speculation may lead sudden fluctuation in the price of commodities in the short term. According to FAO (2012) [13], excessive speculation in agricultural commodity markets could transmit inappropriate market signals to agricultural producers, leading to inefficient allocation of resources.

5 Consequences of Food Price Volatility

Price volatility is majorly a concern to producers rather than high prices [4]. Volatility affects production decisions due to uncertainty of price and yield. It can induce large swings in the profit realized and as such reduce investment. However, when prices are high producers are willing to produce because more profit will be made. Volatility leads to inefficient investment decisions because resources would have been committed before price and yield are known [4].

Price volatility threatens the food security situation of a country and renders the vulnerable ones more vulnerable [15]; [21] When uncertainty is high, investor tends to reduce their volume of investment to reduce risk. This will in turn affect the level of production and consequently scarcity and higher prices. When food is expensive, accessibility and availability is likely to be possible to only the rich. The situation either impoverishes the low-income earners the more or they might find succor in alternative foods that may jeopardize their balanced dietary intakes. This situation is worsened in children and pregnant mothers [9].

According to FAO (2012) [13], high prices of 2007- 2008 pushed an estimated additional 80 million people into hunger, bringing the world total to around one seventh of global population. It also affects the economy as a whole by reducing the standard of living and national income for exporting countries.

6 Conceptual Model

It is possible to develop a simple conceptual model of oil price and food price volatility. This is presented in Figure 1. Oil price affects food price volatility directly and indirectly. Oil is used in the manufacturing of fertilizer, powering of tractor and other machines used for agricultural mechanization. Oil is also used in powering machines in the processing industries. Oil is used in transporting agricultural commodities and other finished goods to the end users. When there is a shock in oil price, it therefore creates uncertainty in the prices paid by consumers and affects investment in agricultural production if the uncertainty is too high. This will affect the level of agricultural output and hence the supply of food. In turn, these will affect the food price and its volatility.

The hike in oil price has led to the discovery and use of biofuel as an alternative source of energy. In the production of bio-fuel, some agricultural commodities such as corn, sugar, etc are being used as feed stock for bio-fuel production is also competing with available land and water that would have been used for agricultural production. By so doing the production of bio-fuel reduces the stock level, affects food supply and subsequently food price volatility.

