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The Impacts of Biofuel Production on Food Prices: a review

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List of Abbreviations

BMZ	Bundesministerium für wirtschaftliche Zusammenarbeit und Entwicklung
CGE	Computable general equilibrium
CGIAR	Consultative Group on International Agricultural Research
CPI	Consumer price index
DC	Developing country
DRE	Directive on Renewable Energy
EISA	Energy Independence and Security Act
FAO	Food and Agriculture Organization of the United Nations
FAPRI	Food and Agricultural Policy Research Institute
GTZ	Deutsche Gesellschaft für Technische Zusammenarbeit
IFPRI	International Food Policy Research Institute
OECD	Organisation for Economic Co-operation and Development
PEM	Partial equilibrium model
SSA	Sub-Saharan Africa
USDA	United States Department of Agriculture
WB	World Bank

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Abstract

The various calculations of the impacts of biofuel production on the mid-term projections of food and agricultural commodity prices are difficult to reconcile. This is largely due to the intricate set of assumptions, the differences in the baseline scenario and in the projection horizon they are built upon. For similar reasons, studies evaluating the impact of biofuel production on food and commodity prices to date do not provide a clear consensus. Rather than discussing the merits of the different assumptions and methodologies, this paper focuses on the global trends that can be extracted from the different sources.

Agreed upon by all sources is the fact that between 2005 and 2007 many agricultural commodity prices increased sharply, especially nominal prices. The impact of commodity prices on final food prices affecting household food expenditures is less clear. Nonetheless, many food price indices (national CPIs, WB food price index and FAO food price index) have also risen over the same period.

It is a fact that the increasing demand for feedstocks from the biofuel sector is one among several factors impacting on agricultural commodity prices. Other factors cited include poor harvests, the structural change in food demand in certain countries, population growth, high oil prices, or the devaluation of the US dollar. To calculate the longer term projected commodity prices, these factors are integrated in the simulations, which are then subjected to different biofuel production scenarios. These scenarios largely determine the extent of the biofuels' impact on food and commodity prices.

Despite considerable differences in projection results, methodologies and assumptions, some common trends can be observed. The latest EU and US biofuel programs and legislations are expected to have the largest impact on vegetable oils over the mid term, increasing world real prices by more than 30% between 2011 and 2016. The impacts on prices are generally projected as lesser (+3 to 15%) for commodities such as wheat, corn and soybean, whilst the price of oilseed meals (an important part of fodder markets and a by-product of vegetable oil production) is predicted to decline (-11 to -17%) due to the increase in vegetable oil production. A (hypothetical) freezing of biofuel production at the 2007 levels predicts a decline in cassava, oils, sugar and wheat prices by less than 10% between 1997 and 2020. The price decreases would reach 10 to 20% had biofuel production completely stopped in 2007. The magnitude of the impacts is more contrasted when looking at real regional prices, but across all given regions biofuel mandates and targets are projected to impact oilseeds most strongly (+25 to +72%), followed by grains (+5 to +21%).

Kurzfassung

Die verschiedenen Berechnungen, die gemacht wurden und werden, um den Einfluss der Produktion von Biokraftstoffen auf die mittelfristige Preisentwicklung von Nahrungsmitteln und landwirtschaftlichen Erzeugnisse einzuschätzen, gehen weit aus einander. Dies liegt größtenteils daran, dass die Prognosen auf unterschiedlichen Annahmen, Basisszenarien und Zeithorizonten basieren. Aus ähnlichen Gründen ergeben Studien, die rückblickend den Einfluss der Biokraftstoffproduktion auf die Preise von Nahrungsmitteln und landwirtschaftlichen Erzeugnissen bewerten, bisher kein einheitliches Bild.

Die vorliegende Untersuchung beschäftigt sich jedoch nicht mit den Vor- und Nachteilen der verschiedenen Annahmen und Methoden, sondern konzentriert sich auf die globalen Trends, die aus den verschiedenen Quellen abgeleitet werden können. Aus den Analysen geht einheitlich hervor, dass zwischen 2005 und 2007 viele Preise für landwirtschaftliche Erzeugnisse außergewöhnlich stark angestiegen sind, insbesondere nominale Preise. Weniger klar ist der Einfluss dieser Preise auf die Verbraucherpreise für Nahrungsmittel, die sich auch auf die Haushaltsausgaben für jene Mittel auswirken. Allerdings sind viele Preisindizes (nationale Verbraucherpreisindizes, Weltbank- Nahrungspreisindex und der FAO Nahrungsmittel-Preisindex) in der gleichen Zeitspanne angestiegen.

