FGV PROJECTS

EVALUATION OF THE IMPACT OF BIOFUELS ON FOOD PRICES

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Nº 14

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SUMMARY

EDITORIAL

At the end of 2008, FGV Projects sponsored a survey to analyze the determining factors behind food prices. Among the main conclusions of the study, it was established that the expansion in the production of biofuels – more precisely ethanol from sugar cane – was not a relevant factor for the rise in food prices observed over the course of the year 2008. What really contributed decisively to the rise in food prices was speculation in the futures markets and an increase in demand at a time when world stockpiles were low.

The onset of the financial crisis at the end of that same year meant that food prices suffered a significant fall in the years following completion of the first study, returning to the figures prior to the period of the accentuated high. However, at the end of the decade, food prices rebounded dramatically surpassing the peak in prices of the months preceding the crisis.

This publication - specially developed for the Organisation for Economic Co-operation and Development (OECD) and FGV Foundation's seminar 'Agribusiness in Brazil: Policies, Experiences and Perspectives"(Paris, November 2011) - updates the earlier work by investigating the causes of price increases in two groups of factors: those associated with market fundamentals, namely supply and demand for food, and those associated with the financial issue, more specifically the mechanisms of transmission between the futures market and the spot market for agricultural commodities.

Enjoy!

Cesar Cunha Campos
Director
FGV Projects

EXECUTIVE SUMMARY

At the end of 2008, FGV Projects sponsored a study analyzing the determining factors of food prices. Among the main conclusions of this study: the expansion of biofuel production proved to be one important factor, especially sugar cane ethanol that was not related to the spike in food prices observed during 2008. According to the study, what in fact contributed decisively to the spike in food prices were the futures market speculation and the increase in demand in a scenario of low stockpiles.

It should be emphasized that both factors constantly appear in reports and studies sponsored by different international agencies. The United Nations Food and Agriculture Organization (FAO/UN), for example, understands that these factors are crucial to explain the recent increase in food prices, but it is also highlighted that the biofuels strongly contribute to this increase too, a position contrary to the US Department of Agriculture (USDA) which strongly advocates that the biofuels had a very small impact on this price spike.

The World Bank, in a 2010 study (Baffes and Haniotis), also relativized the importance of biofuels in the food prices increase on detailing different impacts from different agricultural cultures. Thus, the impact on food prices from the production of ethanol from corn or other cereals will be different from the impact, for example, of ethanol production from sugar cane. Nevertheless, the study recognizes that the energy and non-energy commodities should maintain some relationship in the future, and that this will be an important determinant of the food market dynamics.

This perspective is consistent with the studies by FGV Projects. It is not true that ethanol production from sugar cane has any significant effect on food prices, although a significant effect has also not been obtained involving corn ethanol. Nevertheless, the productivity differences should be emphasized among the cultures, the destinations of each product and other production characteristics of each commodity for an accurate evaluation of the effects on food prices.

This result is also consistent with the results reached by other studies. In Lagi et al (2011) the results in large measure contradict the belief that all biofuels are the big villains of the food prices crisis. According to the authors the factors that explain the increase in food prices are two: speculation and corn ethanol.

However, specifically in the Brazilian case, the country that precociously adopted a program to substitute fossil fuels, the relation indicated above, among the energetic and non-energetic uses of a determined commodity feeding off of signs coming from the market, has always been present and determined. This relationship ultimately determines how much should be allocated for each purpose, in the case of sugar cane production – between ethanol and sugar. It is not by chance that ethanol production reacts strongly to the proportion of cars in the Brazilian fleet.

Another point demanding attention is the role speculators and the transmission mechanism have between the prices on the futures and spot markets. Similar to a previous study, it was shown that speculative activity in the futures markets has a crucial role in the food prices spikes in 2008 and 2011, and that price setting in the futures markets comes before the cash price setting.

Moreover, the entire work shows that the correlation between a typical financial return indicator, for example, the S&P 500, and a main commodities price index became strongly linked in the months that preceded the 2008 crisis and thus remain until today. Such phenomena reflect some conditioners observed in this period, among which are highlighted: (i) the high international liquidity coupled with very low interest rates in the main developed countries; (ii) the investors' diversified portfolios and same seek assets whose income is not correlated with the assets originally maintained in their portfolios, many of which are related to the US real estate market; and (iii) a more transient effect than those described in previous items, constituting the rebalancing of investment portfolios, avoiding assets in US dollars.

I

INTRODUCTION

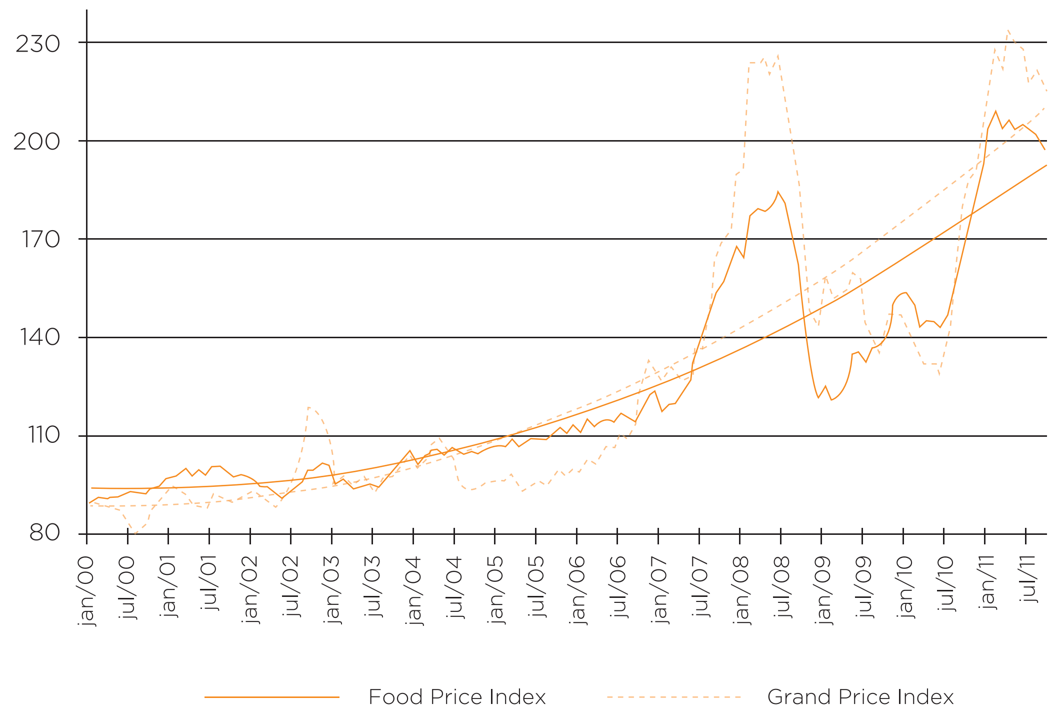
A debate has been gaining space in recent years in multilateral institutions about the recent food prices increase in the main world markets, and about what the main determinants of this increase are. In its main 2011 Report, FAO/UN lists as possible causes for this food increase the spiking of demand for grains from rapidly developing countries, population growth and the growth in biofuel production.

However, despite the institutional relevance of the agency sponsoring such report, the relative importance of each factor is far from reaching a consensus. In other words, although many of these facts are correctly placed, it is necessary to better qualify the context in which the biofuels are produced and commercialized. For example, ethanol production from sugar cane is quite different than ethanol production from corn or from other grains, just as the production of biodiesel from palm oil is different from biodiesel production from soy.

Generally speaking, this work updates the data from the other study conducted by FGV Projects (2008) and qualitatively and quantitatively evaluates the impact of biofuel production on the recent behavior of food prices based on stylized facts and statistical models consistent with and appropriate for market mechanisms. Moreover, focusing on a case study the evolution of a culture is investigated whose main product is increasingly employed for biofuel production: palm oil.

Food prices experienced strong oscillations in the period following the study, radically falling after the onset of the 2008 financial crisis, but recovering up to pre-crisis levels since mid-2010 and remaining at these levels during most of 2011. Figure 1 illustrates the general changes in food prices and especially grains (measured by FAO price index) during the first complete decade since 2000.

Figure 1: FAO Food Prices Index Development[1] (food and cereals)



Source: FAO

It is in this context of changing food prices that the present work updates previous results emphasizing the role of market fundamentals in setting food prices and the mechanisms to transmit the prices between the futures market and spot market for agricultural commodities.

According to the main works on this subject, there is no sole factor to explain the development of the recent increase in food prices, but rather a group of factors. The FAO/UN study mentioned above is quite extensive with respect to the potential causes of the increase in food prices, but it recognizes the difficulty in measuring the isolated contribution of each factor for the price increase. The factors analyzed in the study highlight those that follow:

- Growth in demand for food and the change of the consumption structure - more protein and less carbohydrates – in view of the population's growing income and the urbanization of less developed countries;
- Utilization of cereals and other agricultural products in the production of fuel;
- Operations in the financial markets;
- Crop failures caused by weather;
- Low level of cereal stocks, a result of the governmental policy changes or crop failures;

These elements may be divided into two separate groups: elements associated to market fundamentals – supply and demand of agricultural commodities - and financial elements, such as the relationship between the futures and spot markets. The role of both groups of elements will be explained in more detail throughout this work by means of a review of economic literature and the building of stylized appropriate empirical facts and models.

According to critics of biofuels, the greater search for agricultural products for energy ends may have caused tighter competition for planting areas. Moreover, the expansion of biofuels may have directed part of the production destined to food consumption to fuel refineries.

However, it's necessary to be attentive to a normally overlooked question approaching the theme by the workers[2]. The relationship between biofuels and food prices may be extended as a two-way relationship. This means if the biofuel production can reduce food production, the relationship could work in reverse mode when food production may reduce the production of biofuels. This second mechanism must be especially important in the event biofuel production really becomes an accepted alternative to fossil fuels.

In effect, the energy question, or rather, the price of petroleum is always associated to an agricultural production by a one-way channel of costs, providing materials to produce fertilizers and for the production and outflow of agricultural production. When different agricultural commodities also become used as an alternative source of energy, responding to a concern with alternative renewable sources that may replace petroleum, the food and energy productions become linked by an arbitration mechanism between these two alternative uses of land. Large ruptures on any side of the relationship may cause shocks and adverse prices. It is sufficient to remember the effect on prices of the petroleum crises in the 1970s.

[1] The Food Price Index: is a measurement of the price index from the five groups of commodities followed by FAO (meats, morning products, cereals, oils and fats and sugar) considering the average shares of exports in each group during 2002-2004.
Grain Price Index: compiled by the grain and rice price index taking into account their shares of commerce during 2002-2004.

[2] Exception is the study by Ciaian and Kancs (2011)

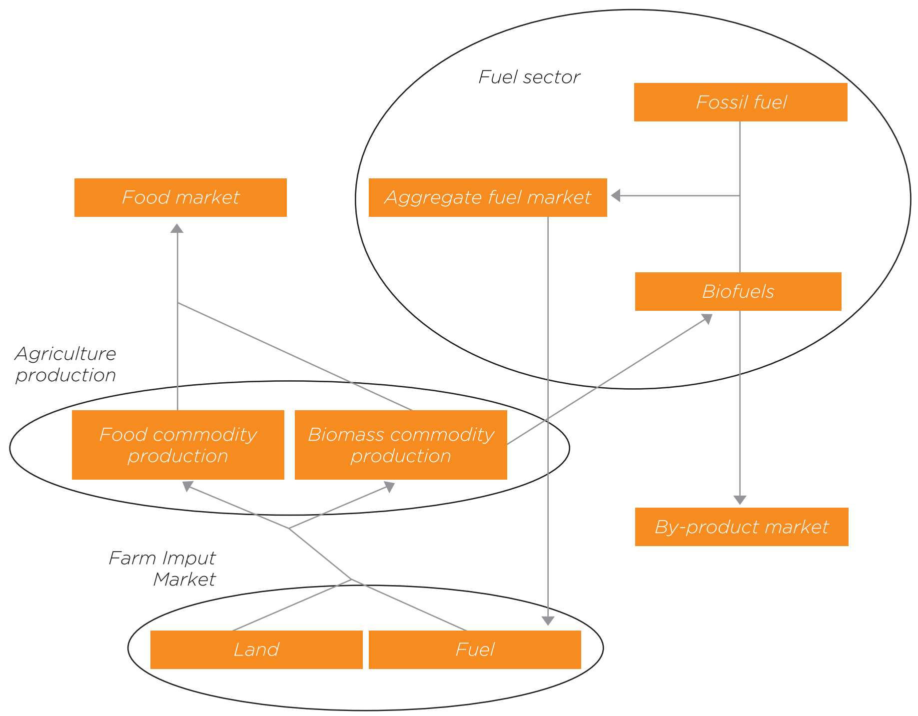
This phenomenon is relatively well known in Brazil, a country that precociously adopted a biomass energy production program: ethanol production by means of sugar cane.

Thus, in the case of Brazil, when the price of ethanol is attractive, the production of sugar cane mills is directed more to the production of ethanol than to sugar. On the other hand, when the price of sugar becomes relatively attractive, the production shifts to this product, reducing ethanol production. Having responded to questions of a regulatory nature with respect to the requirement of a minimum mixture of ethanol added to gasoline, the result of this is that when the price of ethanol fuel increases, part of the demand for the product is substituted by gasoline due to the large share of biofuel cars in the national fleet. For no other reason, which was obtained from the results of this work, the supply of ethanol responds strongly to the share of flexfuel cars in the national fleet.

To summarize, since sugar cane ethanol became consolidated in Brazil as a viable alternative of fuel, the two-way relationship proposed herein became clear. Unfortunately ethanol is not a good substitute for diesel oil. If it were, this relationship would be crystal-clear, since diesel is both a direct material for agricultural production and a product derived from said production: biodiesel. However, other cultures prove to be very promising for biodiesel production. This is the case of palm oil, briefly analyzed in this update of the FGV Projects study.

The Figure below, extracted from Ciaian and Kancs (2011) helps to clarify this relationship. Generally speaking, it summarizes the possible impact channels of Biofuel production in the food markets (spot and futures) in two: (i) the indirect channel of availability and costs of materials, notably land and fuel; and (ii) the direct effect of allocating part of agricultural production (called biomass) for the purpose of biofuel production.

Figure 2: Impact Channels – Biofuels and Food



Source: Extracted fax from Ciaian and Kancs (2011)

One of the main studies, which had a good initial repercussion and which concluded that the impact of biofuel production was one of the main factors responsible for the increase of food prices between mid-2007 and 2008, was carried out in the scope of the World Bank (Mitchell, 2008). According to this study, 75% of the increase in food prices could be attributed to the expansion of bioenergy. IMF estimates conclude, following this line, that the increase for demand of biofuels would be responsible for 70% of the increase taken place in the price of corn and 40% of the increase in the price of soy (Lipsky, 2008). On the other hand, the US Department of Agriculture (USDA) arrived at very distinct conclusions: in which the weight of factors show an impact from biofuel production on food prices, but this impact would have been small (Reuters, 2008). According to the USDA, only exactly 3% of the 40% increase in food prices would be attributed to the effects of biofuel production. The European Commission argued along these lines that biofuel production would not have created such an impact on food prices, since only 1% of European cereals production has been used to produce ethanol, "a drop in the ocean", as the memorandum itself highlights the topic (European Commission, 2008, p.7).

It should be emphasized that in 2010 the World Bank produced a new study (Baffes and Haniotis, 2010), that addressed correction of the conclusion in the 2008 study and then gave more importance to financial speculation in futures markets as a factor explaining the crisis of food prices:

> *"... the effect of biofuels on food prices has not been as large as originally thought, [but that] the use of commodities by financial investors (the so-called "financialization of commodities") may have been partly responsible for the 2007/08 spike."*
>
> *(Baffes and Haniotis, 2010).*

Nevertheless, the World Bank argues that there is a significant connection between prices of energy commodities and non-energy commodities and this is due to a relatively important determinant of the food market dynamics in the near future. In the explanations of the 2008 crisis in food prices, the World Bank study highlights that there was a combination of adverse climatic conditions which significantly reduced the supply, and simultaneously the conversion of lands for biofuel production had an effect, but its concern is above all with corn in the USA and the edible oils in Europe:

> *"In the case of agricultural commodities, prices were affected by the combination of adverse weather conditions and the diversion of some food commodities to the production of biofuels (notably maize in the US and edible oils in Europe). That led to global stock to use ratios of several agricultural commodities down to levels not seen since the early 1970s, further accelerating the price increases."*

On the other hand, a controversial question in economic literature refers to the possibility of having a significant distancing between agricultural commodities prices in futures markets and the prices in the spot market, which should reflect market fundamentals. However, there have been some important advances both in the formulation of economic models, such as the empirical evaluation of a hypothesis of a lasting distancing between futures prices and spot prices. These advances allow the possibility of this price discrepancy having its own grounding in the speculation activity.

One example is the recent study by Lagi et al (2011) which argues that the brusque transactions that led to price peaks in the 2008 crisis – and again in 2010/2011 - are consistent with dynamics typical of speculation bubbles and that the confirmation that speculation would be at the heart of explanations of these crises requires a quantitative model for price dynamics which directly incorporates the role of speculators. Lagi et al (2011) thus build a dynamic model of supply and demand in which there is also the speculators' participation. The model describes the trend-following behavior and may produce explicit dynamics of the bubble-crash type.

In this model, if the well-informed investors believe that supply and demand are at odds, there is a force that offsets this effect in order to obtain an equilibrium price. When prices are above equilibrium these investors sell, and when it is below, they buy. The alternation between the types of dynamics of the trend-following type and the restoring of the financial equilibrium of fundamentals may produce different types of results, depending on the relative importance of each agent in each situation. For a sufficiently large number of speculators participating in the market (as opposed/expense of the agents' shares who operate only seeking protection, i.e., hedge); the trend-following behavior may lead to a very big discrepancy between the current prices and those equilibrium prices between supply and demand. Moreover, as this gap increases, the equilibrium restoration forces enter into action, and are then accompanied by trend-following behavior, reverse direction, which is to reassume the fundamentals (even able to go beyond the equilibrium point).

