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Analysis of the Link between Crude Oil and Staple Food Prices and Its Implications on Developing Countries

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ANALYSIS OF THE LINK BETWEEN CRUDE OIL AND STAPLE FOOD PRICES AND ITS IMPLICATIONS ON DEVELOPING COUNTRIES

Dissertation

Submitted by: Katharina Averdunk

May 2010

ANNEXE

LIST OF FIGURES

ABBREVIATIONS

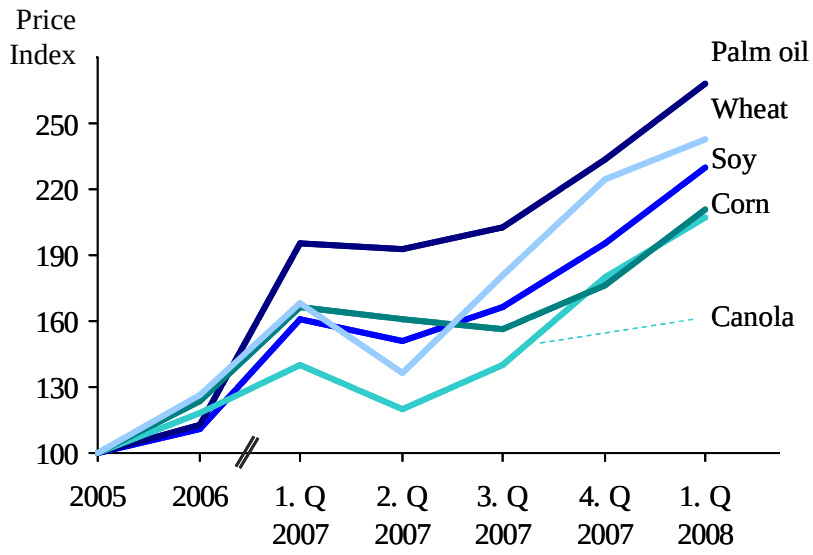
bbl	Barrel
Btu	British thermal units
CC	Carbon Credits
CDM	Clean Development Mechanism
CTS	Cents (U.S.)
E85	Ethanol gasoline blend with 85 percent denatured fuel ethanol
EIA	Energy Information Agency
FAPRI	Food and Agricultural Policy Research Institute
FAO	Food and Agriculture Organization of the United Nations
FOB	Free on Board
GC	Green Certificates
GDP	Gross Domestic Product
GMP	Guaranteed Minimum Price (Agriculture)
HFCS	High Fructose Corn Syrup
HH	Henry Hub (U.S. gas hub)
IEA	International Energy Agency
IMF	International Monetary Fund
LDC	Least Developed Countries
LNG	Liquefied Natural Gas
MRS	Marginal Rate of Substitution
mBtu	million British thermal units
MWh	Megawatt hour (electricity)
NBP	National Balancing Point (British gas hub)
OECD	Organisation for Economic Co-operation and Development
PFDS	Public Food Distribution System (Bangladesh)
PPO	Pure Plant Oil
P_{Crude}	Price of a barrel of crude oil
P_{Plant}	Price of a barrel of plant oil
WHO	World Health Organization
WTI	West Texas Intermediate (crude oil)
Q	Quarter
UNDP	United Nations Development Programme
UNICEF	United Nations International Children's Emergency Fund
USAID	United States Agency for International Development

1. INTRODUCTION AND OBJECTIVE OF THE STUDY

1.1 Introduction to a controversial question: Does biofuel production link food to crude oil prices?

Food prices – particularly prices of agricultural commodities used as a feedstock for biofuel production – reached record highs in 2008. Within a period of slightly more than two years prices for staple food such as corn, soy, wheat, and vegetable oils have more than doubled (International Monetary Fund (2008a), p. 1).

Development of selected agricultural prices 2005-2008
according to the International Monetary Fund



I. Development of agricultural prices 2005-2008

Source: International Monetary Fund, 2008, p. 1, own illustration

This price acceleration has occurred at a time of surging crude oil prices and a rapid expansion of biofuel production, which relies mainly on feedstock from food crops (UN Energy Department (2007), p. 31-35). Consequently, the market development has triggered a controversial debate on the question whether the increase of agricultural prices in line

with crude oil prices is a mere coincidence, due to stock market speculation, or result of a lasting integration of the agricultural and the energy sector.