Tatsache ist, dass die steigende Nachfrage nach Rohstoffen für den Biokraftstoffsektor als einer von mehreren Faktoren die Preise für landwirtschaftliche Erzeugnisse beeinflusst. Andere zitierte Faktoren sind schlechte Ernten, strukturelle Veränderungen der Nachfrage nach Nahrungsmitteln in verschiedenen Ländern, Bevölkerungswachstum, hohe Ölpreise und die Abwertung des US Dollar. Um langfristige Prognosen für die Warenpreise zu berechnen, werden diese Faktoren in die Simulationen integriert, welche dann mit verschiedenen Szenarien der Biokraftstoffproduktion kombiniert werden. Diese Szenarien bestimmen wesentlich, inwieweit Biorohkraftstoffe die Preise für Nahrungs- und Handelswaren beeinflussen.

Trotz beträchtlicher Unterschiede zwischen den Ergebnissen der Prognosen, Methoden und Annahmen können einige allgemeine Trends beobachtet werden. Es wird erwartet, dass die jüngsten EU und US Biokraftstoffprogramme und –gesetzgebungen mittelfristig auf pflanzliches Öl den größten Einfluss haben und einen realen Preisanstieg von mehr als 30% zwischen 2011 und 2016 verursachen werden. Für Erzeugnisse wie Weizen, Mais und Sojabohnen sind die Preisprognosen meist geringer (+3 bis +15%). Im Gegensatz hierzu wird für den Preis von Ölsamen-Produkten (die ein Nebenerzeugnis aus der Produktion von pflanzlichem Öl sind und einen wichtigen Teil des Marktes für Viehfutter bilden) aufgrund des Anstiegs der Produktion von pflanzlichem Öl eine Preisabnahme von -11 bis -17% vorausgesagt. Ein (hypothetisches) Einfrieren der Produktion von Biokraftstoffen auf dem Niveau von 2007 ergäbe einen Preisrückgang für Cassava, Öle, Zucker und Weizen von weniger als 10% zwischen 1997 und 2020. Bei einer kompletten Einstellung der Biokraftstoffproduktion im Jahr 2007 hätte der Preisrückgang eine Höhe zwischen -10 und -20% erreicht. Wenn die realen regionalen Preise in

Betracht gezogen werden, ist der Effekt noch unterschiedlicher, doch werden den Prognosen zufolge die Biokraftstoffziele über alle Regionen hinweg am stärksten Ölsamenpreise (+25 bis +72%) betreffen, gefolgt von Getreidepreisen (+5 bis +21%).

1 Introduction

The debate over the direct and indirect impact of increased demand for biofuels (defined here as bioethanol and biodiesel), especially from rich countries, on the global food prices has reached unprecedented levels over the past few months. Global real food prices were already at a decade-high by the end of 2007 and several more increases have been observed in 2008. Riots in several developing countries (DCs) have erupted as a result of high food prices. The international community also struggles to provide adequate food aid as commodity surpluses are diverted to the biofuel sector and commodity prices have soared, decreasing the purchasing power of fixed aid budgets.

In that context, ambitious fossil fuel replacement targets, primarily in the US and the EU, driving the expansion of biofuel production and its increasing appetite food crops, have become obvious foci for critiques. Yet, when it comes to quantifying the impact of biofuels on food prices over the last few years and to project this impact over the next decade, few sources provide directly comparable figures. This has led to some confusion, as these impacts can be measured in many ways but are often referred to globally.

In this discussion paper, we review existing evidence, projections and opinions about the impacts of biofuel production on commodity and food prices. We also summarize the different discourses on the various “non-biofuel” causes of the recent soar of food and commodity prices. We compare all results and highlight their differences and the causes of these differences.