The quantitative analysis conducted by Lagi et al (2011) brings results contradicting in large measure the belief that biofuels are the big villains of the food prices crisis. Moreover, it reveals that biofuel production which has some impact on food prices is that regarding ethanol produced from corn:

> *"Here we provide a quantitative model of price dynamics demonstrating that only two factors are central: speculators and corn ethanol"*
>
> *(Lagi et al, 2011 p. 2).*

In effect, the authors disclose that the corn-ethanol conversion sets the tone for the long term tendency underlying the behavior of food prices, while the speculative activity explains the dynamics of strong oscillations in crisis periods.

Huang and Ho (2011) make an interesting analysis of the effects of adopting pro-biofuel policies, based on four legislative changes which took place in key countries: Brazilian laws at the end of 2004 (and early 2005) about biodiesel, the Energy Policy Act dated August 2005 and the Energy Independence and Security Act dated December 2007, both in the USA and, finally, the European package of laws changing energy and climate regulations dated March 2007. The authors divide the period of analysis into four sub-periods in order to test the effects of these legislative changes. Their finding supports the idea that financial speculation had an important role in the crisis over food prices:

> *"Excess demand of the world oil and food and not enough supply cause the expectation of higher oil and food prices. However, the oil and food spot prices and futures prices cannot be explained by the economic fundamental alone. In addition to the fundamental demand and supply, bio-fuel policy, speculation and investor herding can also affect oil and food spot prices and futures prices. Higher expected oil and food prices in the market draw the attention of futures speculators. Speculators predict the oil and food spot prices will increase and speculate on higher oil and food futures prices. In addition, the speculators use one oil/food futures price change to predict another oil/food futures price change. Therefore, an oil/food futures price is used to be the predictor variable of another oil/food futures price. Investors in the futures markets herd together. Herding behavior of followers in the oil and food futures markets intensifies the causalities of oil and food futures prices. In the early time periods, followers have a passive long strategy and drive the oil and food futures prices upwards. This phenomenon is more serious in the first period and gradually fades away in the following periods."*
>
> *(Huang and Ho, 2011, p 172).*

Huang e Ho (2011) then concluded that the pro biofuels policies cannot be responsible for the spike in oil and food prices:

> *"If it is the bio-fuel policies that cause higher oil and food prices, there should be more and more Granger causality relationships in these four periods. No evidence is found to show that the bio-fuel policies cause higher oil and food prices."*
>
> *(Huang and Ho, 2011, p. 172).*

In view of recent suspicion cast with respect to the influence of biofuels on food prices and the intense debates on this theme, it is fundamental to understand how and why the historical tendency of food price changes has occurred, which forces drove the prices up of agricultural commodities, as well as what will finally be the importance of biofuels in this process. This is the intention of this work which is organized as follows: the next section discusses what the main determinant factors are for food prices, while the third section will carry out an empirical analysis to illuminate the role of each one of these elements on the observed variation of prices in recent years. In the final section the main conclusions obtained from the study are listed.

II

DETERMINANT FACTORS – SUPPLY AND DEMAND

Whereas we have witnessed the exceptional performance of the Asian economies, especially those of India and China, the world demand for food has experienced a strong increase in the last decade. With improving income, the nutritional standard in the developing countries changed rapidly, and the diet composed almost exclusively of cereals was substituted by another one that is richer in animal protein.

The growth rhythms of income and population certainly were central elements in the expansion of agricultural products consumption. However a third element has recently been added to them and it is capable of increasing demand for different agricultural commodities: agroenergy. This new factor is nothing more than an answer to the growing international concern over environmental problems – the search for renewable energy sources has become strategic.

2.1

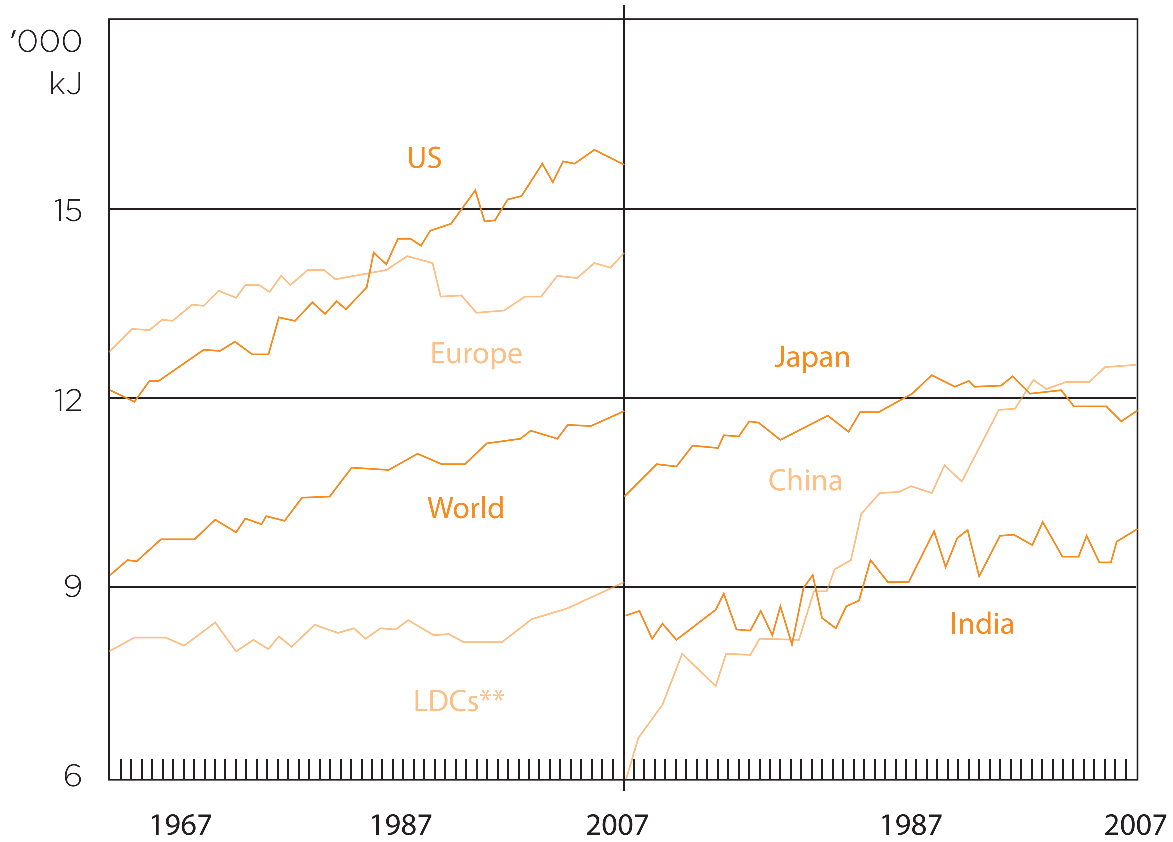
DEMAND - INCOME, POPULATION AND FOOD CONSUMPTION

Since the mid-twentieth century the nutritional levels of the world population, especially in developing countries, have grown strongly. As mentioned in the previous FGV Projects study, between the 1980s and the current period, the availability of protein increased from 40 to 70 g/inhabitant/day and calories from 1,950 to 2,680 kcal/inhabitant/day. In China the current consumption is 3,000 kcal/day and 50 kg of meat/year.

The following Figure, extracted from Rayner, Laing and Hall (2011) shows the progress of average energetic consumption in the developed countries and the rapid growth of Asia, confirming the rapid increase in daily food consumption for large sections of the population.

The increase in income level observed by the developing countries in the last decades tends to change the diet of the population, which abandons the direct consumption of grains and begins to eat more meat and morning products. The Figure shows, for example, that the daily level of Kilojoules (a unit of energy) ingested by China surpassed that of Japan and is now approaching levels consumed in Europe and in the United States.

Figure 3: Daily Food Ingestion (per capita)*



** Data represent the caloric value of food supplied to retail and for families, divided by the total population;*

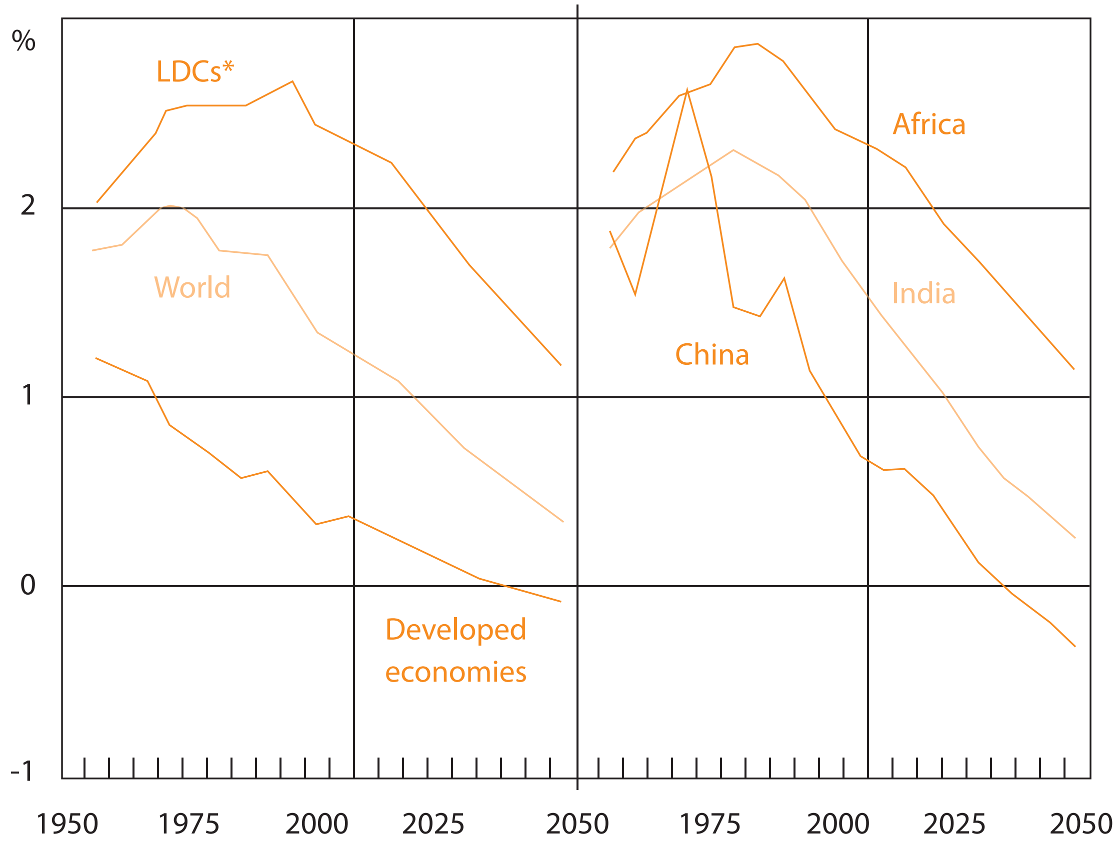
*** Less Developed Countries – 49 Underdeveloped countries*

Source: FAO, RBA. Extracted fax from Rayner et al (2011)

Although the population growth rate should decrease in coming decades, as shown in Figure 4 below, the absolute size of the population, coupled with a greater number of people at an economically active age – which increases income and consumption – will keep the demand for food at a high level

One may also note in the same Figure 4 that the expected population growth rate of developing countries is greater than in the developed countries, as the first group of countries is still passing through strong urbanization processes – and may also expect a scenario of high demand for food.

Figure 4: Population Growth Rate (Annual 5-year average)



** Less Developed Countries – 49 underdeveloped countries*

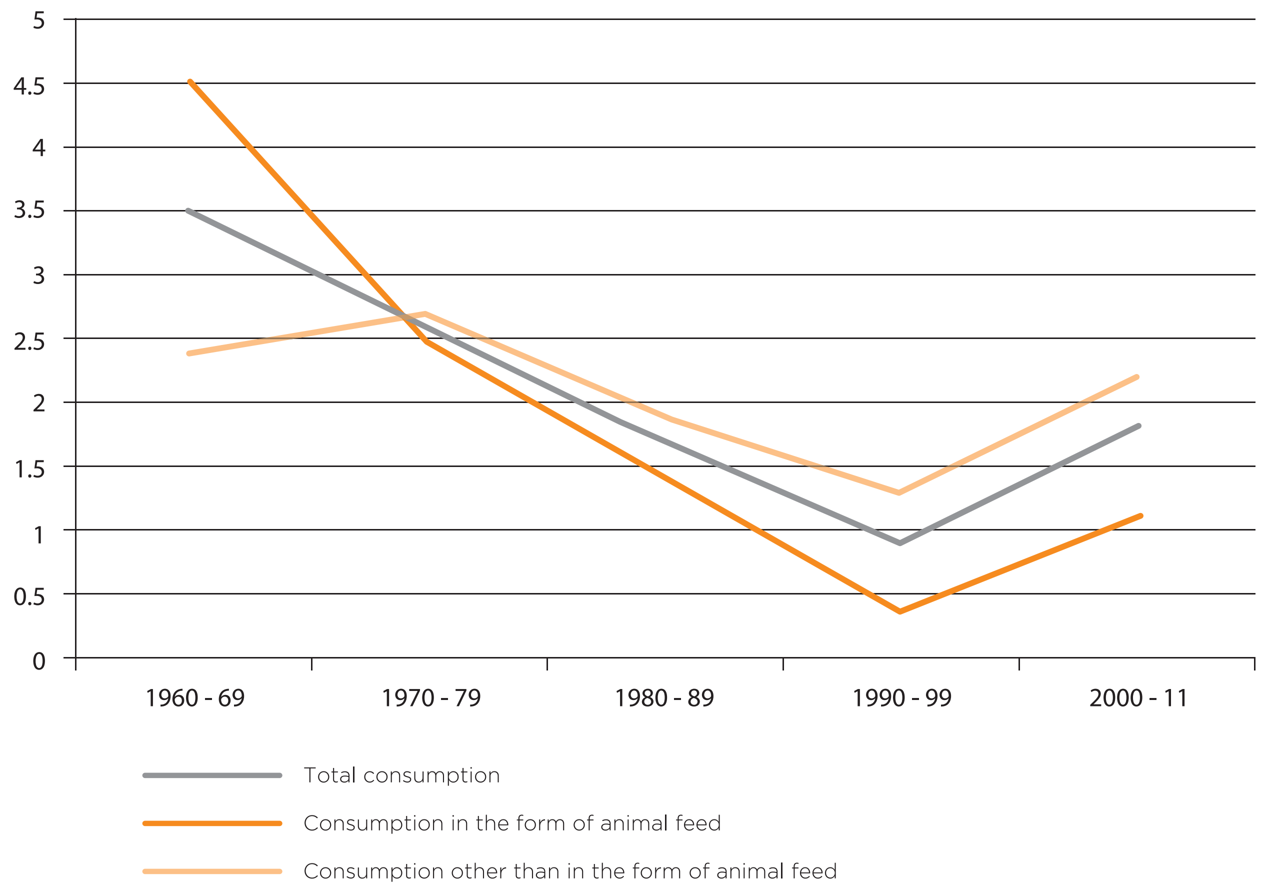
Source: United Nations. Extracted fax of Rayner et al (2011)

One may see that the demographic phenomena and rising income will continue to pressure the demand for food. According to the report "Global Economic Prospects" by the World Bank , the perspectives are that in the next few years income will grow an average 4.4% worldwide (GDP real PPP) per year and 6.3% per year in developing countries (6.3% GDP real) (World Bank, 2011) [3].

In a recent report (HLPE, 2011), the Global Committee for Food Safety of the FAO confirmed that the role of income growth tends to be small in terms of capacity that explains the rise in food prices. In this report, the FAO specialists show that the growth rate of cereal consumption, excluding soy, was much less in the first decade since 2000 than in the 1960s and 1970s and is equal to that verified in the 1980s. There was an increase in the growth rate in the 1990s, but small. The report also details that cereal consumption for animal feed increased slower than direct consumption as one may verify in the figures.