The debate has a strong impact on the global perception of biofuels. Once considered as a major chance for developing countries, biofuels were at the heart of policy agendas in 2005/2006. Studies and reports published by international institutions like the World Bank, the United Nations, or the EU Commission accentuate manifold advantages of the locally produced fuels. The main risk of biofuels highlighted in these studies is the need for ongoing subsidies to the industry. Environmental effects and negative impacts on food security are also mentioned, yet not the main focus in most of these reports (Kojima and Johnson (2005), p. 17ff; Dufey (2007), p. 1; Coelho (2005), p. 7ff; European Commission (2006a), p. 6-7; European Commission (2006b), p. 30-32; UN Energy Department (2007), p. 31-35).

In the light of escalating food prices, the negative impacts on food markets have become the focal point of many research studies on biofuels. Some papers published by large international institutions, such as an OECD study that dates back to September 2007, even openly address the question whether biofuel programs might be worse than any disease they are supposed to cure (Doornbosch and Steenblik (2007), p. 5ff; Sachs (2007), p. 5-7; Zilberman and Rajagopal (2007), p. 51f).

A potential integration of crude oil and food markets is assumed to increase the level as well as the volatility of food prices and thus threaten food security, which is defined as the ability of individual households to sustain an adequate level of calories. In most cases undernourishment does not result from a lack of available food – but from a lack of income to buy it. High and volatile food prices reduce the ability of net-food-purchasers in developing countries to prevent under nourishment (Thomas et al. (2006), p. 53). The effect of biofuel production on food prices is therefore of high importance to policy makers around the globe. The issue has been analysed by various universities and institutions – yet the results of their analyses strongly diverge as summarized in the following paragraphs.

1.1.1 The controversy over the current impact of biofuel production on food prices

Among the advocates of the hypothesis that the recent food price increase is driven by various effects and not mainly due to biofuel production are the authors of a joint report published by the OECD and the Food and Agriculture Organisation of the United Nations (FAO). The two institutions find that the observed price changes for agricultural products are mainly due to

- weather-related shortfalls in production,
- low stocks,
- and an increase in demand

According to the report the increase in demand for agricultural products has been caused by a confluence of factors such as economic growth, an expansion of meat consumption and the conversion of agricultural feedstock into ethanol and biodiesel. Consequently, biofuel production is seen as *one* factor contributing to the price surge – yet not the most important one. The report illustrates the impact of weather effects and biofuel production by describing their respective impacts on cereal markets:

"For cereals, weather-related shortfalls in production have occurred in a number of producing countries most notably in Australia, where production fell by more than 50 percent. In a global context of low global cereal stocks in recent years, these lower supplies have been a strong factor underpinning world prices. Reduced global stocks and production are confronted with stronger than expected demand for cereals for biofuel production (…). It is noteworthy, however, that the combined cereal supply shortfall in North America, Europe and Australia in 2006 of over 60 Mt was nearly four times larger than the 17 Mt increase in cereal use for ethanol in these countries."
(OECD-FAO (2007), p. 28)

Supporting the results of the joint OECD-FAO analysis, a report published by the German Federal Ministry of Finance also states that the acceleration in agricultural commodity prices has been due to a combination of factors such as increasing demand for dairy products and meat in traditionally rice consuming countries, failure of crops, reduction of stock levels, and rising transport prices. Biofuels are seen as an additional factor

contributing to the upward trend in an already tight commodity market (German Federal Ministry of Finance (2007), p. 79-80).

In a 2008 statement, the administration of the United States equally does not consider biofuel production to be the most relevant factor contributing to the food price surge. Instead, the growing demand in emerging countries is identified as main driver behind the market development. Biofuel production is found to contribute less than three percent to the acceleration in staple food prices (Sen (2008), p. 17; Chakrabortty (2008), p. 1).

In sharp contrast to these analyses, the World Bank states that 70-75 percent of the increase in food prices within the period 2002 to 2008 was due to biofuel production. A report published by the institution in August 2008 concludes that the food price development has indeed been caused by several factors – yet, the rapid expansion of biofuel production from grains and oilseeds in the United States and Europe is assumed to be by far the most important one (The World Bank (2008d), p. 2; Mitchell (2008), p. 17).

The diverging opinions on the issue demonstrate that the impact of biofuel production on staple food prices is highly debatable and approaches to calculate the effects might be influenced by political factors. While it is important to identify the drivers of the past acceleration in agricultural commodity prices it is, however, even more relevant to understand their future development in the light of a continuous expansion of biofuel capacities. The following paragraph therefore summarizes the most important studies on the expected future developments of agricultural prices.