Three main types of studies (and results) focusing on biofuel production and food prices are found in the literature. The first type focuses on the impact of biofuels to-date and thus looks at historical data on commodity prices and food indexes. The extent of the impact of biofuels on today’s food prices is quantified by extrapolations or ad-hoc calculations based on such data.

A second type of studies projects food and commodity quantities and prices in the medium term (anywhere between 2015 and 2020). To that effect, a model is developed to describe the interactions between demand, supply and trade of the main agricultural commodities at the global level. The impact of biofuels on food prices is seen through projections simulating various biofuels trade and policy scenarios.

Finally, many studies provide commentaries and opinions from commodity market experts on the causes behind the current food price crisis. Identifying which segments of the agricultural markets these experts are commenting on is crucial, as different commodities are and will be affected very differently by the expansion of biofuel production. Nonetheless, some of these studies provide crucial information on specific markets. Such information cannot be gathered from the simulation studies presented, which are global by nature and do not differentiate among regional markets, biofuel feedstocks and biofuel production systems.

The next three sections describe the results and findings of each type of studies and discuss their differences; the main numerical results are summarized in table format at the end of the next two sections. The final section summarizes our findings and conclusions, also drawing from the analysis of two general reviews of the agricultural commodity markets.

2 Impacts to date

Three reports were identified which give specific figures on the impacts that biofuel production has had on commodity prices in recent years. The findings and methodologies of these three reports are discussed below. Their methodologies are very different and present no similarities in their approach, a fact that is naturally reflected in their contrasting results.

Firstly, researchers at IFPRI (see Rosegrant 2008 and von Braun 2008b) have produced a study in which they compare the real prices for a number of grains over the period 2000 to 2007 to simulated prices under a number of scenarios. One scenario is relevant to look at the biofuels impact on current (or past) prices. The actual price data for rice, wheat and maize is compared to a simulated 2000-2007 evolution of prices *had the biofuel growth continued along its 1990-2000 trend*. The comparison reveals that the sharp change in biofuel production, largely caused by policy-driven demand, accounted for **30%** *of the actual increase* in production-weighted average real price for grains over the seven year period. This aggregate real grain price is the production-weighted average of rice, wheat, maize and other coarse grains. The percentage share is calculated as follows: $\%share = \frac{p_{2007}^{actual} - p_{2007}^{simulated}}{p_{2007}^{actual} - p_{2000}^{actual}} * 100$ with $p_{2007}^{actual} > p_{2007}^{simulated} > p_{2000}^{actual}$.

The methodology used to compute the simulated prices was not described in either of the studies. Yet is understood that these simulations were conducted using the same IFPRI model (IMPACT) used to project agricultural production and prices in the future (see next section). The difference with projections is that here many parameters used in the simulation are actual historical data (e.g. population growth between 2000 and 2007 is now known). This is also true for the growth in biofuel production, which is assumed to follow its observed trend between 1990 and 2000.

Alternatively, the expanding biofuel sector is estimated to have increased the aggregate real grain price by approximately **12%** by 2007, which is equivalent to less than 2% per annum over the period. This number is simply the percentage difference between the actual and simulated price in 2007 and was computed from the data presented in Rosegrant 2008 and is computed as $\frac{p_{2007}^{actual} - p_{2007}^{simulated}}{p_{2007}^{simulated}} * 100$.

<u>Note:</u> there are two main approaches to measure the impact of the demand for biofuel feedstocks on food and commodity prices: (1) the share of the biofuels' impact in the increase of commodity and food prices and (2) the increase in price which can be imputed to biofuels. These are two fundamentally different numbers. The former will always be larger than the latter if the total price increase is less than 100% and thus can give a more negative view of the impacts of biofuels.

Detailed for the three main coarse grains, biofuels accounted for 39% of the real price increase for maize, 21% for rice and 22% for wheat over the whole period. Again, these denote the shares of the price increases imputed to biofuels, not the biofuels-induced increase in price. The latter were not possible to compute from the data presented in the study.

The period 2000-2007 is interesting as it captures the recent sharp increase in food crops usage in the biofuel sector and the consequent sharp increase in prices for these particular crops and their substitutes. Nonetheless, several more increases have been recorded in 2008 and are not part of the data referred to in these studies. Given the large food price increases recorded in 2008, the numbers cited above may be increased substantially in a 2000-2008 comparison.