[3] *The averages are for the period 2011-2013.*

Figure 5: World Cereal Consumption Growth Rate

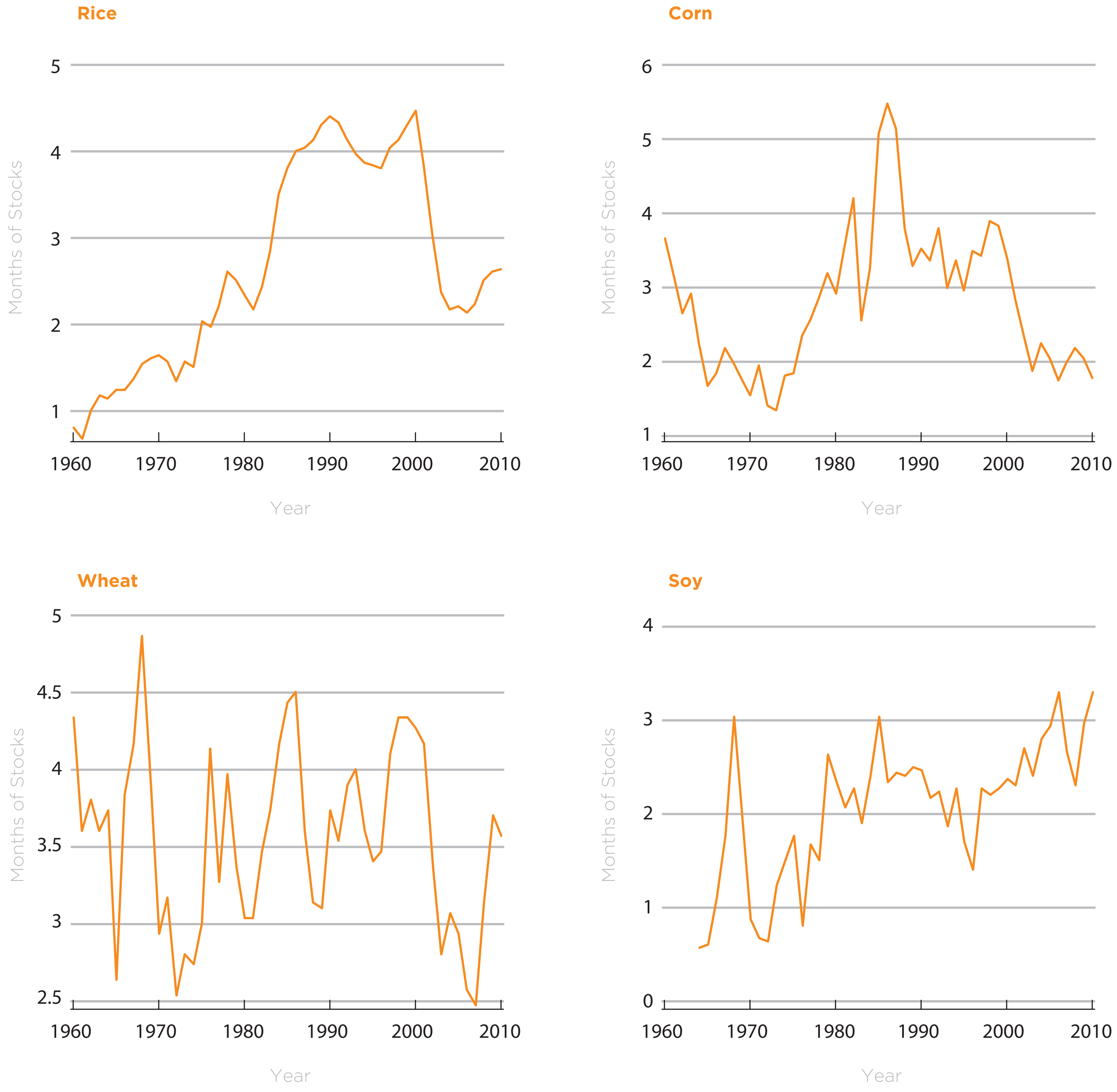


Source: HLPE (2011)

However, one sees a problem in this argument. There was exaggerated concern about the exclusive consumption of cereals and soy excluded from the analysis. If this product had been computed, since this addresses agricultural production for food, the result would certainly be distinct, since there has been a substantial growth in the consumption of this product, widely employed as animal ration. This is even consistent with the previously mentioned diet change resulting from economic and demographic questions, especially in the Asian countries.

In any case the growth in demand (for grains) is also reflected in the reduction of stocks of agricultural commodities. The following figures show the progress of stocks – in terms of months of consumption – for four of the most important grains on the international market: soy, wheat, corn and rice.

Figure 6: Stocks of main commodities on the internacional market (in months)



Source: USDA

As one can see in the diagrams above, most of the grain stocks are found below their normal averages, with the exception of soy, whose stocks presented a growth tendency in the last 30 years. All other agricultural commodities show lover levels than those observed throughout the 1980s and 1990s. Corn stocks, for example, a product widely converted into ethanol and one of the main targets of critics when speaking about food safety and biofuel production, have fallen from levels close to 3 to 4 months of consumption throughout the 1980s and 1990s to only two months in early 2000.

A similar phenomenon has occurred with the stocks of rice, although the current levels of this product are compatible with those observed in the early 1980s, and with wheat, whose stocks have shown a strong volatility, but the current levels recovered the three and a half months of consumption verified in the first half of the 1990s.

The agricultural products highlighted above are relatively and easily stocked and, thus, the behavior of the stocks is fundamental to understanding the role of the speculative activity on their prices. Therefore it is important to highlight that the charts above show what the specific period of the food prices crisis (2007-2008) is and there is a significant drop in the stocks of the four products under study, without exception (including soy).

In summary, the background of rising food prices in 2007 and 2008 includes the growth in demand (already initiated in previous periods) and a reduction of worldwide grain stocks. Likewise, the rising costs of fuel and lubricants and the loss of the US dollar's value after 2001 helped to prepare the scene for what was to happen.

However, it should be noted that the strong growth in demand encompassed a quite longer period than 2006-2008. The spike in demand was constant during the whole decade and may not be indicated as the immediate cause of the food crisis.

2.2

SUPPLY: BIOFUELS AND FOOD

Figure 2, shown previously, illustrates the channels of influence between the energy and agricultural commodities. It's most important finding is that the effect of fuel prices vis-à-vis food prices should not be understood as a one-way street. In effect, even before the biofuel question dominated the debate about food safety, fossil fuel prices had already strongly influenced food prices, since petroleum had always been an important ingredient in modern agricultural production because it constitutes a relevant ingredient to produce fertilizers, because diesel oil is an important fuel in the production and distribution of agricultural commodities.

The recent popularization of biofuels simply made a second channel of influence more visible, since now different agricultural commodities are also accepted as sources of energy and not just food. One may note that this transmission channel is a direct result of concern with renewable energy sources that substitute fuels derived from petroleum. The point should be emphasized that biomass energy does not involve only biofuel production, but also produces energy, for example, by the burning of sugar cane bagasse. This equally favors agricultural growth and will do so in the future development of countries producing grains and other raw materials for energetic ends.

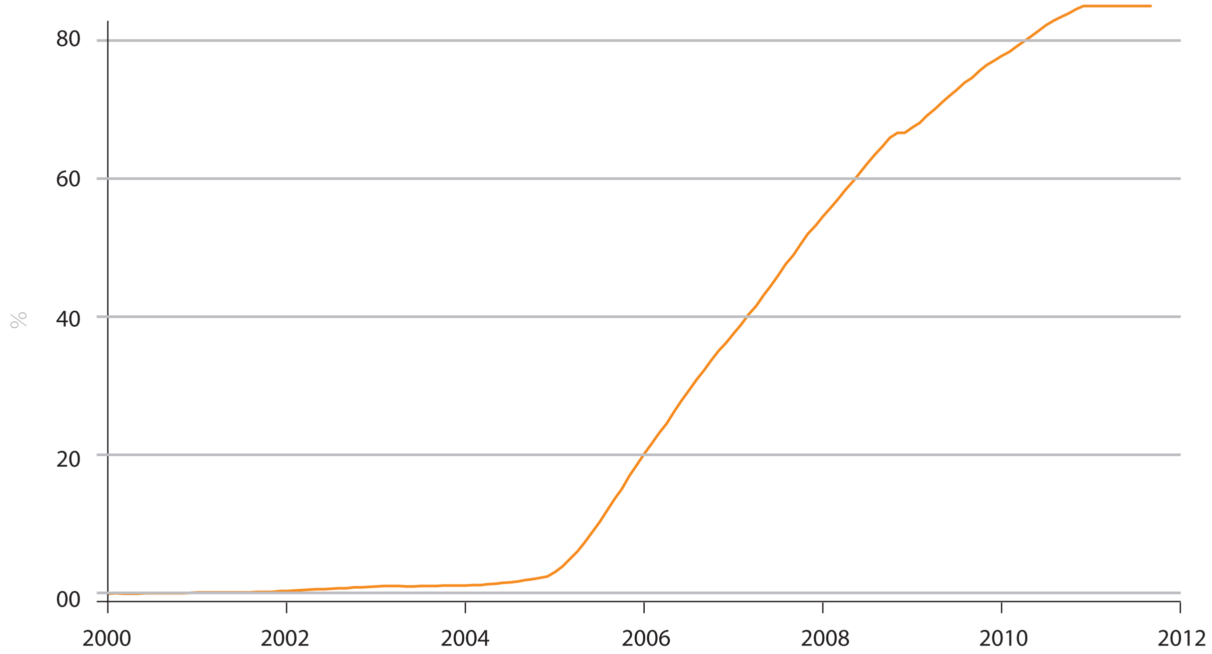
In fact, important effects already exist in world agriculture in view of the demand provoked by the increase in biofuel production. The production/consumption of agricultural goods had as a main fundamental to meet the food needs of the population. Thus this grew at an accelerated rhythm primarily because of demand in developing countries with the Asian nations standing out. However, more recently it received the challenge of also supplying renewable energy. The petroleum prices spiked – and its effects on growing economies dependent on it – but the world concern with the environmental impact caused by the burning of fossil fuels – created an environment favorable to the employment of biofuels, such as biodiesel and ethanol.

As mentioned in the introductory section of this work, these two-way channels of influence have already been perceived for a long time in the case of Brazil, since the country has one of the oldest programs of biofuel production by means of ethanol from sugar cane. In this case, the strong correlation is known between the prices of ethanol and sugar derived from sugar cane and that, in the absence of an artificial arbitration mechanism, the production of one or the other product changes in favor of that supply of the best return to the producers.

Therefore, when the price of ethanol is attractive, the production of sugar cane mills is oriented to produce more of this product at the expense of sugar production. On the other hand, when the price of sugar becomes relatively more attractive, the production changes to this product, reducing the production of ethanol. Having responded and met the questions of a regulatory nature with respect to the requirement of the minimum mixture of ethanol to gasoline, the result of this is that when the ethanol fuel price rises, part of the demand for the product is substituted by gasoline due to the high share of biofuel cars in the national fleet. For no other reason than that obtained among the results of this work, the supply of ethanol strongly responds to the share of flexfuel cars in the national fleet.

The Figure below, which illustrates the reasoning mentioned above, shows that the share of flexfuel cars reached more than 80% of the national fleet around 2010. In other words, except in the case of Brazil, agricultural production and energy production are already intimately related. What is sought to be shown throughout this work is that this may occur without loss to food production.

Figure 7: Participation of flexfuel vehicles in Brazil



Source: ANFAVEA

Both the type of biofuel and the raw material employed in its production vary among countries. Biodiesel substitutes diesel oil, and ethanol substitutes gasoline. In the case of ethanol, corn is used in the USA, sugar cane in Brazil and wheat in Europe. For biodiesel, the variety is greater: soy, palm, rapeseed, canola, sunflower, cotton and raw materials of animal origin, such as beef tallow. Unfortunately ethanol does not constitute a good substitute for diesel oil. If it did this two-way street relationship between agricultural production and energy production would be even clearer, since diesel is both a direct ingredient for agricultural production such as derived products in the case of biodiesel. However, other cultures prove to be extremely promising to biodiesel production. This is the case of palm oil, analyzed in this update of the FGV Projects study.

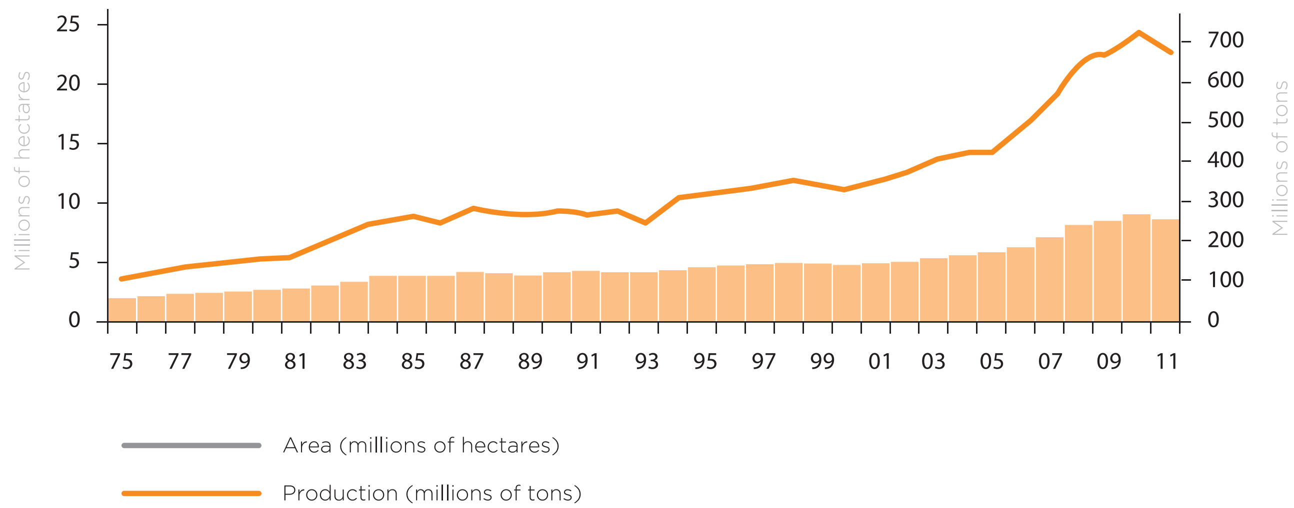
The argument of biofuel critics is that there has been a substantial increase in the search for agricultural products for energy purposes, which has stimulated greater competition for planting areas and also a deviation of agricultural production from the production of food to fuel refineries. These two conditioners, according to the thesis, have brought about an increase in food prices.

As mentioned above such arguments must become relative to the different cultures, their productivities and other production conditions. Thus it would be possible to increase biofuel production without compromising food production, even those commodities whose problem of food-energy conversion is more direct, which is the case of corn, but not sugar cane.

On the other hand, there is no way to deny that the price and the use of land reflect its costs of opportunity. Productivity increases also involve the use of more productive lands which should be reflected in their prices. The following Figure shows the development of top grade land prices[4], ready to cultivate and of virgin land (with original native vegetation) in the State of São Paulo, an important sugar cane producer.

This means that in a scenario in which the demand for food (and for sugar) is high, each agricultural region must be occupied with the cultures best adapted to that region and that ensures the best return. Nevertheless, in the case of Brazil in 2008, only 1% of arable land was used for the production of sugar cane ethanol, according to Macedo and Seabra (2008). The ethanol production grew rapidly until 1985 with the implementation of the stimulus program for production (Pro-Alcohol) and remained basically unchanged up to 2002. The following figures show the progress of area planted with sugar cane, the production of sugar cane and the productivity per hectare of culture.

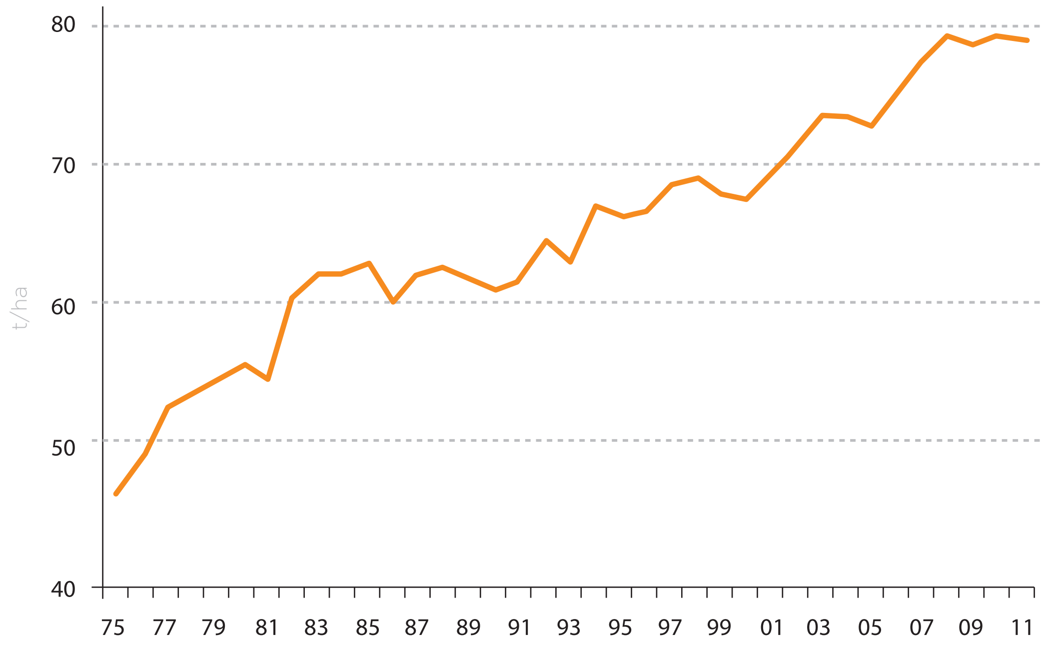
Figure 8: Progress in production and area planted with sugar cane in Brazil



Source: MAPA and IBGE

[4] *As defined by the Agricultural Economics Research Institute of the State of São Paulo, this is potentially suitable for annual crops, perennials and other uses that support intensive management of cultivating practices, soil preparation, etc. It is land of average and high productivity, suitable for mechanization, flat or slightly hilly and the soil is deep and well drained.*

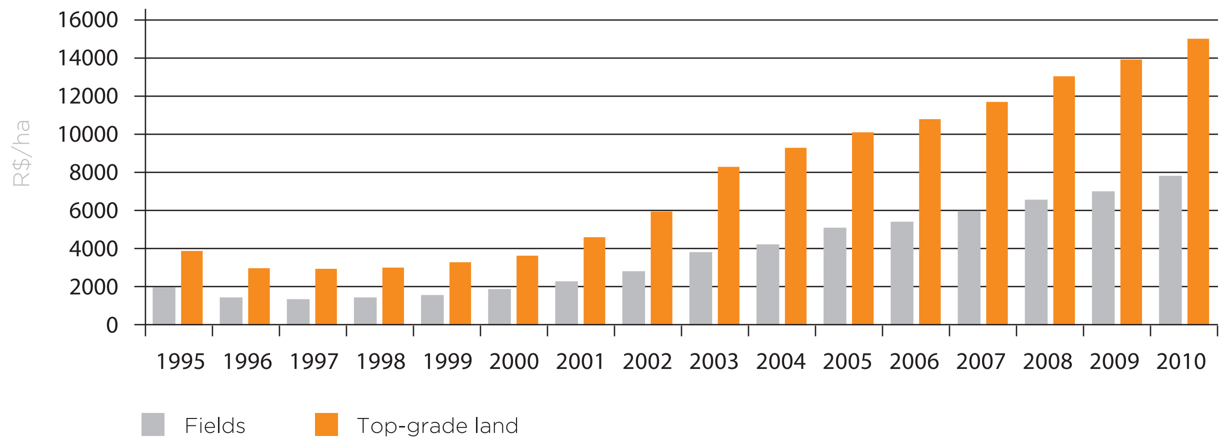
Figure 9: *Progress of productivity of sugarcane*



Source: MAPA and IBGE

As one may observe, the increase in planted area is less than the production increase, mainly in 2005-2010, which shows the high productivity gains of the culture in the period. In effect, the productivity of the culture practically doubled in the last decades which reflect, among other factors, the use of lands with better productivity and new cultivation techniques. The lands of the State of São Paulo for no other reason are the main producers of sugar cane, and have had reasonable price increases, mainly during 2000-2010. The Figure below illustrates this fact.