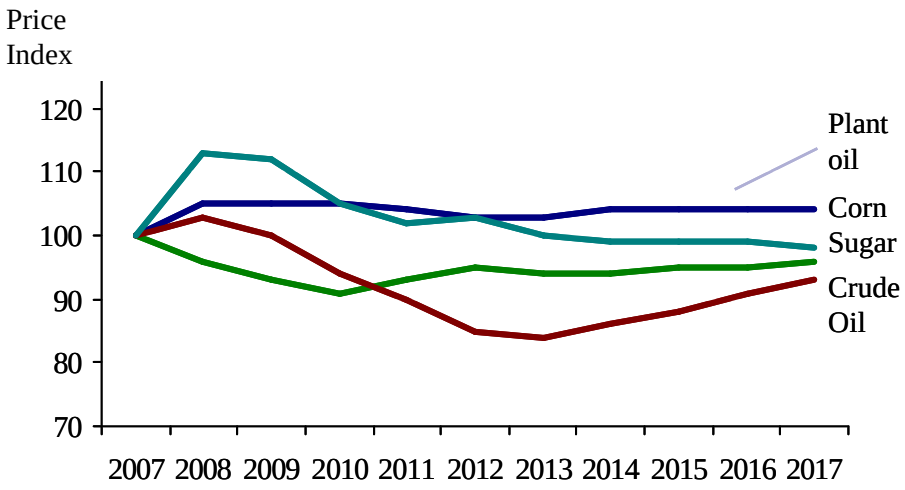
1.1.2 Expected future developments

Like the analysis of the current market situation, the outlooks of the future development of food markets diverge markedly. Most forecasts include global biofuel production as a factor driving demand. Yet, the overall effect on anticipated agricultural price levels largely depends on expected supply-side responses, i.e. on the question to what extent the supply side can match the increasing demand through an expansion of planted areas and a more intensive use of available arable land.

Therefore, forecasts by the U.S. Food and Agriculture Policy Research Institute, the European Commission, the OECD-FAO, the Purdue University, or the International Food Policy Research Institute include diverging scenarios of future food prices depending on the underlying assumption regarding demand as well as supply side responses

The following graphs show two forecasts of food price developments: The first one is taken from a report published jointly by the Organisation for Economic Co-operation and Development (OECD) and the Food and Agriculture Organization of the United Nations (FAO) in 2007. The second one was published by the Food and Agriculture Policy Research Institute of the United States in the same year.

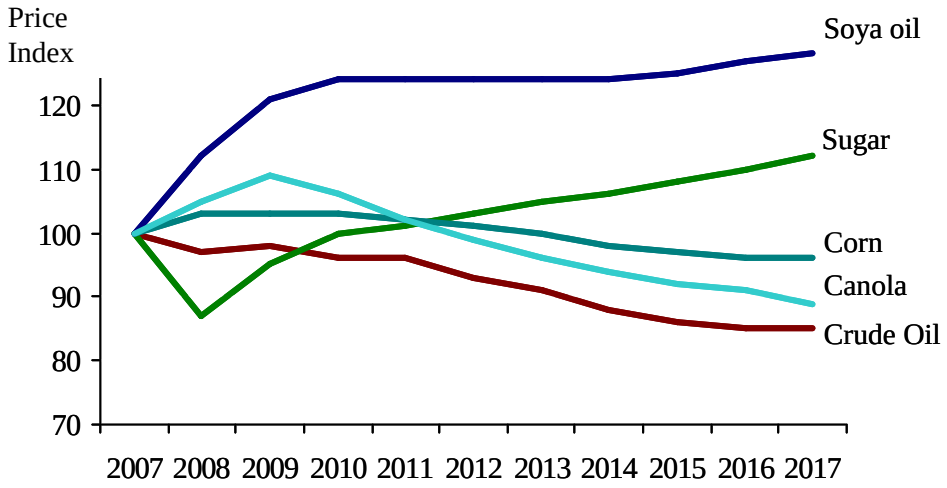
Development of Feedstock and Crude Oil Prices 2007-2017
according to the OECD-FAO