The authors of the two studies both mention that although triggers for high food prices include biofuel policies, bad weather and high oil prices, resulting in poor government policies (e.g. export bans) and speculative trading and storage behavior, existing pre-conditions underlying the long-term food supply and demand play a crucial role too. These pre-conditions are listed as: increased demand for meat and milk putting pressure on feed grains, economic growth in SSA since the late 90s increasing their demand for wheat and rice, economic growth in Asia increasing demand for wheat, meat, milk, oils and vegetables, and finally long-term underinvestment in agricultural research, technology and rural infrastructures, as well as increased pressure on land and water resources.

The second report is a working paper authored by Donald Mitchell of the World Bank (WB), which was presumably leaked to the media in July 2008. It relies on an entirely different methodology to estimate the impact of the demand for biofuel feedstocks on the World Bank index for food prices. The index is an export value weighted dollar index of developing countries prices of export food crops. It rose by 140% between January 2002 and February 2008. The author of the working paper attributes a maximum contribution of 15% coming from increased energy prices[1] and 20% coming from a weak dollar.[2] This leaves three quarters of the increase, or an increase of the price index of **105%**, unaccounted for. That whole share can be imputed to the biofuel expansion, he claims, as supply shocks averaged out over the period and structural changes in demand were hardly noticeable (global consumption of rice and wheat grew 1.0 and 0.8% per annum between 2000 and 2007, 2.1% for maize if one excludes US ethanol use). In the author's view, speculation, export restrictions and stocks effects are all consequences of the large and sudden increase in feedstock demand from the biofuel sector and therefore cannot be dissociated from the biofuels' impacts on commodity and food markets.

The methodology used in the paper relies only on statistics, a few "back-of-the-envelope" calculations, and their interpretation by the author. The only solid fact is that the WB food price

[1] Energy and fertilizer costs to food producers in the US increased by 50% between 2000 and 2007, contributing to a 15% increase in production costs. As US agriculture is the most intensive, the 15% are used as a higher bound on the global impact.

[2] The decline in the dollar is understood to increase dollar commodity prices with elasticity between 0.5 and 1. Mitchell assumes a value of 0.5 for food prices. The currency which most improved against the dollar over the period January 2002 to February 2008 is the Euro, which appreciated by 40%. Thus a higher bound of the impact of the weak dollar on food prices is given at 20%.

index rose 140% between January 2002 and February 2008. Therefore, without specific knowledge of the statistics and assumptions that serve as the base for the report, it is difficult to find fault with the reasoning of Mr. Mitchell, which can be rather persuasive due to the simplicity of its methodology.

It is not the place here to debate the choice of prices included in the index. Yet it must be noted that it is a rather specific way to measure aggregate food prices. One of its advantages is that it by-passes the impacts of national food subsidies. Some experts suggest that the WB food price index is over-influenced by edible oil prices (Urbanchuk 2008), which by all accounts have experienced the highest price increase among food crops, especially in 2007 and 2008. The increased world wheat prices which Mitchell attributes to the diversion of wheat area to maize and oilseed production is also statistically debated, as are links between biofuels and speculative activities and export bans, and the fact that low agricultural prices in the absence of biofuels *might* have reduced agricultural production and thus stocks even more than biofuels did (Urbanchuk 2008).

Finally, a consultant report to the US food industry (Collins 2008) has shown that even with an impact of the US ethanol sector causing the US price of maize to increase by 60% between 2006/07 and 2008/09 (compared to figures cited in other studies between 25 and 50%), the final impact of the ensuing increased feed and ingredient costs on the annual growth of the US food Consumer Price Index (CPI) would be about 0.6 to 0.9%. This is an increase of about **25 to 35%** on the current values and long-term projections of the annual US food CPI growth rate of 2.5%. The effect of such an impact on the consumers' food bill is certainly not to be underestimated, but is not dramatic either. According to the USDA, the US food CPI grew by 4.8% in 2007 and the seasonally adjusted annualized growth rates of the first semester 2008 is 6.6%. In comparison, the US food CPI grew annually by over 8% during the seventies, 4.6% in the eighties, 2.8% in the nineties and 2.5% between 2000 and 2006.