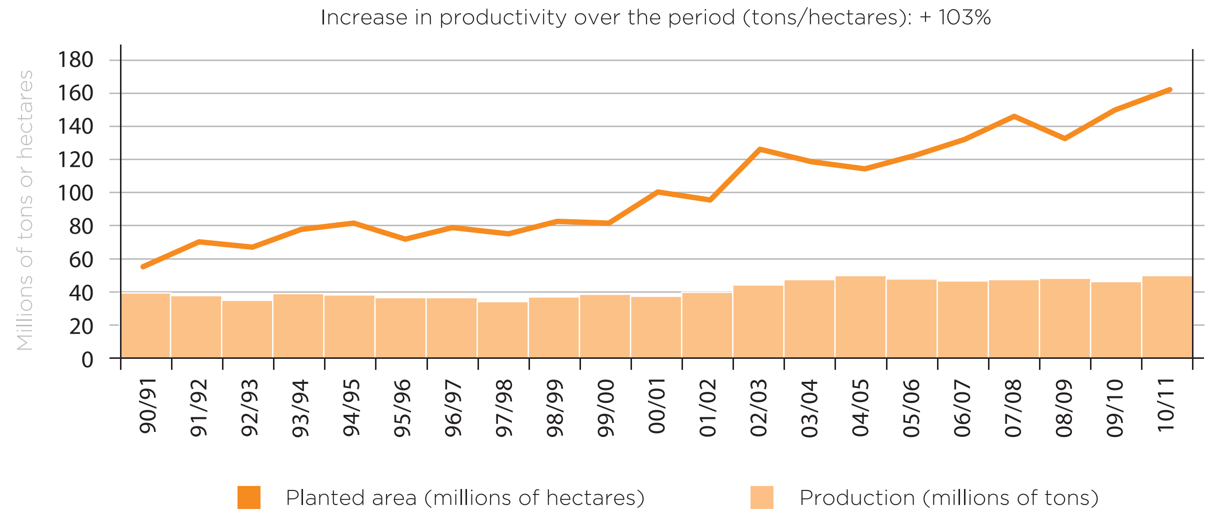
Figure 10: *Progress in the nominal price of land – State of São Paulo*



Source: IEA/SP

What's more important in the case of Brazil is a phenomenon similar to what happened with the other grains; the increase in planted area is small, but the increase in production is very big, which means a radical increase in productivity in the cultivation of grains. The Figure below illustrates this fact.

Figure 11: *Progress in planted area and grain production in Brazil*

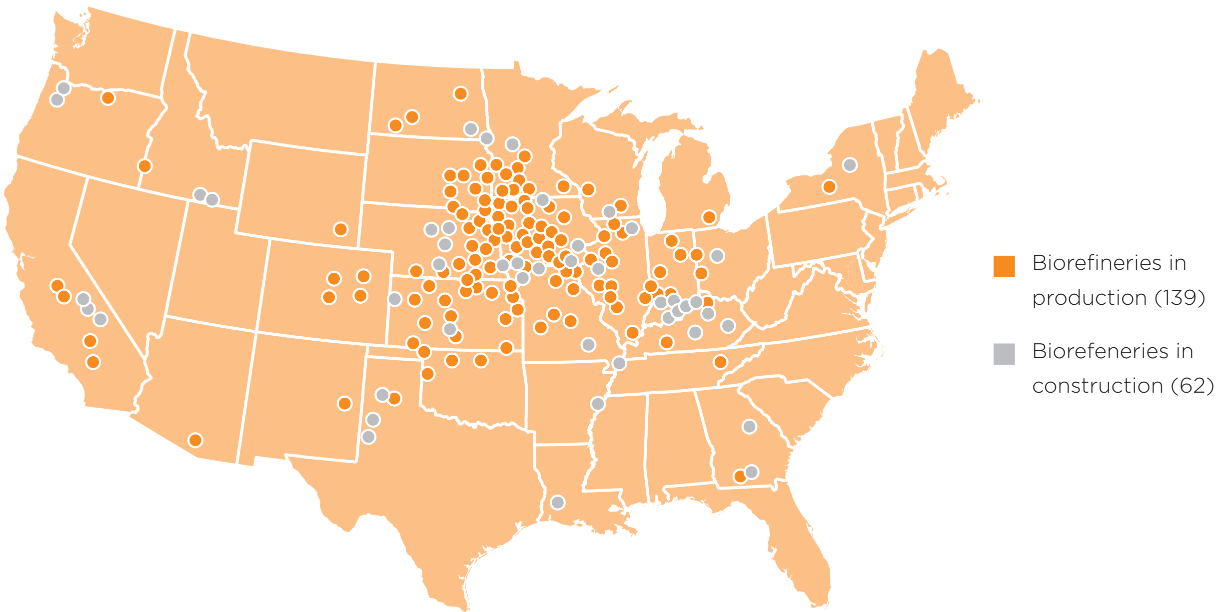


Source: Conab

Such factors allow the conclusion of total production expansion of sugar cane, and consequently ethanol and sugar production without compromising the production of the other grains.

This situation is different in the case of ethanol produced from corn in the USA. The USA Department of Agriculture (USDA, in English acronym) estimates that in 2007/2008 83 million tons of corn will be processed to produce ethanol, equivalent to about 25% of the US harvest, estimated at 340 million tons in 2007. The following Figure presents a geo-referenced map with corn production and the ethanol mills in the USA.

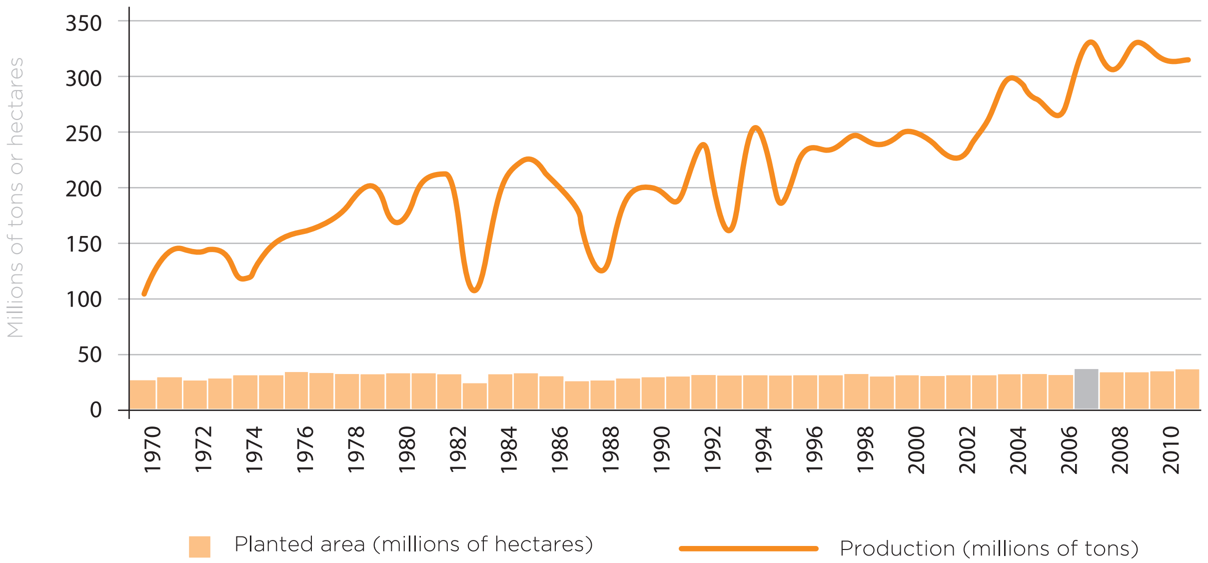
Figure 12: Corn Ethanol Refineries in production and under construction in the USA



Source: Renewable Fuels Association

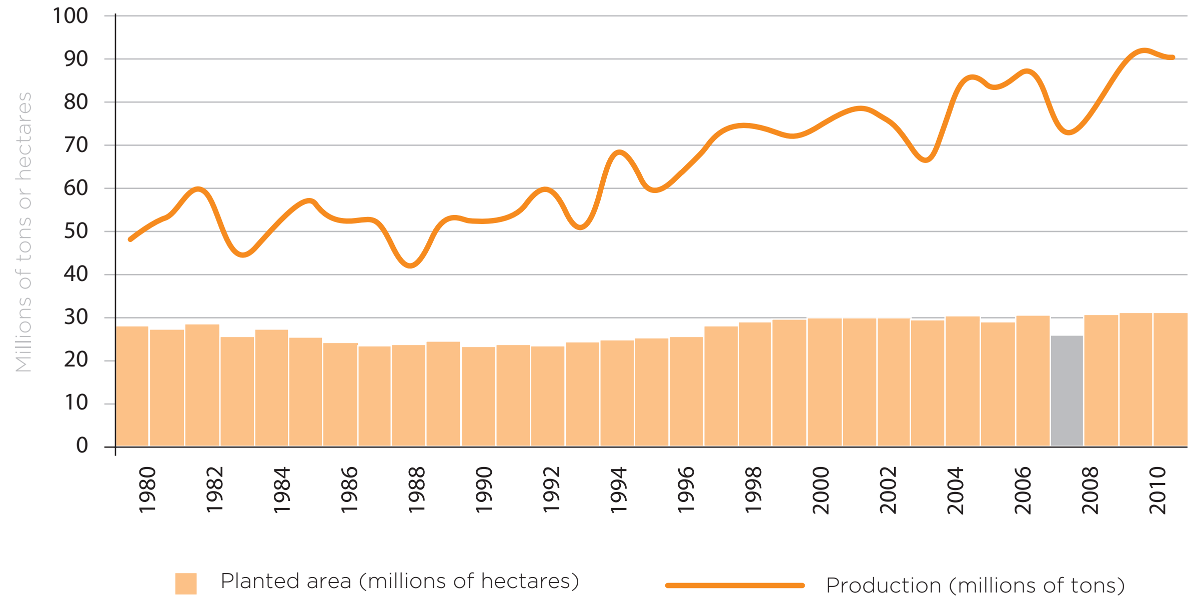
In the case of the United States, the changes in land use associated with an increase of area dedicated to the production of raw materials for biofuels led to a rapid reduction in production of other cultures. The area dedicated to corn production increased approximately 23% in 2007 in response to a spike in corn ethanol production. Such expansion led to a contraction of 16% in area planted with soy, leading to a large increase in US soy prices between April 2007 and April 2008 (Mitchell, 2008). The Figures below show the progress in planted areas and corn and soy production in the USA.

Figure 13: Progress of planted area and corn production in the USA



Source: USDA Data

Figure 14: Progress of planted area and soybean production in the USA



Source: USDA Data

The case of Brazil is also perceived herein as quite distinct from that of the US. According to Mitchell (2008), Brazilian ethanol production does not contribute significantly to the recent increase in the prices of commodities, because the sugar cane production increased rapidly, even though the sugar exports almost tripled that of 2000. The country uses approximately half of its sugar cane production for ethanol production for domestic consumption and exportation and the other half to produce sugar. The sugar cane production increase was sufficiently large to allow a sugar production increase from 17.1 million tons in 2000 to 32.1 million in 2007, besides permitting that exportation increase from 7.7 to 20.6 million tons. Brazil's participation in sugar exports increased from 20% in 2000 to 40% in 2007, and this was sufficient to maintain sugar price increases low, except in 2005 and in the beginning of 2006, when both Brazil and Thailand had bad harvests due to drought (Mitchell, 2008, p. 9).

2.3

THE ROLE OF SPECULATION

The analysis of food price variations discovers one of the controversies of economy: are the prices controlled by real supply and demand, or are they affected by speculators who can cause "artificial bubbles"?

The futures commodities markets were developed to reduce uncertainty, permitting a pre-purchase or pre-sell at known prices. In recent years, the funds permitted the investors (speculators) to bet on a price increase of commodities thanks to the deregulation of the market. The important point is to know if these investors, who do not receive the delivery of the merchandise, may affect the futures market prices. A segment of the literature denies the possibility of the effects of speculators in commodities markets. Others claim that it is possible, although there has been no quantitative description of its effect.

The rapid fall in prices in 2008, due to the crisis, increased the conviction that speculation performs an important role. For example, it was discovered that the price increase of commodities in the 1970s could not have existed simply due to supply and demand. The discrepancies between the real prices and the changes in the expected price because of the behavior of the consumption and production were attributed to speculation by several studies, but no quantitative model was provided for its effects (Lagi et al., 2011).

Many concepts relative to speculation have been discussed, in many of them inconsistently and without a focus to integrate them. We may highlight, among them:

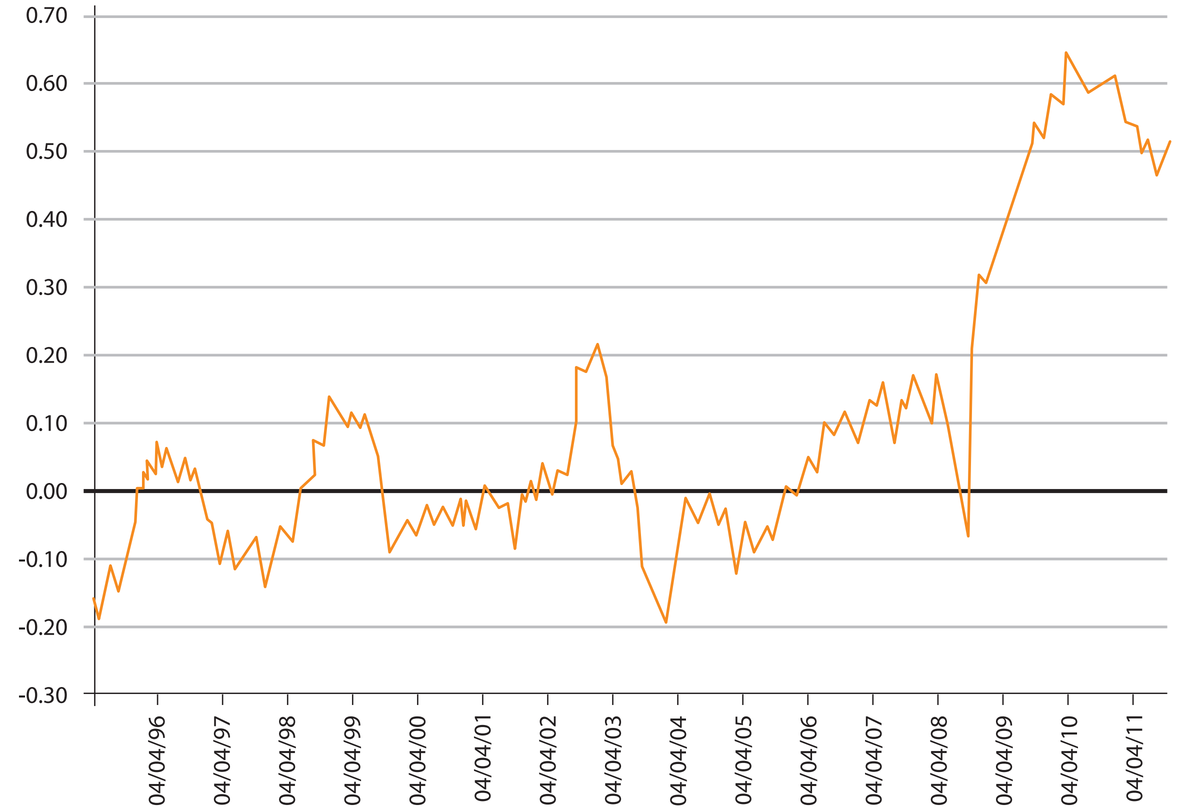
- Excessive liquidity in the markets (one of the sources of new resources in the futures markets);
- Indexed Fund Activities (the main vehicle for the entrance of these new resources into the markets);
- Speculation (a badly defined activity, but necessary for the functioning of the futures markets and, at times, a source of manipulations);
- The role of futures markets (the nerve center of mechanisms of price discovery in the commodities market);
- The role of stocks (which are more important for non-perishable commodities, such as grains);
- Speculative bubble (a quite broad term and difficult definition).

In effect, both immediately to the 2008 crisis and in the months leading up to it, a high volume of financial resources was observed in search of assets whose risks were not very correlated to the investors' portfolios at the time. In summary, one could observe three sources of resources:

- Diversification of investors' portfolios. Throughout the last decade the investment fund managers noted that the returns of assets usually selected for allocation of resources were becoming increasingly correlated. A search thus began for assets whose returns were not very correlated with the original portfolios. Agricultural commodities and gold seemed to be an alternative.
- Rebalancing investment portfolios. The rebalancing of investment portfolios fleeing assets in US Dollars added more resources to the commodities market. This rebalancing is more transient than the previous item, depending on how much time the change lasts of the investors' point of view about the relative risks of the different assets;
- Excess liquidity. The environment of low interest rates kept by many central banks resulted in excess liquidity, which in part found its way to the commodities market. It is believed that the excess liquidity was the main reason for the US real estate bubble, but this conclusion is not unanimous about the commodities market, although it is probable.