II. OECD-FAO prognosis of Feedstock and Oil Prices 2007-2017

Source: OECD-FAO (2007), p. 49-50, own calculation/illustration

Development of Feedstock and Crude Oil Prices 2007-2017
according to the FAPRI



III. FAPRI prognosis of Feedstock and Oil Prices 2007-2017

Source: Food and Agricultural Policy Research Institute (2007), p. 55-299

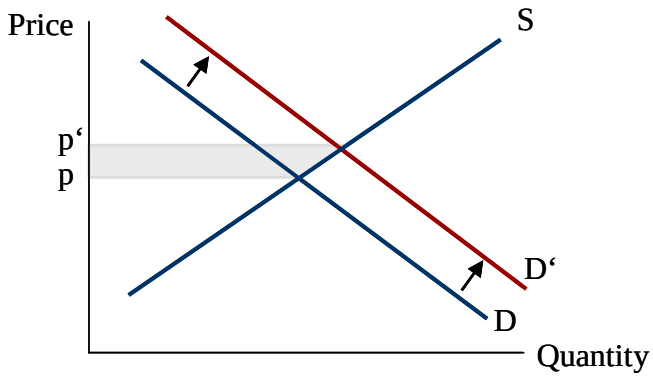
The authors of the OECD-FAO report forecast prices of most of the main agricultural commodities to decrease slightly in the next decade due to increased production levels. Only the prices of plant oil are expected to increase marginally. Based on different assumptions regarding land availability and demand the Food and Agriculture Policy Research Institute, on the other hand, expects soybean oil and palm oil as well as sugar prices to continue to rise substantially while corn and canola oil prices are expected to drop.[1]

In spite of the differences in projected price levels of specific commodities, the forecasts cited above share a common aspect with respect to market integration: None of the studies

[1] The two forecasts comprise marketing years for the respective agricultural commodities. The marketing year 2006/2007 is denoted as 2007 in the diagrams. These marketing years are, however, not homogenous. While the U.S. marketing year for corn comprises the period September 1 to August 31, the marketing year for soybean oil covers October 1 to September 30. For crude oil prices, on the other hand, the years included in the forecast are calendar years. This lack of homogeneity represents a limiting factor of the diagrams

expects agricultural and crude oil markets to link up within the next decade. Feedstock and crude oil prices are anticipated to develop independently in the long-run. The analyses define agricultural price levels as the balance between production – which is a function of arable land and yields – and demand arising from the food sector and industrial market segments. Biofuel production is consequently seen as a factor shifting the demand function and thereby changing equilibrium prices as illustrated on the following graph.

Calculation of the impact of biofuel production on food prices
using a supply and demand based approach



IV. Supply/demand based approach of the impact of biofuel production

Source: Own illustration

Other authors and institutions, for example the European Commission, the United Nations or the German Agency for Renewable Resources share this perspective. In recent reports these organisations calculate break-even points of different types of biofuels as a function of oil price levels.

Such a calculation is only possible if prices for agricultural commodities – which represent up to 80-90 percent of biofuel production costs – do not rise and fall in line with crude oil prices but remain constant. Hence, the underlying assumption of many reports on biofuel production published in the last years is that crude oil price movements will not affect agricultural commodity prices significantly and that the two markets will not integrate in

the long run (European Commission (2007a), p. 9 ; European Commission (2007b), p. 11; Schmitz et al. (2006), p. 23, 25; Larson (2007), p. 23).

Other studies, however, indicate that agricultural commodity markets and crude oil markets might be linked in the future. Research papers published by the Purdue University and the Stanford University's Program on Food Security and the Environment, for example, conclude that biofuel production links agricultural and energy markets. Consequently, the authors find that the world enters into an era with a close long-term connection between crude oil and agricultural commodities prices. An independent movement of energy and food prices is thus considered as being impossible (Tyner and Taheripour (2008), p. 2-4; Naylor et al. (2007), p. 30-43).

These papers support the hypothesis of Schmidhuber, an economist of the Food and Agriculture Organization of the United Nations, who concludes that energy prices define the floor and ceiling prices of agricultural feedstock. As prices for fossil energy reach or exceed the energy equivalent of agricultural products, the energy market creates demand for agricultural products linking prices in the long run (Schmidhuber (2007), p. 10-15).

Under this assumption the acceleration in agricultural prices in line with crude oil prices is neither a coincidence nor simply due to a shift of the demand function. Moreover, an expansion of agricultural production in the coming years will not be able to compensate the increase in demand and will not result in lower food prices either – unless crude oil prices decrease as well. If agricultural commodity and energy markets are integrated, food price levels will be defined by energy prices rather than depending on land availability and yields.

1.2 Objectives and approach of the study

In the light of these controversial opinions on an issue that could have a far reaching impact on global producers and consumers of food – particularly those in developing countries – the objective of this study is to analyse whether agricultural commodity and

crude oil markets might be linked in the future and how an integration of markets would affect developing countries.

The study is structured as follows:

- Part I will analyse under which conditions prices in commodities markets might follow the same trend. This part of the dissertation will be based on a comprehensive literature review.