Four other reports mention and loosely investigate the causes of recent hikes in food and commodity prices. The impacts of biofuel production are not quantified, but these studies are interesting as they illustrate the fact that measuring food or commodity prices can itself lead to disagreements. Indeed, there is not one universal definition of "food prices", or even of a specific commodity price. Both represent aggregate prices or indices which are calculated in different ways by different institutions.

The World Bank Development Report 2008 relies on figures from Rosegrant 2006, which are slightly outdated, and only mentions that "biofuels development pushes feedstock prices up".

A report from the IMF (IMF 2008) investigates food and fuel price statistics. It uses notably an index of world real (deflated by US CPI) food prices, which grew from 100 to 130 between 2007 and 2008. The report notes also that this index was higher than 150 throughout the 70s and early 80s and was below 100 only from the late 90s until 2006, but that the current increase in food prices is part of a general price boom in commodity prices, including metals and oil, the strongest such boom since the 70s. The causes of this development in the food market are generally analysed as a mismatching of supply and demand, leading to lowest stocks in all four major food crops since the early 70s. Demand from the biofuel sector is mentioned as one reason for this, alongside bad weather conditions, energy prices and production costs, and trade policies aimed at reducing domestic prices whilst raising domestic supplies (notably rice export bans).

The OECD-FAO Agricultural Outlook 2008-2017 briefly reviews the developments between 2005 and 2007, using the same figures as the OECD report on rising wheat, coarse grains, rice and oilseed crops world prices (OECD 2008a). These reports clearly make a difference between agricultural commodity prices and food prices, noting that for instance food prices in countries which import either food or commodities have been strongly influenced by a 250% increase in transport costs over the two year period. Similar analyses to the IMF report are offered, mentioning the demand for biofuel feedstocks as one of several factors behind the food price crisis.

The USDA Grains and Oilseeds Outlook for 2008 (USDA 2008b) measures the percentage change in US season average farm prices from the previous season, for 2006/2007, 2007/2008, but without computing specific impacts of biofuels. The commodities are wheat, corn, rice, soybean, soybean meals and soybean oil. Note that for the latter two, prices are average prices recorded in Decatur (Illinois).

These four reports and the three earlier studies illustrate how different prices are used to illustrate and analyze the increase in "food prices". Some use indices, some use national prices, farm prices or world prices, which are all aggregates and can cover either commodities or final food products. Based on this fact alone, it is very risky to compare figures from different reports, or to take figures of one specific report and use it as "the" measure of the biofuels impact on "food prices".

Table 1: impacts of biofuel production on food prices to date

Authors	Impacts	Measured as…
Rosegrant 2008	+30% +12%	the difference between 2007 actual and simulated grain prices divided by the increase in prices between 2000 and 2007 under the actual biofuel growth scenario. the difference between 2007 "low-biofuel-growth" (simulated) and actual grain prices.
Mitchell 2008	+105%	the "biofuel-induced" percentage increase in the World Bank food price index between 2002 and 2008.
Collins 2008	+25 to 35%	the increase in annual growth of the US food CPI projected between 2006 and 2009, caused by an "ethanol-demand-induced" 60% increase in US maize price over the period.

3 Projections

A crucial aspect of modeling and simulation studies lies in their description of the biofuel sector and its interactions with the other sectors of the economy. Partial Equilibrium Models (PEMs) and Computable General Equilibrium (CGE) models have both been used for such simulation purposes; most studies to-date have used PEMs, with several institutes having developed their own model (e.g. IFPRI IMPACT model, FAPRI, OECD-FAO AGLINK/COSIMO model). *Stricto sensu* a PEM would focus on the agricultural markets, bundling the rest of the economy into one sector. Thus it can not simulate much cross-sectoral adjustment to shocks in the agricultural markets, and much of the impact of such shocks is passed on to the agricultural commodity prices. For medium term projections, a CGE model (by nature cross-sectoral) might portray a more accurate picture of the actual price adjustment (i.e. smaller). Yet, a CGE approach is difficult to implement in a multi-country context, as is the case for agricultural commodity markets, a strong argument in favor of PEMs. Some of these points are discussed in the Gallagher Review (2008).