An important illustration of the phenomena discussed above is in the following figure that, for each instant of time measures the correlation of returns in the 360 days immediately previous between one of the most important index of the US stock market (S&P 500) and a commodities price index – the Thomson/Jefferies CRB Index Total Return.

Figure 15: Coefficient of correlation between returns - S&P 500 and the CRB Total Index Return Movable 360-day Window



Source: Author

The figure shows that except for specific periods, before 2005 the correlation between returns of shares and commodity prices maintained surprisingly low, even being negative for large periods. However, from 2006 on, there is an increase of this correlation, rising from approximately zero in April 2006 to 0.65 in May 2011, this increase being interrupted only by the beginning of the US financial system crisis in the second semester of 2008 (when, due to the crisis, the S&P500 performance was extremely negative).

This figure reflects the increase of the importance of investments in commodities within the global allocation of investment funds resources. At the beginning of the sample, such allocation was small and, exactly because of this, the shocks that occurred in one of the markets were hardly transmitted to the other market. However, with the transaction of large volumes of resources for commodities, shocks in the stock market led to changes in long and/or short term positions of purchase or selling commodities, causing price movements in this market too.

The most recent studies indicate that the activities related to the financial side of the commodities market may even affect in the short term the prices in the spot market; however, the long-term tendencies are usually given by market fundamentals. Thus, these activities produce greater price volatility, exacerbating the duration and variability of these cycles.

Work conducted by the Organization for Cooperation and Economic Development (OCDE or OECD, in the English acronym) approaches the possibility that the spot prices of commodities may not be a cause, but rather a consequence of futures prices inflated by the growing long position of investors.

Strong evidence of this possibility lies in growth in the 1986-2011period, of the number of contracts in the Chicago Commodities Market (CBOT) in a position bought for non-commercial traders (speculators) and their stake in the total long position contracts . The following table illustrates this development well.

Table 1: Non-Commercial Futures Contracts and Participation of Total

		1986 - Average January/April	2005 - Average January/April	2008 - Average January/April	2011 - Average January/April
CORN	Nº of Contracts	10,011	133,416	614,574	781,254
	% of Total	14.3%	25.0%	48.1%	53.6%
SOYBEAN	Nº of Contracts	12,514	65,116	243,864	313,093
	% of Total	32.5%	29.7%	49.2%	54.0%
WHEAT	Nº of Contracts	5,630	60,684	170,382	189,691
	% of Total	34.5%	33.3%	44.8%	41.2%

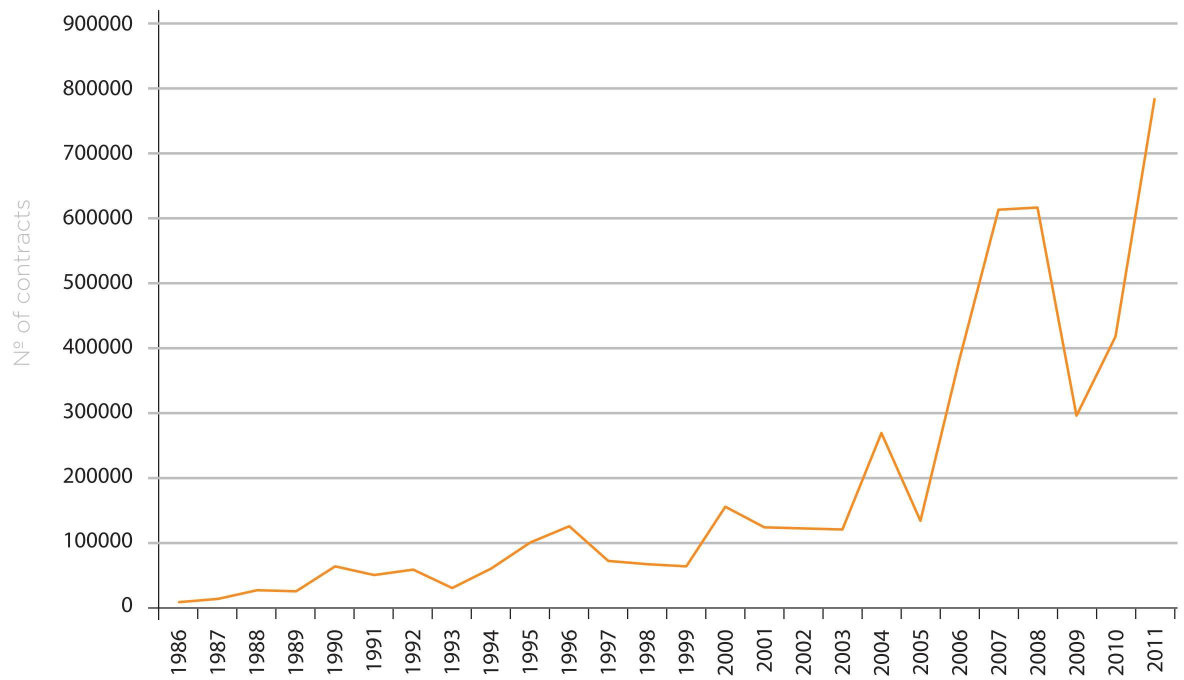
Source: CBOT

The tendency is quite clear in all cases. For the products detailed in the table, besides the enormous increase in the absolute number of non-commercial contracts, one also perceives a substantial increase of the stake of same in the total. In two cases, of corn and soy, the non-commercial contracts thus respond for more than half of the total open contracts.

The growth of positions purchased as speculation (non-commercial) in the period from January/April 2005 to January/April 2008 is significant. This growth as one knows is accompanied by an increase in food prices. The number of non-commercial contracts, as well as its relative stake in the total number of contracts, then underwent a drop in 2009, but soon afterwards grew again in importance in 2010 and especially in 2011.

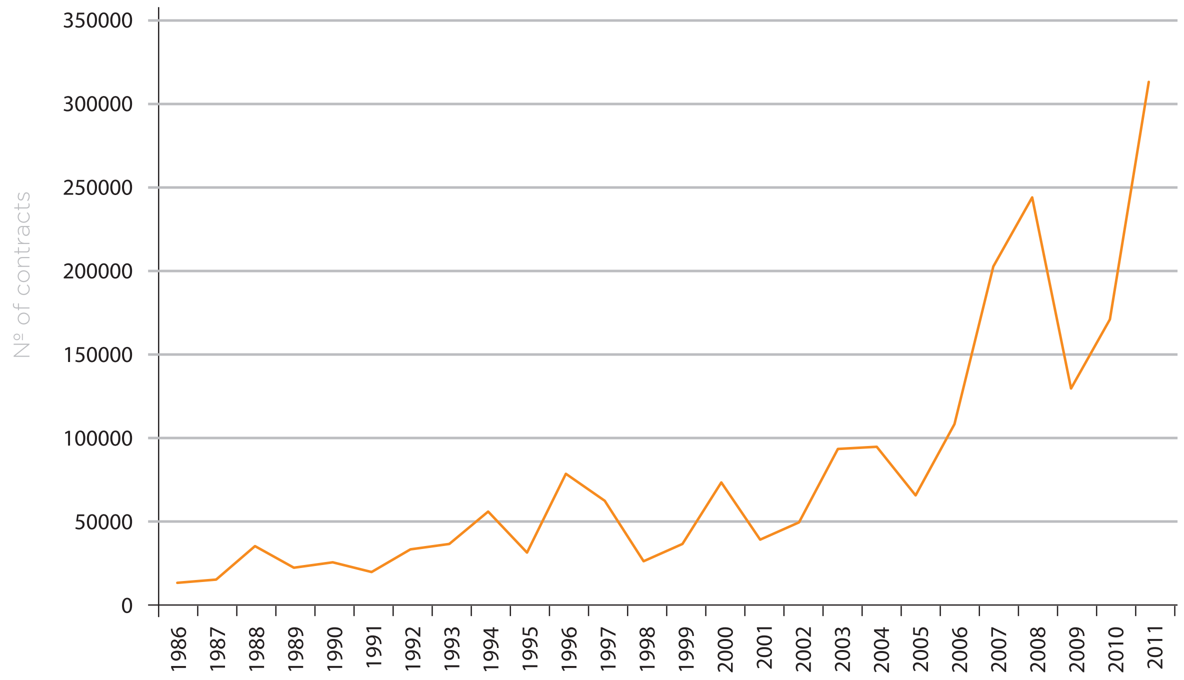
The following figures show the progress of non-commercial positions purchased and the non-commercial positions spread.

Figure 16: Non-commercial Positions Purchased – Corn



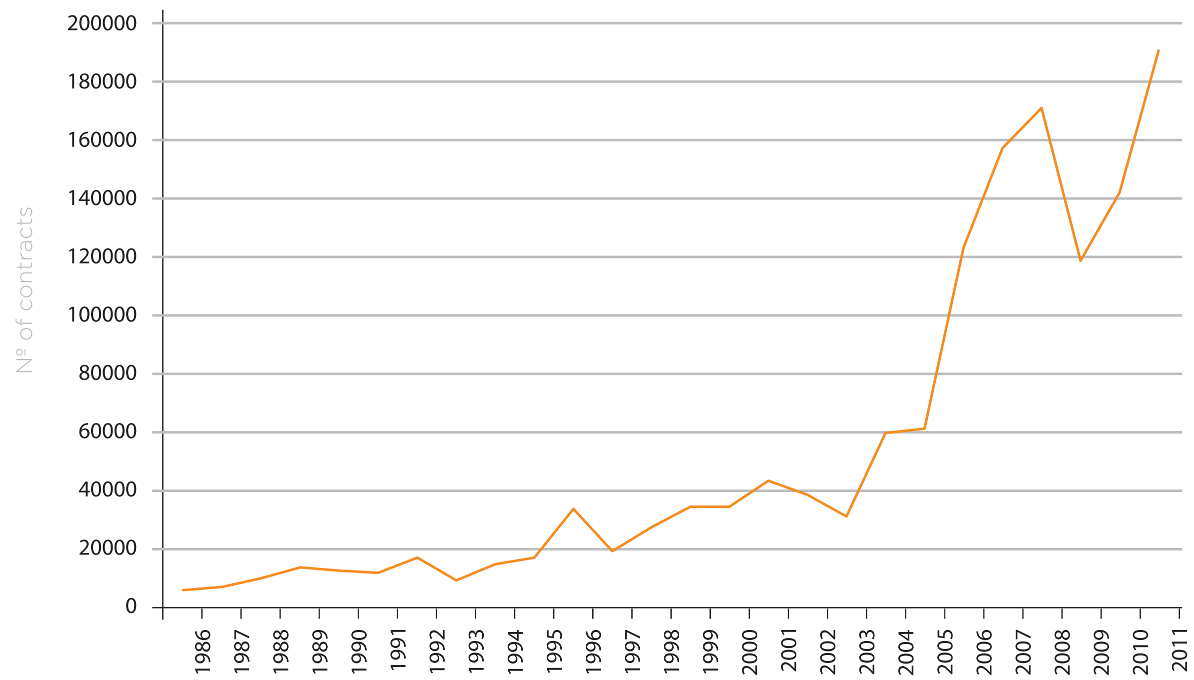
Source: CBOT

Figure 17: Non-commercial Positions Purchased - Soybean



Source: CBOT

Figure 18: *Non-commercial Positions Purchased - Wheat*



Source: *CBOT*

As one can see after the inspection of the charts above, the data clearly shows an enormous increase in non-commercial positions of the financial agents in the commodities market; however there was a shift in this trend from 2008 to 2009. In 2010 and 2011 there has thus been a recovery that led the number of these contracts to even higher levels than those verified in the food crisis period of 2007/2008.

III

CRISIS IN FOOD PRICES: FUNDAMENTALS OR SPECULATION?

In spite of having contributed to the spike of food prices during the 2007-2008 crisis, the effects of the increase in demand and the reduction of stocks were not strong enough to explain explosive behavior of the prices in that period. Therefore we should analyze the hypothesis previously raised about the possibility of speculative activity also having significantly contributed to the exacerbated increase of prices. The empirical evidence and the statistical tests presented in the following subsections support this hypothesis.

3.1

SPECULATIVE ACTIVITY IN THE FUTURES MARKETS

With respect to that said about the relationship between physical markets (spot) and the futures markets of a product, the theory widely accepted is that the futures markets become directed towards prices indicated by spot market fundamentals. Thus, a wager at the peak position of prices would be the result of prior fundamentals for each product. However, it is also common knowledge that since mid-2006 an extraordinary increase has occurred in the number of non-commercial contracts in the futures markets. Since this phenomena is interpreted as an increase of speculative activity, this is thus an increase in the market stake of agents who do not have any intention in making trades in physical markets of a product; there is then another possible explanation for the increase in food prices, one that suggests an effect in the opposite direction, which is from futures market prices to spot market prices.

To conduct a test of this type it is first necessary to define a measurement of "speculative position". The indicator chosen was the number of contracts by non-commercial agents in positions of spread negotiation (Non-Commercial Spread). This indicator originally expressed in number of contracts of 5,000 bushels, represents the position in futures and options contracts and may be obtained from the Commitments of Traders report, from the Commodity Futures Trading Commission (CFTC) [5].

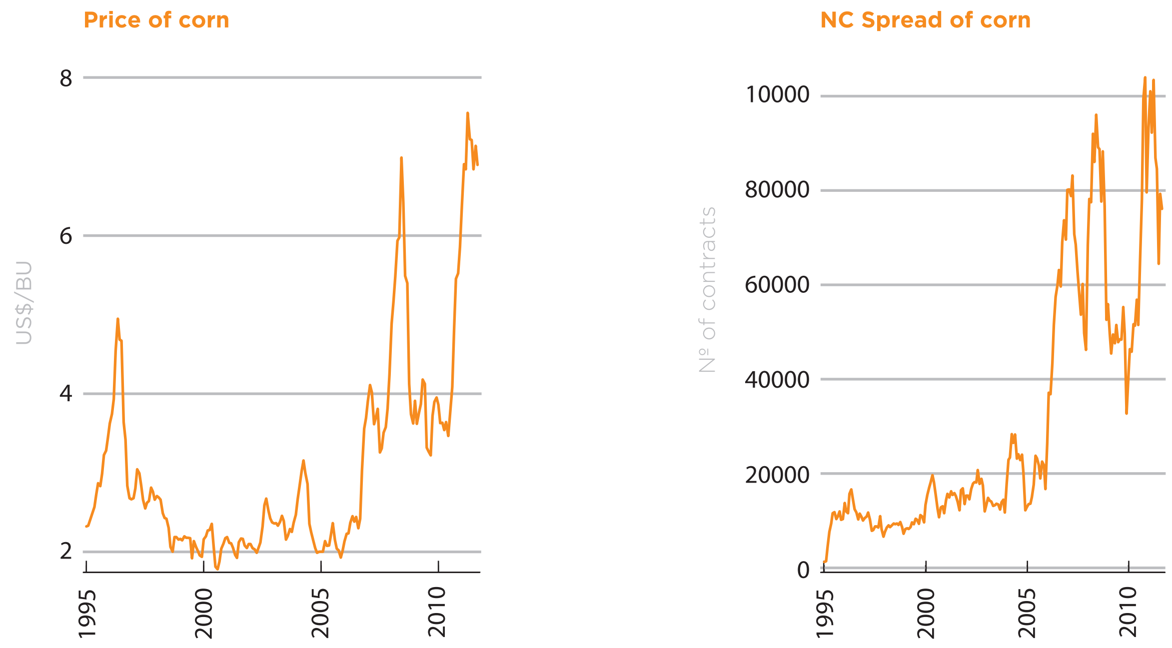
In effect, the empirical evidence illustrated by the figures above suggest that the speculative activity may also represent an important factor in rising food prices, which means there may be another explanation consistent with the observed data.

One may see in the following figures , simultaneously to the increase of corn, soy, wheat and rice prices a very strong growth in the number of position contracts purchased and assumed by non-commercial traders in the futures markets for each of these commodities.

Thus, there is material to investigate to verify if the data effectively supports the causality from the spot market direction to the futures markets, or if such causality may function in a reverse direction.