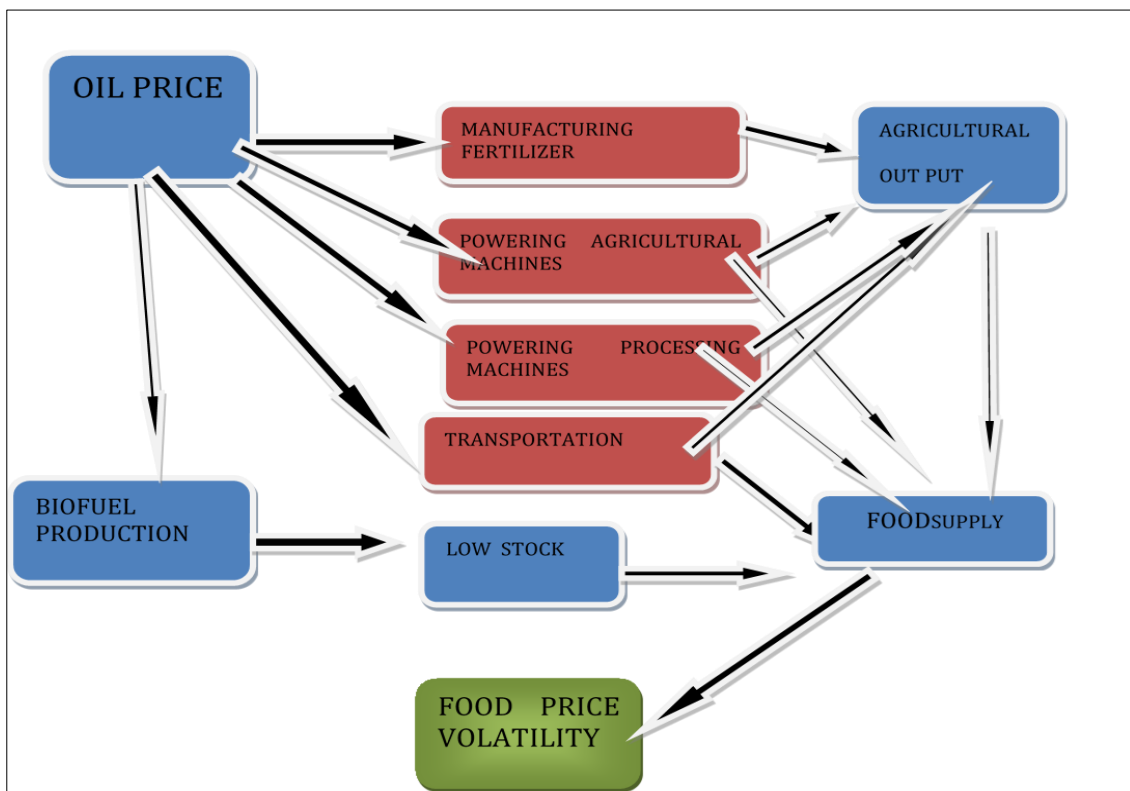


Figure 1 The Conceptual Framework of Oil Price and Food Price Volatility

7 Review of Empirical Studies on Oil Prices and Food Prices/Volatility

Gogoi (2014) [2] investigated the long run relationship between crude oil and world food commodity prices such as maize, rice, soybean and wheat for the period between 1980-2011 using time series econometric technique. The co-integration test revealed that there is a long run relationship between crude oil prices and the prices of maize, soybean, and wheat with the exception of rice prices. He also conducted a Granger causality test to check whether causality exist between the two prices. He found that there is unidirectional causality, with only crude oil prices 'Granger causing' each of the four food commodity prices while crude oil prices were not found to be influenced by price of food commodities.

Arshad and Hameed (2009) [10] also investigated if there is a lon term relationship between petroleum and cereal prices using monthly data over the period of January 1980 to March 2008. The bivariate co-integration approach using the Engle-Granger two stage estimation procedures was applied and the result revealed unidirectional long run causality from petroleum price to cereal prices.

Campiche *et al.* (2007) [17] examined petroleum prices and global agricultural commodities prices. Their aim was to analyse the co-variability between crude oil prices and commodities such as corn, sorghum, sugar, soybeans, soybean oil and palm oil. Using weekly data for the period of 2003-2007, they investigated the co-integration (i.e. long run) relationship between the variables using Johansen co-integration test. The Johansen co-integration test carried out for the period of 2003-2005 and 2006-2007 revealed a co-integration of corn and soybean prices with crude oil but only during 2006-2007.

However, some studies found no relationship between crude oil price and agricultural commodity prices. For instance, [1] found no direct long run relationship between oil prices and agricultural commodity prices. Yu *et al.* (2006) [27] examined the long run relationship between crude oil prices and the prices of vegetable oils (oil palm, soybeans, rape seeds, sunflower) and found that crude oil price have no effect on vegetables oils prices.

Alvalos (2013) [11], investigated whether oil price granger cause corn and soybeans prices using a VAR model on monthly prices from January 1986- April 2006 using international prices. His findings showed that oil price shocks exhibited no predictive causality over corn and soybeans prices. Oil prices have a negative impact both in the long and short run price dynamics of the two food commodities.

As far as oil price and food and /or agricultural price volatility is concerned, there are also a number of studies. This is particularly so since the recent food crisis in 2007-2008 and 2009-2010 has drawn the attention of researchers on the increased volatility of agricultural commodities. For instance, Hutchet-Bourdon (2011) [21], statistically analyse the historical commodity price volatility over the last half century for an extended range of agricultural commodities such as beef, maize butter, rice, soybean oil, sugar, wheat and whole milk. The paper also investigated the relationship between oil price, fertilizer price and each of these agricultural commodities using spearman's correlation coefficient on monthly data. The paper also concluded that a causal effect exists between the changes in crude oil price, fertilizer price etc and the changes in each of the agricultural commodity price series. It is also concluded that there is no increasing tendency in price volatility over the past fifty years for individual agricultural product price. However, in general price volatility in the recent period of 2006-2010 was higher than that in the nineteen nineties but not higher than that of the 1970's.