  A structural link between prices of two or more commodities is often referred to as market cointegration. In cointegrated markets prices may deviate in the short term and correlation coefficients can be low at times. However, the markets return to equilibrium in the long run so that prices follow the same trend. This equilibrium or structural relationship can be empirically evaluated in order to prove the link between the markets (Alexander (1999), p. 24; Hendry and Juselius (2001), p. 75; Granger and Newbold (1974), p. 111-120; Jones and Nesmith (2006), p. 2f).

  So far, no general framework on cointegration in commodity markets has been developed that explains why and under which conditions prices of two or more commodities are characterized by a stable long run relationship. However, drivers for cointegration effects have been identified in various studies focussing on *specific* commodities such as crude oil/ natural gas, cotton/ polyester, and natural rubber/ synthetic elastomers.

  The results of the most relevant studies in this field of research will be summarized in order to develop a general framework on cointegration in commodity markets. This framework will be the conclusion of the first part of this dissertation.

- Part II will investigate whether a co-movement of staple food and crude oil prices is technically possible given the structural relationship of both markets. The analysis included in this part will be based on the framework developed in the first part of the dissertation. Sources used for the analysis, will comprise both, desk research as well as interviews with industry experts.

The focal point of the analysis will be plant oil which is the main input factor for biodiesel production, but can also substitute for petroleum derivates in industrial applications such as paints, surface coatings and plastics. As cointegration effects are mainly due to the substitution potential between two or more commodities (see Part I), the objective of the second part of the dissertation is to analyse all relevant market segments in which plant oil could replace crude oil. The approach will be to estimate the overall substitution potential and to calculate the marginal rates of substitution between crude and plant oil in each market segment. These estimates will be included in a model that identifies

- how much of the global vegetable oil market could be absorbed within each market segment,
- at what price ratio switching is economically attractive,
- whether the substitution potential between crude and plant oil could result in a co-movement of prices as observed in other commodity markets.

- Part III will summarize the potential effects of an integration of plant and crude oil markets on developing countries. When plant oil prices are linked to crude oil prices other staple food prices would be equally affected by rising or falling crude oil prices. Agricultural commodities compete for arable land so that any change in the prices of one type of crop results - ceteris paribus – in price changes of most others.

  As mentioned above, high and volatile staple food prices reduce the food security of net food purchasers in developing countries. How severely consumers in these countries are affected depends on the degree of price transmission from international to domestic markets which differs by regions as demonstrated in previous research studies (Blein and Longo (2009), p. 1-2).

  In addition to the effects on household level, a co-movement of staple food and crude oil prices will also affect the countries' balance of trade either mitigating or worsening the effects of rising oil prices on the economic development.

Besides summarizing the potential effects of a co-movement of crude oil and staple food prices, the third, and last part of the dissertation, will analyse measures to mitigate the negative effects of a market coupling. This analysis will be based on the main findings of Part II and draw attention to the role of direct subsidies and tax relief programmes in various market segments.

PART I

FRAMEWORK ON PRICE LINKS IN COMMODITY MARKETS

2. INTRODUCTION

The purpose of the first part of this dissertation is to analyse under which conditions prices in commodities markets might follow the same trend. As presented in the next chapter, the methodology used in this part is a systematic review of the literature on price links between two or more commodities. Based on key findings of this review a general framework on price links in commodity markets will be developed.

Part I starts with an introduction to the role of prices, how they are meant to reflect the social value of commodities and why they frequently fail to do so. While the subsequent literature review focuses on the reasons why prices in two or more commodity markets might be interlinked, this chapter introduces the theoretical context allowing for an interpretation of the results.

Factors that result in price distortions as presented in the following tend to have an influence on price levels in most commodity markets. Consequently, these factors have to be borne in mind when interpreting the results of the literature review.

2.1 The role of prices

As stated in the efficient market theory, prices have two main roles: firstly, they are meant to convey information (informative function) and secondly, they facilitate the efficient allocation of scarce resources (allocative function). As conveyors of information, prices inform about the willingness of buyers to acquire goods at a given price based on their subjective values and utilities. These prices are defined as buyers' reservation prices and indicate the largest amount any specific buyer would be willing to pay for a good or service. Likewise, prices indicate the willingness of sellers or providers to sell at a given price based on the assessment of their production costs and profit expectations (Bernanke and Frank (2004), p. 62; Wienert (2008), p. 85ff; Friedman (2007), p. 8ff).

This rapid, two-way transmission of information enables an efficient coordination of markets, which would be difficult to organize otherwise. In perfectly competitive markets a price mechanism is thus the most efficient way to transmit information between economic units in the sense that a minimum number of variables is used (Thomsen (1992), p. 31).