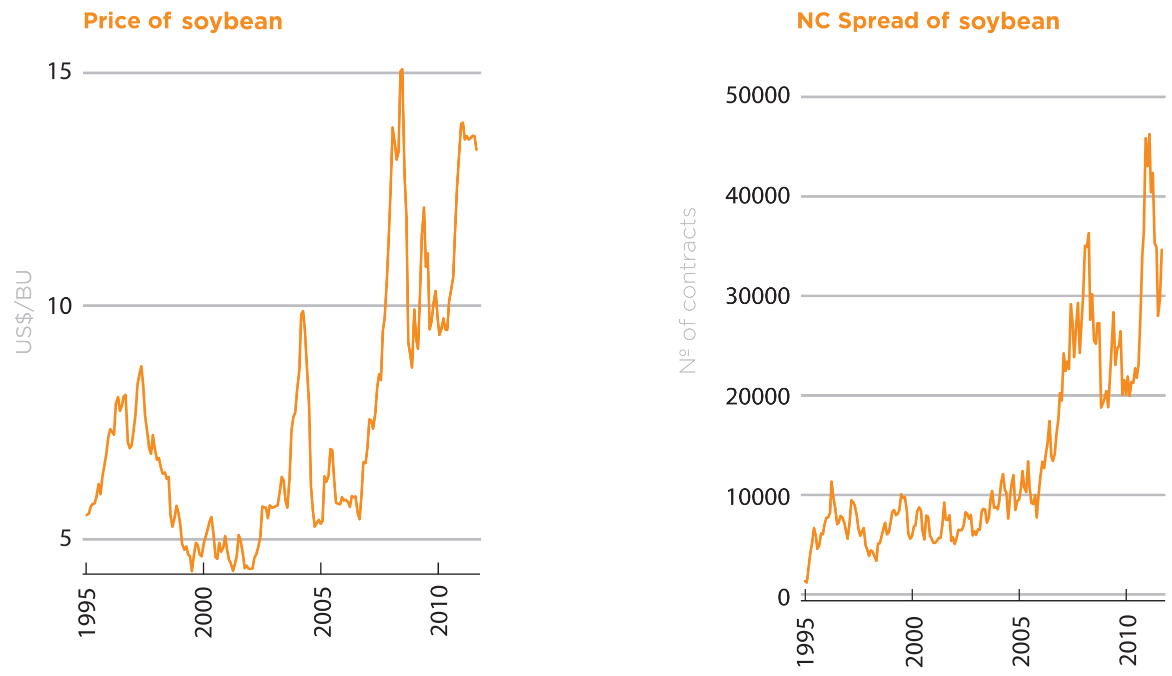
[5] *In these negotiations an investor carries out an operation marriage, in which a purchase and sale is made. This purchase and sale may be the same commodity or may be a purchase of one commodity and the sale of another commodity or even a purchase in a type of market (e.g.: futures) and a sale in another market (e.g.: physical).*

Figure 19: Corn: Prices and Non-Commercial Spread



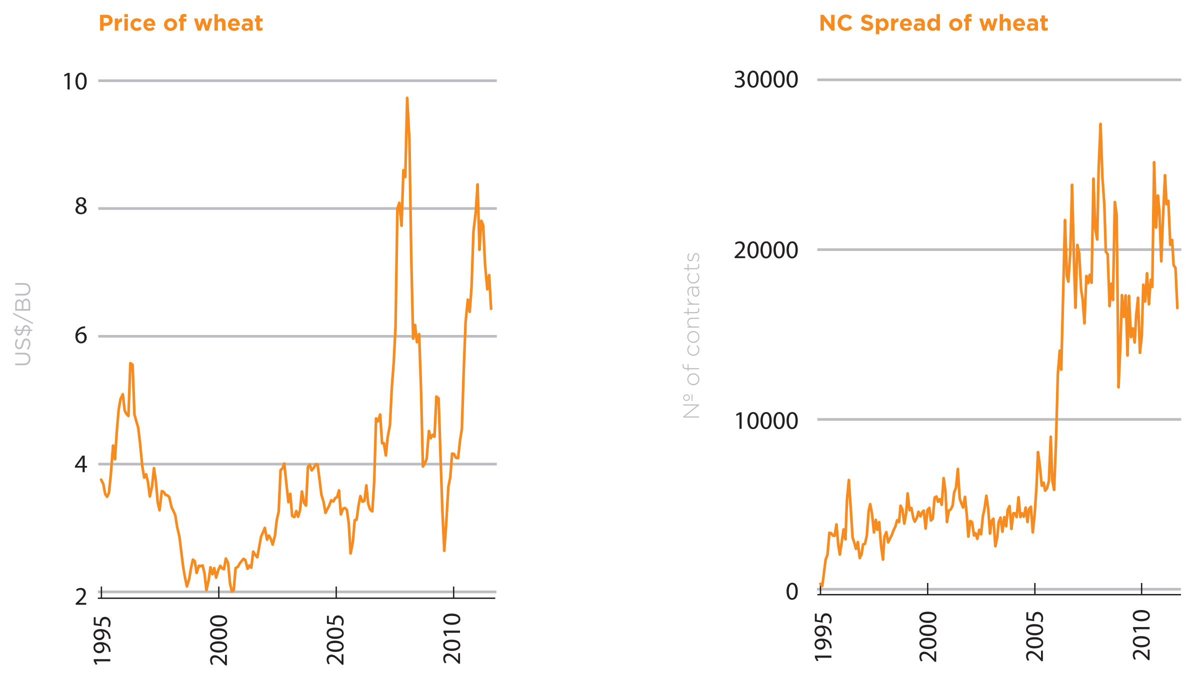
Source: CBOT

Figure 20: Soybean: Prices and Non-Commercial Spread



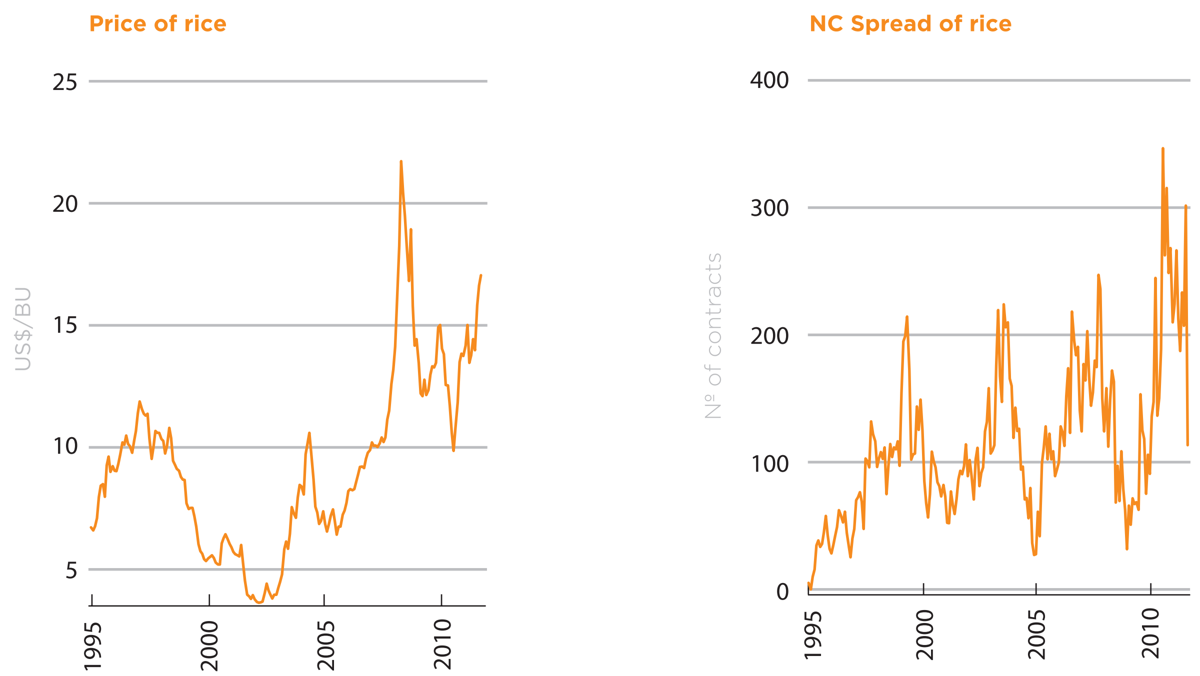
Source: CBOT

Figure 21: Wheat: Prices and Non-Commercial Spread



Source: CBOT

Figure 22: Rice: Prices and Non-Commercial Spread



Source: CBOT

To investigate the relationship between speculation and physical markets, we repeated the Granger Causality Tests conducted in the previous study with updated information. In accordance with such test, for each pair of series– the physical market price and the number of non-commercial spread contracts of each product (NC Spread) – test the precedence of series in both directions. To conduct the tests the data utilized was from contracts negotiated on the Chicago Commodities Market (CBOT), disclosed by the CFTC.

The causality tests were conducted from the dynamic specifications of the models and the results are shown in the following table:

Table 2: Granger Causality Test Results

Hypothesis		Corn	Rice	Soy	Wheat
H0: Phy. mark. price doesn't cause NC Spread	Statistic F	0.0122	0.0686	0.016	0.5415
	p-Value	0.9121	0.7933	0.8992	0.4618
H0: NC Spread doesn't cause phy. mark. price	Statistic F	7.0851	7.1604	12.842	5.682
	p-Value	0.0078	0.0075	0.0003	0.0171

Source: Author

Table 2 shows the first hypothesis tested, that the physical market price does not cause the variable NC spread, and may not be rejected for the four grains analyzed. However the second hypothesis tested that the variable NC Spread does not cause the physical market price is rejected for all four grains analyzed.

Therefore, the results obtained in this study do not corroborate the traditional theory, which covers causality in the direction of the fundamentals for the futures markets. Instead we arrive at the result that the direction of causality is a speculative activity for spot prices.

3.2

NEW EQUILIBRIUM OF PRICES

For the same products discussed in the previous section, dynamic linear regression models are also estimated using the prices of these agricultural commodities as dependent variables.

Both in terms of inclusion of variable and in terms of time lags involved, what is sought is meeting the standard methodology of adaptation tests for this class of models. In practical terms nothing has been changed related to the first FGV Projects study, both in time lags considered and in the explanatory variables entering each model. Initially a broad set of explanatory variables and time lags was considered.

Thus, from these models the protocols of traditional specifications of models were applied – tests of parameter significance, Schwartz information measures and the inclusion of dummies to incorporate the effects of intervention in periods with very divergent observations. The final specification was then investigated with respect to the presence of a serial correlation in residue.

Once the final specifications were obtained, each one of the models was resolved for the respective long term equilibriums. The estimated models may be then interpreted as reduced forms of structural equations of behavior that reflect the interactions between supply and demand by the different commodities considered; thus, the parameters obtained should reflect the fundamentals of the international price evolution [6].

The results of the estimates for corn, soy, rice and wheat, in this order, are shown in the following tables, and each is accompanied with short interpretations of the coefficients.

Corn

Table 3 to follow shows the results of the estimated coefficients for the case of corn.

One may see that only the coefficients related to past prices , production, the stocks and the production costs (fertilizers) are significant. The coefficient of production, although statistically significant, has no economic importance due to the estimating method employed. The results show inertia in the corn price behavior, which is illustrated by the high value of the coefficient associated to the price of the previous year. Moreover there are important negative effects coming from the stocks, which means the smaller the corn stock, the higher the price levels.

With respect to corn consumption this analysis is divided in the evaluation of two effects on prices: (i) the impact of corn quantity destined for ethanol production in the USA, represented by the M_Etanol variable; and (ii) the effect of world corn consumption (Corn Consumption).

[6] *Precisely because many of these parameters represent influences of supply and demand , it is difficult to interpret them without ambiguity about which of the fundamentals, supply or demand, is predominant. Accordingly we interpret only the coefficients in the following results when it is clearly possible to identify the predominant fundamental.*

Table 3: Dynamic Regression Model –Dependent Variable: price of corn

	Coefficients	
Corn Price (t-1)	0.76346 (9.0455)	***
Corn Production	4.01e-06 (2.0313)	*
Corn Stocks	-0.000013 (-3.1139)	**
Fertilizer Price	0.0032351 (3.0494)	**
Corn for ethanol production(M_Etanol)	0.0002387 (0.38134)	
M_Etanol (t-1)	-0.0002648 (-0.43032)	
Corn Consumption	-1.01e-06 (-0.10595)	
Corn Consumption (t-2)	3.09e-06 (0.30124)	
Corn Consumption (t-3)	-0.000025 (-2.4356)	*
Federal Funds' Rates (FF)	0.04721 (1.5188)	
R2 Adjusted N	0.980 48	

Statistics in parentheses; * p<0.05, ** p<0.01, *** p<0.001.

Source: Author

A list of results for a long-term solution follows, indicating that the stocks have a long-term negative effect on corn prices.

Table 4: Long-term Solution - Corn

	Coefficients	t	
Corn Production	0.000017	3.1623	**
Corn Stocks	-5.5E-05	-3.6213	**
Fertilizer Price	0.0137	1.9672	*
M_Etanol	-0.00011	-0.1470	
Corn Consumption	-9.7E-05	-1.9023	*
FF	0.2000	1.4142	

* p<0.05, ** p<0.01, *** p<0.001

Source: Author

In long-term equilibrium, the coefficient of corn destined for ethanol production(M_Etanol) inverts the signal, but the result is not statistically significant; thus, we may not say with total confidence that the corn destined for ethanol production affects the long-term commodity prices. However, the positive impact continues and is significant for costs (fertilizer prices) and the negative impacts of stocks and other corn consumption.

Soybean

Table 5: Dynamic Model – Dependent Variable: Price of Soybean

	Coefficients	
Soybean Price (t-1)	0.97285 (18.919)	***
Soybean Stocks	-0.0001086 (-4.8452)	***
Soybean Stocks (t-2)	0.0001316 (5.7093)	***
FF	0.012254 (.2584)	
FF_2	0.32757* (2.3725)	*
Dummy (1974)	-1.9056 (-3.0747)	**
R2-Adjusted N	0.974 45	

t Statistics in parentheses: *p<0.05, **p<0.01.***p<0.001.

Source: Author

As one may see by the Table 5, also in the case of soy, a strong price inertia is observed. The stocks appear to have a short-term negative effect and the interest rate has a positive coefficient. With respect to interventions, it was necessary to incorporate an intervention variable for 1974, which reflects the 1970's petroleum crisis. The results of the long-term model are in the table below:

Table 6: Long-term Model - Soybean

	Coefficients	t
Soybean Stocks	-0.0040	-0.5147
FF	0.4510	0.2835
dum74	-70.2000	-0.4576

Source: Author

The persistence in the series is so strong that it makes the long-term coefficients lose statistical significance, even though the negative signal for soy stock is maintained.

Rice

In the case of rice the inertia is lower than in other agricultural products previously analyzed. Moreover, there is a positive effect of the price of fertilizer on the final short-term price.

Table 7: Dynamic Model - Dependent Variable: Price of Rice

	Coefficients	
Rice Price (t-1)	0.48845 (3.8051)	***
Fertilizer Price	0.02343 (3.3457)	**
Electricity Price	-1.48456 (-3.1779)	**
Constant	11.80733 (3.2809)	**
R2-Adjusted N	0.764 38	

t Statistics in parentheses: *p<0.05, **p<0.01.***p<0.001.

Source: Author

The long-term results are in the following table:

Table 8: Long-term Results - Rice

	Coefficients	t
Price Fertilizer	0.0458	4.1296
Price Electricity	-2.9000	-5.2086

Source: Author

The results point out a long-term effect on the fertilizer prices, also positive. However note that the absolute value of the coefficients is uneven due to the scale of variables (since the fertilizer price is expressed in terms of index and the price of electricity in cents of one US Dollar).

Wheat

Table 9: Dynamic Regression Model - Dependent Variable: Price of Wheat

	Coefficients	
Wheat Price (t-1)	0.62734 (3.0642)	**
Wheat Price (t-2)	-0.034898 (-22803)	
Fertilizer Price	0.0061595 (6.1628)	***
Fertilizer Price (t-3)	-0.01345 (-3.4153)	**
Constant	2.5699 (3.6857)	***
R2-Adjusted N	0.729 48	

t Statistics in parentheses: *p<0.05, **p<0.01.***p<0.001.

Source: Author

The persistence in the series is less than that in the case of soy, but even higher than in the case of rice. Moreover, the short-term effect of fertilizer prices is positive on the price of the product. The long-term effects are in the table that follows.

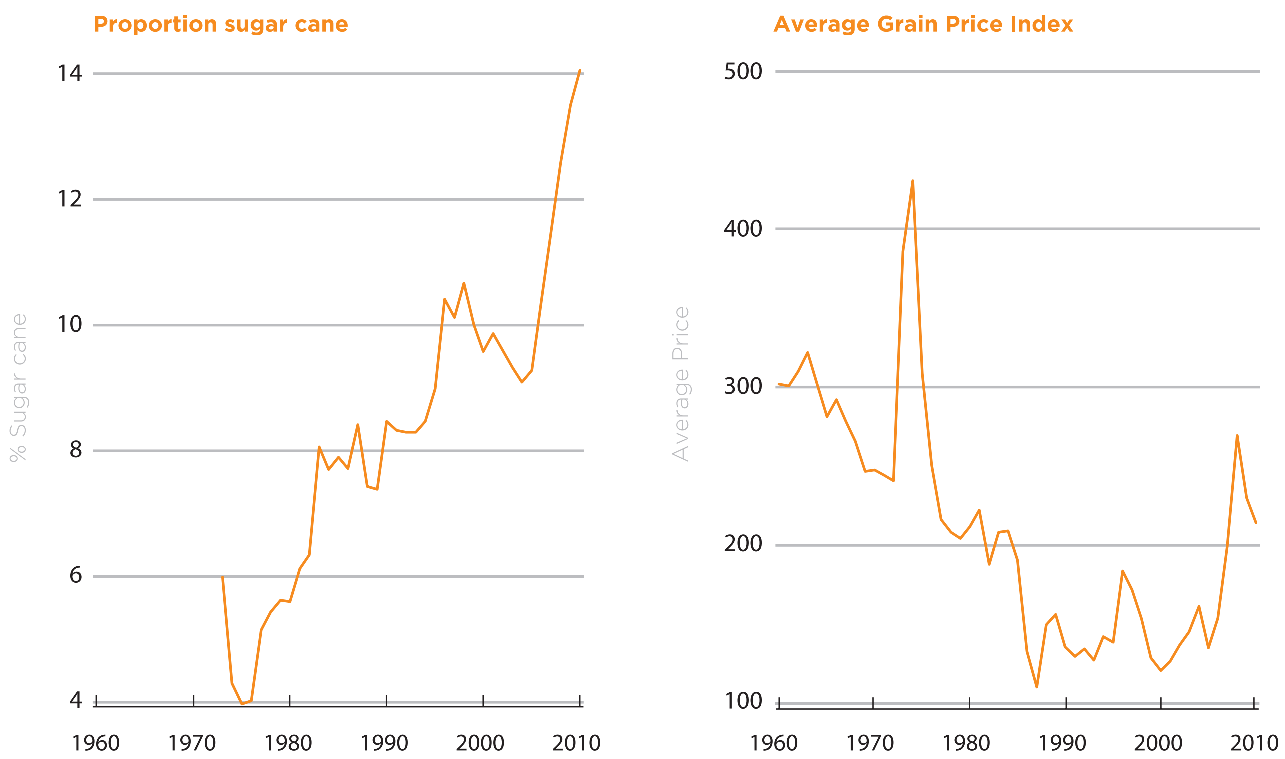
Table 10: Long-term Results - Wheat

	Coefficients	t
Constant	6.3056	7.1015
Fertilizer Price	-0.0179	-2.4012

Source: Author

Finally, an average price index was built for these four products, whose progress was studied vis-à-vis the progress of a portion of sugar cane in the planted area in Brazil. The following figure shows the progress of these two variables and suggests in principle a negative correlation between them.