In the same vein Sujithan *et al.* (2014) [20] used Bayesian multivariate frame work to assess the effect of oil price and other drivers on the volatility of global prices of cocoa, coffee, sugar and wheat in recent periods. Using monthly data covering the period January 2001 to March 2013, an impulse response function of food volatility to oil price shocks revealed that, an oil price shock leads to an increase in the price volatility of cocoa, coffee, sugar and wheat for 2-3months followed by a downward peak after 4 months. The result showed a negative impact on the volatility of soybeans and sugar and a positive impact on cocoa, coffee, corn and wheat prices.

Gilbert and Morgan (2010)[3] conducted an analysis to ascertain the assumption that international food price volatility has risen over time. Using generalized autoregressive conditional heteroscedasticity (GARCH) model they analyzed monthly food prices between 1970 to 2009, and 1990 to 2009 for the purpose of comparison. The result revealed that, volatility has increased over the most recent years but there have also been periods of high volatility in the past and the recent episode does not appear exceptional. It is therefore possible to hope that volatility levels will drop back to historical levels. This is also in line with the findings of Hutchet-Bourdon (2011)[21] even though they mentioned some other factors which they feared could lead to future increase in volatility such as global warming, oil price volatility etc. This implies that with increase in these factors there are possibilities of increased volatility in the future.

Furthermore, [28] analysed volatility in food commodities and its co movement with crude oil prices. DCC-MGARCH models were used to estimate daily logarithmic prices over the twelve-year sample 2000-2011 using international prices. His findings revealed the empirical evidence that increased volatility in grains during the 2008-09 spike was substantially due to shocks transmitted from crude oil to grains especially corn, wheat and soybean prices but contributed relatively less at other times.

Minot (2011) [23] studied price volatility in Africa with the aim of verifying the assumption that African food price has become more volatile recently. Using F-statistics he tested the changes in price volatility between 1980-2006 and 2007-2010. His analysis for both 2011 and 2013 studies respectively revealed that food price volatility in the international market has increased in the past five years, though it is still relatively low. However, the result showed that in a group of 11 African countries, food price volatility is high and has not increased in recent years.

Udoh and Egwaikhide (2012) [8] investigated the relationship between international oil price volatility and domestic food price in Nigeria from 1970 to 2008. Using Johansen co-integration test involving three variables: oil price volatility,

food price inflation, and exchange rate, they revealed that the three variables were co integrated implying that there is a long run relationship between oil price volatility and food price inflation and exchange rate. Also, the Granger test indicates that causality runs from oil price volatility to domestic food price inflation in Nigeria, but not vice versa.

From the foregoing, the results are mixed. Moreover, the majority of the studies analysed the relationship between international oil and international food prices. There is need for studies contributing to the debate as to whether these two are related using domestic food price volatility. Also, while some country level studies have examined aggregate food price and its volatility, more studies are needed on individual food prices and volatility. Further, there is need for more empirical studies that look at the holistic relationship between oil prices and food price and their volatility. Holistic in the sense, that those studies will consider the long run, short run and causal relationships simultaneously using the same data set.

8 Conclusion

In this paper we show how oil price may affect food price volatility. The conceptual model for this clearly shows that oil price is important in the production, processing and distribution of agricultural produce and products. This is because oil is used to produce fertilizer used in improving yield of most agricultural crops. Also, oil is used to power the machines used in the production process and for transporting of both inputs and products to and from the market. It is also shown that the current use of biofuel as an alternative to crude oil could affect the stock of land and water resources available for production of food. This will consequently affect food supply and hence food price. If the hike in oil price becomes so severe, it can deter agricultural investment, food production and supply and hence introduce uncertainty about food prices. Although a number of empirical studies have examined the link between oil price and food price, little is known about food price volatility and even the available studies show mixed results. This calls for more in-depth research in this area.

Compliance with ethical standards

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There is no conflict of interest as this work is an extract from my M.Sc. work.

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