Figure 23: Share of sugar cane in planted area and average grain prices index



Source: IPEA Data, IBGE

Source: USDA

To more formally evaluate the validity of this correlation, it employed a dynamic regression model to control potential effects that are simultaneously occurring to those represented in the previous figure. The results of this dynamic model are in the table that follows.

Table 11: Dynamic Model - Dependent Variable: Average Price of Grains Coefficients

	Coefficients	
Average Grain Price (t-1)	0.74302 (15.193)	***
Grains Consumption	0.0000371 (1.3896)	
Grains Stock	-0.0003193 (-4.0875)	****
Grains Stock/Grains Consumption (t-1)	304.42 (3.2048)	**
dum7374	125.96 (6.5308)	***
Planted area of sugar cane	7.86e-06 (1.2378)	
R2-Adjusted N	0.988 50	

t Statistics in parentheses: *p<0.05, **p<0.01.***p<0.001.

Source: Author

The results of the long-term model are the following:

Table 12: Long-term Model

	Coefficients	t
Grains Consumption	0.000144	1.428
Grains Stock	-0.00124	-5.631
Grains Stock/Grains Consumption	1184.62	4.601
Dum7374	490.162	4.860
Planted area of sugar cane	3.06E-05	1.239

Source: Author

What one can note is that the stocks act to depress average prices of grains and, what is most important that we have the planted area with sugar cane and in Brazil it would have a very small effect on these prices, not statistically significant. For a more careful analysis a specific model is estimated for this point, which will be presented in the following section.

3.3

THE BRAZILIAN ETHANOL MARKET

One way to separately investigate the impact that ethanol has on the international commodities market is by means of analysis of the inter-relations between the supply of ethanol and the supply of sugar. The focus targets these two products, since they are closer from the point of view of substitutability by the supply side. In the event one does not confirm a clear relationship between sugar and ethanol production, the argument that there are important effects of sugar cane ethanol on the price of other commodities becomes quite weakened. Moreover, one may investigate if there is an effect on average prices in the international market on ethanol supply.

In the event the estimates of these cross effects are made by OLS, the estimates of the coefficients would be inconsistent due to a recognized problem of simultaneity bias. Such problem is the result of the difficulty to distinguish movements along supply curves and demand curves (as well as displacements of same) since the observable data may be interpreted as equilibrium points, which means equality between the supply quantity and the demand quantity.

One consequence of the problem of simultaneity bias is the impossibility to identify parameters , after all, since the quantity observed is a representation of equilibrium quantity (for each price), it is not possible to distinguish supply shocks from demand shocks (which represent displacements of the respective curves). Finally, the parameters estimated by OLS would not have any economic interpretation.

To consistently estimate the parameters it is necessary to isolate the demand shocks from the supply shocks. This is performed by means of the 2SLS method, which makes the parameters identifiable on employing variables that are shifters of supply and shifters of demand. The shifter variables of demand must be correlated with the quantity of demand and not correlated with the supply quantity, while the shifter variables of supply must be correlated with the quantity supplied and not correlated with the demand quantity. These shifter variables are also called pre-determined variables, or exogenous variables, and the estimate by 2SLS is possible only when there are more exogenous variables than endogenous variables.

Another way to consistently estimate the coefficients is by means of regression in 3 steps (3SLS method), whose technique is similar to two-step regression, but offers the benefit of employing the estimate of the correlation of residues between the equations for calculating the variance of coefficients.

To estimate the parameters of the demand equation by hydrated alcohol it is necessary to describe the equation of the supply of hydrated alcohol. Since the hypothesis of correlation exists between the hydrated alcohol supply and the price of sugar, it will be necessary to estimate a system with the three equations: (i) equation of hydrated alcohol supply; (ii) equation of hydrated alcohol demand; and (iii) equation of demand for sugar. In the results, we present only the supply equations of ethanol for two cases: price of sugar or the price of grains as explanatory variables.

In the problem in question there are three endogenous variables (price of hydrated alcohol, quantity of hydrated alcohol and the price of sugar). To make it possible to estimate consistently the parameters it is necessary that there are at least three exogenous variables (one for each equation). When there is a shifter for each endogenous variable, it is said that the estimate problem is exactly identifiable. If there is more than one exogenous variable per equation, the problem becomes over-identified.

To follow, each one of the equations of the system is described and the pre-determined variables chosen as shifters of each curve.

Equation of ethanol supply

$$Q_{hidrat} = \alpha_0 + \alpha_1 P_{hidrat} + \alpha_2 P_{cer} + \alpha_3 X_3 + \alpha_4 X_4 + \alpha_5 X_5 + \alpha_6 X_6 + \alpha_7 X_7 + \alpha_8 X_8 + \varepsilon_1$$

Whereas:

- Qhidrat= Quantity of hydrated alcohol
- Phidrat= Price of ethanol
- Pcer = Price of cereals
- X3 = Quantity of anhydrous alcohol;
- X4= Proportion of flex cars and alcohol-powered cars;
- X5 = Price of sugar cane received by the producer;
- X6 = Price of potassium chloride (KCl);
- X7 = Price of urea;
- X8= Price of ammonium sulphate.

Equation of demand for hydrated alcohol

$$P_{hidrat} = \beta_0 + \beta_1 Q_{hidrat} + \beta_2 P_{gas} + \beta_3 Z_3 + \beta_4 Z_4 + \beta_5 D \times Q_{hidrat} + \beta_6 D \times P_{gas} + \varepsilon_2$$

Whereas:

- Pgas= Price of gasoline;
- Z3= Proportion of flex cars and alcohol-powered cars;
- Z4= Consumption of electric energy (proxy for income);
- D= Dummy ("0" preflex period; "1" in postflex period).

A dummy variable was added that was iterated with both the quantity of hydrated alcohol and the price of gasoline, before and after the introduction of flexfuel cars on the Brazilian market.

Equation of demand for sugar

$$P_{sug} = \gamma_0 + \gamma_1 P_{hidrat} + \gamma_2 W_2 + \gamma_3 W_3 + \varepsilon_3$$

Whereas:

- W2 = Industrial Sugar Production;
- W3 = Importation of sugar by the USA.

The results of the hydrated alcohol supply equation that would capture these effects follow:

Table 13: Structural Model – Dependent Variable: quantity of hydrated alcohol (prices of grains as explanatory variable)

	Coefficients	
Price of Ethanol [7]	-0.296 (-2.987)	**
Prices of Grains	-0.046 (-0.945)	
Price of Season-adjusted Anhydrous Alcohol	-0.325 (-0.739)	
Flexfuel Stake	1.452 (4.174)	****
Price of Sugar Cane	0.001 (0.577)	
Price KCl	0.000 (1.426)	
Price of Urea	-0.000 (-1.137)	
Price of Ammonia	0.000 (0.902)	
N-Obs	114	
R-Quad	0.951	
p-val	0.00	

t Statistics in parentheses: *p<0.05, **p<0.01.***p<0.001.

Source: Author

We may note that the grain prices on the international market do not have effects on the supply of hydrated alcohol. A similar analysis was performed substituting the price of sugar in the estimable equation.

[7] *The negative coefficient of this variable may indicate the existence of economies on a scale but not taken advantage of by the producers.*

Table 14: Structural Model – Dependent Variable: quantity of hydrated alcohol (price of sugar as explanatory variable)

	Coefficients	
Price of Ethanol	-0.306 (-3.760)	***
Prices of Sugar	0.057 (0.838)	
Price of Season-adjusted Anhydrous Alcohol	-0.450 (-1.122)	
Flexfuel Stake	1.228 (19.061)	***
Price of Sugar Cane	0.002 (1.369)	
Price of KCl	0.000 (5.666)	
Price of Urea	-0.000 (-1.671)	
Price of Ammonia	0.000 (1.276)	***
N-Obs	96	
R-Quad	0.967	
p-val	0.00	

t Statistics in parentheses: *p<0.05, **p<0.01.***p<0.001.

Source: Author

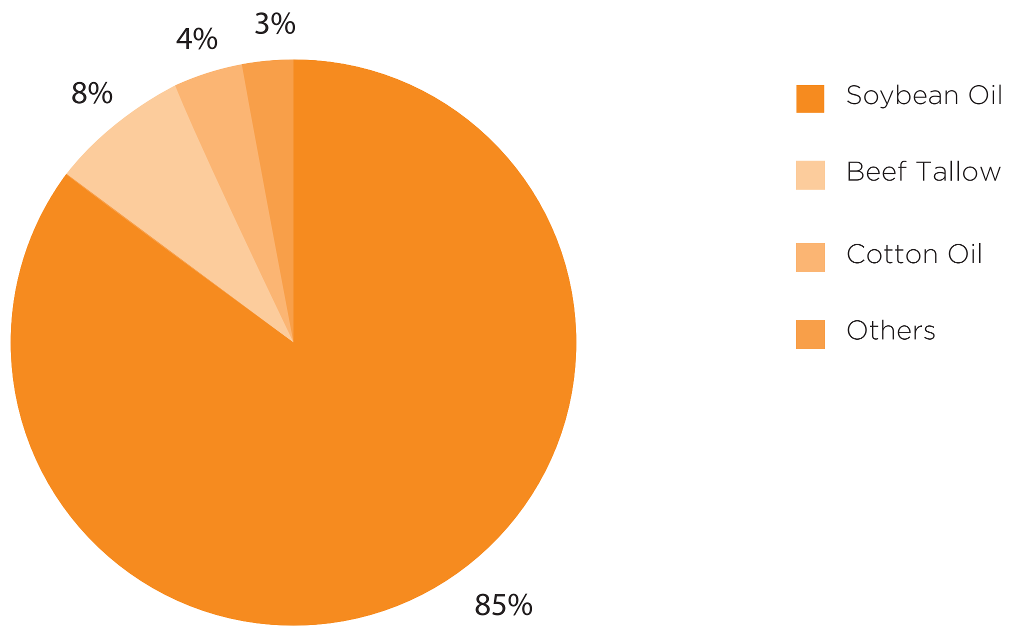
The results that appear in the table above are consistent with the idea that sugar and alcohol are substitutes on the supply side, despite the statistical effect of little importance. On the other hand, both tables confirm the expressive meaning that the proportion of flexfuel cars in the national fleet can explain ethanol production.

IV

CASE STUDY:
THE PALM OIL MARKET

Another agricultural product typical in tropical regions whose importance for biofuel production has been growing in recent years is palm oil (or dendê). Characterized by a versatile industrial employment, it may be found in about 50% of the products exhibited on supermarket shelves. Its main uses include food, where it has substituted advantageously the hydrogenated fats, to cleaning products (soap, detergents), passing through the cosmetics industry. Additionally, palm oil may also be used as a biofuel, although in Brazil its use with this purpose is residual as related to other raw materials. The Diagram below shows the main raw materials used in the fabrication of Brazilian biodiesel.

Figure 24: Participation of raw materials in biodiesel production (August 2011)



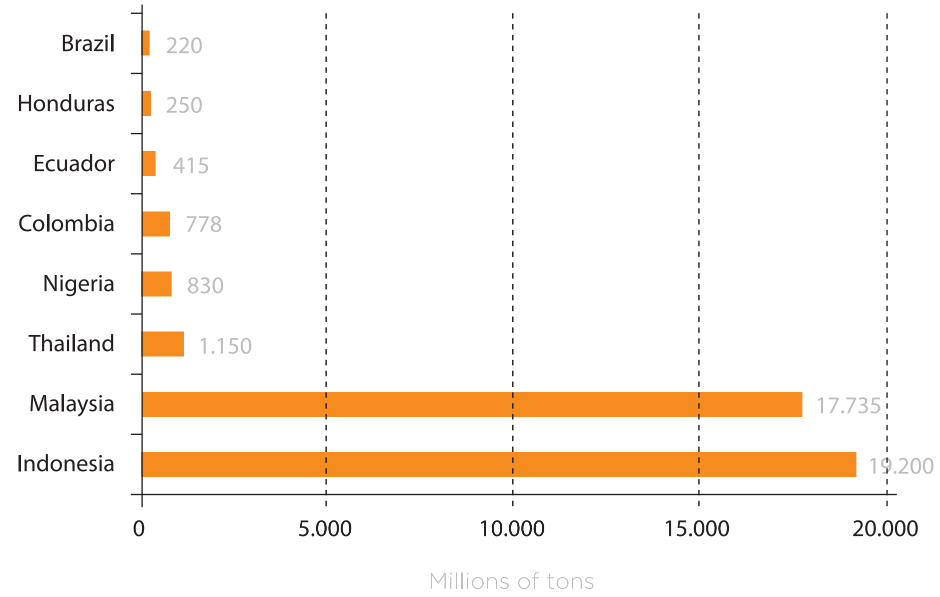
Source: ANP Boletim do Biodiesel

In Brazil, the increase in demand for biodiesel has been stimulated by official policies such as the National Program for Biodiesel Production and Use – PNPB, created at the end of 2004, by the creation of Petrobras Biocombustíveis in 2008, the same year in which the mandatory mixture of biodiesel (in traditional diesel) rose from 2% to 3% of the volume.

Palm cultivation is specific in tropical regions with high temperatures and with much rainfall and it would not be able to prosper in regions with climate different than that described. The palm oil production became an important drive of economic development in different countries that have areas with these climatic conditions, especially in Southeast Asia. It must be emphasized that palm oil represents an important part of economic activity in Indonesia and Malaysia and has great importance in both exports and in the internal market of these nations. In Indonesia approximately 50% of plantations belong to large private producers, 40% of smaller producers gathered in cooperative enterprises (shareholders) and 10% are produced by governmental initiatives.

In Brazil the palm oil culture is concentrated in the Northern and Northeastern states. Despite having extensive areas appropriate for the palm cultivation, Brazil is not one of the biggest world producers, a slot occupied by Indonesia followed by Malaysia. The following Figure shows the largest world palm oil producers.

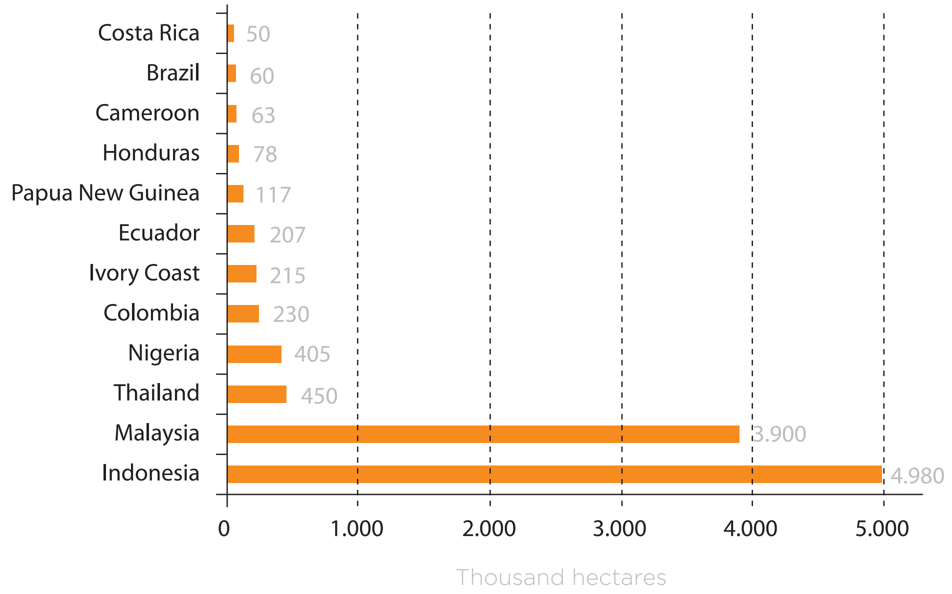
Figure 25: Palm Oil Production in 2008



Source: Oil World Annual 2009 (extracted from Marborges)

It is estimated that in Brazil there are about 66,800 hectares planted with dendê palm trees. Research shows that there are companies with expansion plans in the states of Pará, Bahia, Roraima and Rondônia which broadens this area to 235.5 ha (Becker 2010). The main Asian country producers have wide areas for cultivation. In Indonesia, for example, the area cultivated corresponds to approximately 2.6% of all national territory and in Malaysia the culture occupies almost 12% of the territory. Unlike these Asian producers, in Brazil the culture occupies a negligible swath of territory, and the product is cultivated in degraded forest areas, according to agroecological zoning in Amazônia (ZAE – Dendê) promoted by Embrapa Solos (2010). In addition, the official policies stimulate that the cultivation take place in these areas, offering subsidies to family agriculture and stimulating the acquisition of raw materials produced in a sustainable model, by means of the creation of a special company fuel seal (Selo de Combustível Social – SCS). The following Figure shows the planted area with palm in the main producing countries:

Figure 26: Planted area with palm in 2008



Source: Oil World Annual 2009 (extracted from Marborges)

The recent strong expansion of palm oil production is due in large part to the high productivity per hectare planted with palm. In effect, the income in terms of oil production is more than six times more than rape seed and about nine times greater than soy. The Table below shows the productivity per hectare of different oilseeds.

Table 15: Productivity of the main oilseeds (world averages 2004 – 2008)

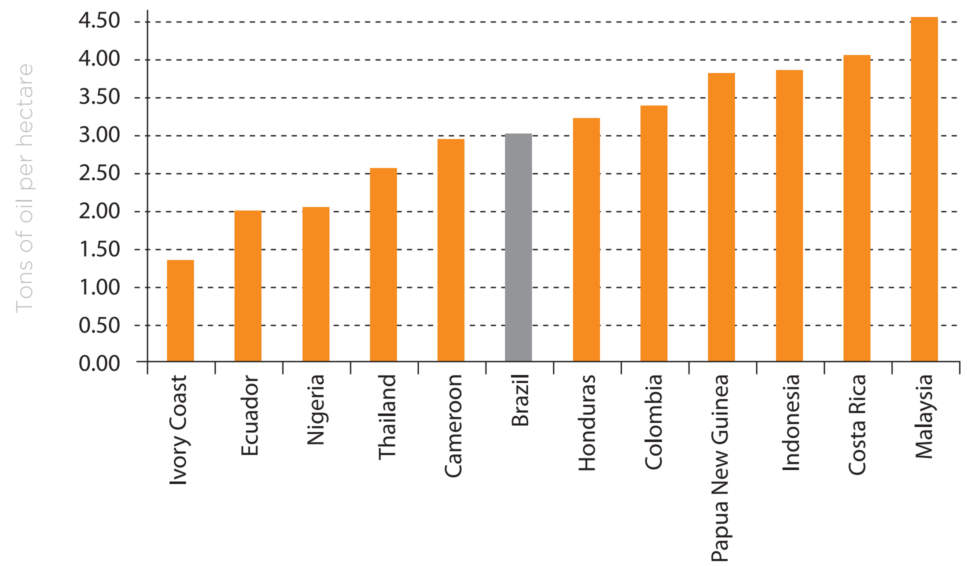
Culture	Benefited Product	t/há	Oil (% extr. ind.)	Oil (t/ha)	Commercial Product
Dendê Palm Oil	CFF *	18.39	20	3.68	Palm Oil
Dendê Palm Oil	Almond	0.97	40	0.39	Palm Oil
Soybean	Grain	2.35	18	0.42	Soy Oil
Coconut Dried	Coconut Kernel	0.55	65	0.36	Coconut Oil
Rapeseed	Grain	1.76	34	0.60	Soy Oil
Sunflower	Grain	1.30	42	0.54	Sunflower Oil
Peanut	Grain	1.06	39	0.41	Peanut Oil
Castor Bean	Seed	0.96	50	0.48	Castor Oil
Cotton	Seed	1.30	15	0.20	Cotton Oil

* Bunches of fresh fruit

Source: Oil World Annual 2009 (extracted from Marborges)

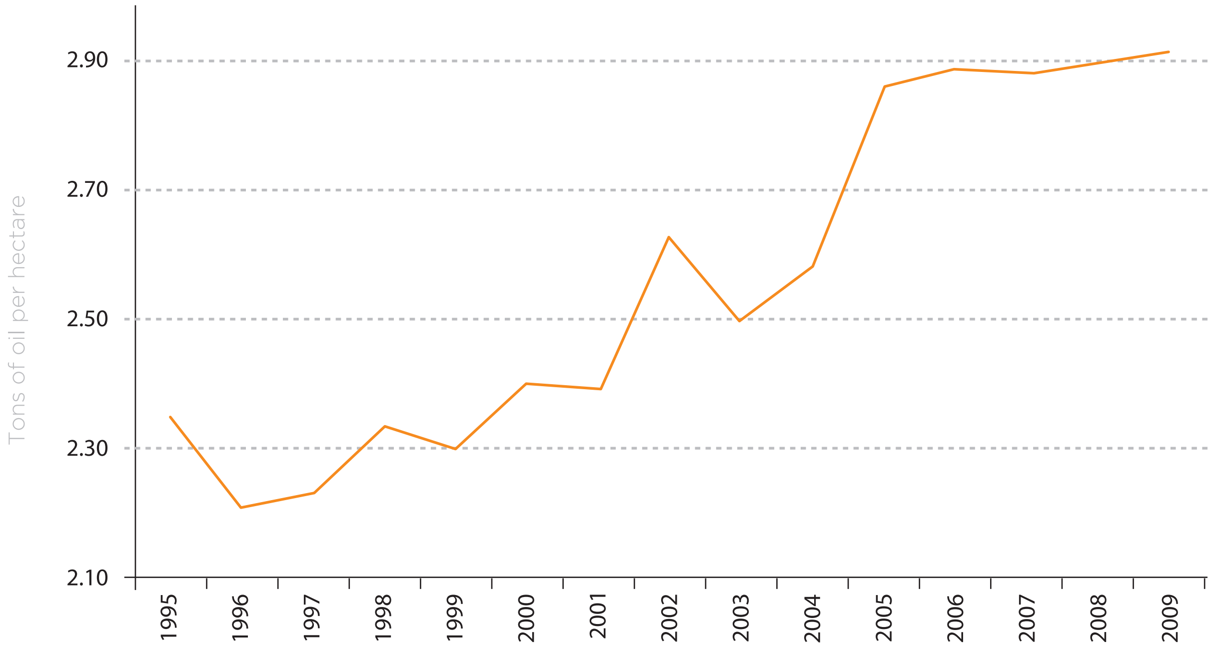
Although the cultivation has been increasing as the cultivation has been professionalizing and technical improvements have been incorporated, Brazilian productivity is still approximately 33% less than the productivity of the main Asian producers. The Figures below show the productivity per hectare of the producer countries and the progress of Brazilian productivity since the second half of the 1990s.

Figure 27: Average Palm Productivity in the main producer countries in 2008



Source: Oil World Annual 2009 (extracted from Marborges)

Figure 28: Progress in Palm Productivity in Brazil



Source: FAOSTAT

The expansion of palm oil production has been accompanied by a long-term trend of decreasing prices, which reveals the sharing with consumers of the gains of productivity which have been reached throughout years. The data about prices, corroborated by differences of productivity, show a significant advantage of this activity about the competing oils such as rapeseed , soy and sunflower seed. This means that the supply of Palm Oil is produced at favorable prices to the food industry that employs it as an ingredient, contributing to lower prices of final products in this sector (or at least not supplying pressure for high prices).

Even in view of these numbers, the growing of the palm tree is questioned (The Economist, 2010), mainly by Environmental NGOs (ENGOs, English acronym) which preach drastic policies of territorial restriction from production.

Such policies are based on the environmental concern to halt the reduction of native forest areas, and they must be evaluated in a global manner, weighing the costs and benefits. Notwithstanding there may be a legitimate environmental concern in specific producer regions, and it is also true that such restrictive policies present expressive consequences from the point of view of economic development. It has been stated in several nations including some of which present the greater incidence of poverty and hunger on the planet, Palm Oil signifies an economic exit that helps to surpass subdevelopment (but of countries as a whole, at least the vast regions within its borders). The question is still more problematic when one thinks of the climatic conditions for palm production and the government has already greatly restricted the areas where the culture may occur.

The restriction to palm expansion may lead to a rhythm of growth of supply of the product well beyond the progress of its demand, provoking a spike in prices and consequently rising costs of production in a series of industrialized food products, as well as non-food products. This would inhibit the expansion of other grounded industries in the use of Palm Oil and its derivatives. The result may then be a spike in food prices and in other products (such as cleaning products), simultaneously to a reduction of the growth rhythm of personal income in underdeveloped nations. The final scenario would then be a reduction in the capacity of consumption of this poor population, provoking the worsening of social problems.

As emphasized above, the palm culture is what today permits greater productivity in oil production. To use these lands for the production of other types of oil, for example, would not make economic sense. Other possible employments of areas today destined to palm planting are reasonably restricted and there is no base for argument that they are economically better than the palm. Secondly, the benefits should be emphasized of using biofuels instead of fossil fuels in terms of emissions that cause climatic changes.

The non-conversion policies preached by the ENGOs have become even more radical in recent years, since now it only defends non-conversion of forest areas, but also the non-conversion of areas already degraded. This type of restriction may have important implications for the palm in Brazil, since its production in the country is conducted fundamentally by taking advantage of areas already degraded. To fail to produce palm or still any other food product in these areas has a very high social and economic cost.

In summary, the possibility that palm oil may be largely employed as a biofuel in Brazil and that this has a consequent and significant impact on the production and the price of food is very improbable. In first place, this is because the Brazilian production is very reduced compared to the Asian countries. Secondly, because the destination of palm oil is essentially the food industry (and other non-energetic uses). As the Brazilian biodiesel raw materials grid shows, other vegetable oils and animal fats represent the almost – totality of national biodiesel production.

In addition, there is much space for growth occupying only degraded areas, without advancing in native woods. More than this, if Brazilian productivity of palm cultivation reaches the standards of Southeast Asia, it will be possible to increase palm oil production by 50% without occupying one sole additional hectare of land.

V

CONCLUSIONS

The hypothesis that financial speculation in the food commodities market, increasingly more disclosed, has an important role in explaining the strong peak of prices in 2007-2008 and again in 2011. The hypothesis that not only the traditional fundamentals of supply and demand are sending food prices up has been evaluated and tested and results of different works have corroborated it. (e.g.: Lagi et al, 2011; Huang and Ho, 2011; Baffes and Haniotis, 2010; UNCTAD, 2011).

The impact of biofuel incentive policies, once embraced as the big causes of the explosion of food prices, has been reviewed and it has become clearer and clearer that the effects on market fundamentals provoked by these policies may not be held exclusively responsible for the phenomena and not even for the greater part of the event.

In tune with this trend, the results of the causality tests applied in this work indicate that the movement in the futures market increased the prices of products in the physical markets and not the reverse, which is consistent with the hypothesis that the increase in speculative movement had an important role in the rising food prices in the international market.

The results of this work also show that the stocks, in most cases, are a very important element to understand the behavior of product prices in the international market, jointly with a high level of inertia that was present in these prices. In other words, one may say that when the stocks are always low in a determined period, several years of high prices should follow.

With respect to specifically the Brazilian ethanol production, we have arrived at the conclusion that it has a negligible effect on prices of sugar and other food in the international market. This suggests that the recent increase in ethanol production is mainly due to gains in productivity and not only to the simple expansion of planted area and conversion of grain production lands. The recent innovations in the process of alcohol production support this interpretation.

With respect to other energetic alternatives, the production of palm to obtain the oil still currently appears to be a small scale alternative. In fact, the vast majority of the Brazilian production of palm oil has the food industry as primary destination and not the use as a biofuel. In this sense, its impact on food prices is to reduce them and not increase them. On the other hand, the environmental campaigns may represent a significant impediment for the expansion of Brazilian palm production, which has broad conditions based on the occupation of degraded lands and for the increase in productivity.

In summary, the arguments above are consistent with the following interpretation: in view of an increase in the consumption of grains, caused by other motives and not the increase in biofuel production, when the world saw itself in 2007-2008 (and again in 2011) in a situation of low stocks. This combined with the increase in the importance of the financial market in setting commodity prices, led to a strong increase in prices.

VI

ANNEX I

DATA BASE

To achieve empirical analysis of this work a data base has been built composed of a large variety of information from very different sources. This is due to the multiplicity of questions that are sought to be responded to. Thus the data bank has information in different periodicities and always sought to employ the largest quantity of observations available in each type of analysis conducted.

In first place, for the analysis of the inter-relations between the prices in the futures market and the position of negotiation of non-commercial agents in the futures market, there were two primary sources of data:

- Future contract price for one month in advance: expressed in USD/Bushel or USD/cwt, depending on the product. Monthly data composed of the average of daily prices within each month, from January 1986 to September 2011, and as the original source: Chicago Board of Trade (CBOT) [8].
- Negotiation positions of non-commercial agents (Non-Commercial Spread). Originally expressed in the number of contracts of 5,000 bushels, representing the position in futures contracts and options. Obtained from the Commitments of Traders report, of the CFTC [9]. The time periodicity of this data is similar to that previous point, from Jan-1986 to Sept-2011.

For the analysis of fundamentals, we have the following sources of primary data:

- Prices Received from the products Corn, Soy, Rice and Wheat: obtained annually and since 1960 up to 2010, jointly with the USDA (in association with the Mann Library at Cornell University) [10].
- World Production of products mentioned above: obtained annually and since 1960 up to 2010, jointly with the Foreign Agricultural Service of USDA [11].
- World Consumption of products mentioned above: obtained annually and since 1960 up to 2010, from the Foreign Agricultural Service of USDA [12].
- Final World Stocks of products mentioned above: obtained annually and since 1960 up to 2010, from the Foreign Agricultural Service of USDA [13].

[8] *Data acquired at the site Norma's Historical Data http://www.normashistoricaldata.com/*

[9] *http://www.cftc.gov/MarketReports/CommitmentsofTraders/HistoricalCompressed/index.htm*

[10] *http://usda.mannlib.cornell.edu/MannUsda/viewDocumentInfo.do;jsessionid=F154BA78C7C50C021C8CA924EDB72FD5?documentID=1002*

[11] *http://www.fas.usda.gov/psdonline/psdQuery.aspx*

[12] *http://www.fas.usda.gov/psdonline/psdQuery.aspx*

[13] *http://www.fas.usda.gov/psdonline/psdQuery.aspx*

[14] *http://econ.worldbank.org/WBSITE/EXTERNAL/EXTDEC/EXTDECPROSPECTS/0,,contentMDK:21574907~menuPK:7859231~pagePK:64165401~piPK:64165026~theSitePK:476883,00.html*

[15] *http://www.ipeadata.gov.br/Default.aspx*

[16] *http://www.agri-outlook.org/document/0/0,3746,en_36774715_36775671_47877696_1_1_1_1,00.html*

[17] *The construction of data and the following text is strongly based on Serigati, Correia and Perosa (2010)*

- International Fertilizer Prices: obtained from the World Bank [14].
- Series of Interest Rates of Federal Funds: obtained from the IPEADATA [15].
- Electric Energy Price: Estimated by the average price paid by the US consumer, obtained from the US Department of Energy.
- Planted area with Sugar Cane in Brazil: obtained from IPEADATA (up to 2007) and IBGE (between 2008 and 2010).
- Net Ethanol Consumption: obtained from the FAO Agricultural Outlook [16].

For the last analysis, focused on the effects that international market prices have on the supply of biofuels, the following series of data were assembled, with monthly periodicity from July 2001 and December 2010 [17].

- Price of hydrated alcohol and gasoline: they are the average monthly prices (R$/l) supplied at the pump to consumer and disclosed by the Agência Nacional do Petróleo, Gás Natural e Biocombustíveis (ANP) in its 'Price Survey'.
- Quantity sold of hydrated alcohol and gasoline: this is the volume (millions m³) total gasoline and ethanol sold in Brazil by the distributors in accordance with ANP data. Due to strong seasonality, the series was season-focused by means of regression with dummy variables.
- Proportion of flex and alcohol-run cars: the proportion of flex cars and hydrated alcohol was calculated from data supplied by the Associação Nacional dos Fabricantes de Veículos Automotores (Anfavea), which discloses monthly the number of vehicles sold by type of vehicle (automobiles and light commercial vehicles) and of fuel (gasoline, alcohol and flex-fuel). As the number of vehicles sold annually is available since 1957 and monthly since 1999, it is possible to calculate the stock of vehicles in circulation by type of fuel. From the function of scrapping – which determines the number of vehicles scrapped in function of its age – and the parameters provided by MCT (2006), the depreciation curve was calculated for cars and for light commercials. On imposing 480 months (40 years) as the maximum average limit of shelf life of a vehicle and on determining the scrapping curve (St) it assumes the form of a Gompertz curve, adapted to the parameters provided by MCT (2006) monthly periodicity and the total number of vehicles in circulation calculated by:

$$EV_t = \sum_{t=0}^{480} NV_t \cdot (1 -$$

Whereas:

$$\begin{cases} S_t = 1 - \exp\left[-\exp\left(1{,}798 - \frac{0{,}137}{12}t\right)\right], & \text{a curva de sucateamento para automóveis} \\ S_t = 1 - \exp\left[-\exp\left(1{,}618 - \frac{0{,}141}{12}t\right)\right], & \text{a curva de sucateamento para comerciais leves} \end{cases}$$

EVt is the number of cars in circulation by type of fuel and ; NVt the number of new vehicles sold in month t.

- Price of sugar cane received by producer: The price (R$/ton) received by the producer for each ton of sugar cane was obtained from the Instituto de Economia Agricultural do Estado de São Paulo.
- Electric Energy Consumption: As proxy for income, the electric energy consumption that was utilized (GWh) the monthly total (commercial + industrial + residential + others) provided by Eletrobrás.

- Industrial sugar production: As one of the shifters of demand for sugar, a monthly seasonal series of Fabrication and Industrial Sugar Refining was employed, one of the subsectors made available by the Monthly Industrial Research of IBGE.
- Price of the main agricultural ingredients for sugar cane production: In accordance with Rossetto et al (2008), within the main traditional agricultural ingredients utilized in the sugar cane planting area, ammonium sulphate, potassium chloride and urea are highlighted. The monthly prices (R$/ton) of these materials are obtained in the data bank of the Instituto de Economia Agricultural (IEA) of the Secretary of Agriculture and Fuel of the State of São Paulo (SAA). Rossetto et al (2008) also cite the NPK 20-05-20 with an important ingredient, but as its price is correlated with the price of petroleum, it was not possible to consider it a supply shifter due to problems of endogeneity.
- Price of sugar: the variable price of sugar reflects the prices (R$) of a ton of sugar in the retail market in accordance with the data bank of the Instituto de Economia Agricultural (IEA).
- US Importation of sugar: The volume (ton) of industrial sugar imported by the USA in accordance with the data provided by the U.S. Department of Commerce and by the U.S. International Trade Commission (USITC). Due to strong seasonality, this series is also seasonalized by means of regression with seasonal dummies.
- Quantity of anhydrous alcohol: as the main destination of anhydrous alcohol fuel commercialized in the form of an additive added to gasoline, the total quantity of anhydrous supplied is calculated by means of the proportion of mandatory anhydrous – determined by rulings of the Conselho Interministerial do Açucar e do Álcool – multiplied by the total quantity of gasoline sold.

VII
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