In practice, some of the PEMs cited here allow for considerable cross-sectoral adjustment and some CGE models have several groups of countries. Thus the attributes of the two types of models are somewhat wider-ranging than basic models. Further, the extent of the commodity or food price variations in both types of models will depend more crucially on the assumptions used in the construction of the economic and “regional” sectors of each model. Hence most studies explain in considerable length under which macroeconomic and trade regimes they operate. A crucial example in the case of biofuels is the inclusion or exclusion of the most recent policies such as the EU Directive on Renewable Energy or the US Energy Independence and Security Act (2007). Other determinant factors affecting the projections include the specification of the scale of each study (e.g. world or national commodity markets), the type of prices investigated (real world prices, real regional export prices, national farm prices have all been used) and the type of biofuel policy and market assumptions that are simulated. Evidently, the direct comparison between studies is difficult.

For all projection models, the impact of biofuel production on food prices is always computed as the difference between baseline prices in a reference period (or sometimes projected prices under a baseline scenario) and projected prices under various biofuel policy scenarios (or simply scenarios of biofuel production growth). It would be overly tedious to report here on all the studies and all the projection scenarios that have been used. So we have selected figures coming from some of the more reputed institutes with established know-how in agricultural commodity markets projections and present the assumptions, methodologies and results of some of the projections these institutes have performed. This is sufficient to illustrate the variety of results (and assumptions/methodologies they rely on) which can be cited from the literature.

The IFPRI IMPACT model (PEM) was used to compute results mentioned in Rosegrant et al. (2006) and von Braun (2007 and 2008a). They forecast an increase in real prices by 2020, compared to a 1997 baseline for crop productivity and usage of biofuel feedstocks. The “policy” assumptions project the impacts without including the latest EU-DRE and US EISA 2007. The projections are believed to account for the emergence of new biofuel technologies. The policy scenarios are described below.

In Rosegrant et al. (2006), the three scenarios reflect (1) 20% gasoline (the 5 ethanol feedstocks) replacement throughout the world by 2020, except for Brazil, EU and US (specific targets). Biodiesel projections for EU-15 members only, crop productivity at baseline level; (2) 15% gasoline displacement by 2015, date at which cellulose ethanol appears, holding biofuel feedstocks constant thereafter, with crop productivity held at baseline level; (3) second generation technologies after 2015 as well as increased crop productivity in line with traditional IMPACT-based studies (e.g. strong productivity growth in SSA).

In von Braun (2008a), incorporating developments in biofuel sector (supply and demand) in 2005/06 which were not in Rosegrant et al. (2006), the two scenarios reflect (1) actual biofuel production plans and projections for relevant countries and regions; (2) drastic expansion of biofuel doubling the levels of scenario (1).

In Rosegrant (2008), the projected prices are compared to the baseline of 2007 prices under two policy scenarios: (1), the freezing of biofuel production at 2007 levels, and (2), eliminating biofuel production after 2007. Thus the focus here is on showing what would happen to commodity prices in the future (2010 and 2015) should steps be taken to slow down or stop biofuel production.

The resulting impacts on specific crops given in the three studies above are summarized in Table 2.

Wiggins et al. (2008), in a consultant report of the Overseas Development Institute for the Gallaguer Review (Gallagher 2008), use a CGE model to project to 2020, looking at the impacts of all major biofuel mandates, targets and support policies (predominantly in the EU, US and Brazil) compared to a 2007 baseline level of biofuel production. The world is split in four specific regions - the EU 27, NAFTA, Brazil and Sub-Saharan Africa (SSA) – and the rest of the world. Prices are average real export (FOB) prices received by the different regions determined by the model, for their exports to all regions of the model. Technology is assumed constant (i.e. no second generation biofuels) and factor markets all clear except in DCs, where labor is fully elastic for a fixed real wage. Results are summarized in Table 2.

The OECD-FAO Agricultural outlook 2008-2017, using their in-house combination of PEMs (AGLINK/COSIMO), does not refer specifically to a biofuel price impact, but projects commodity prices under the assumption of “business-as-usual” (i.e. unchanged trade and agricultural policies for all countries, constant technology, sustained high oil prices, continuing structural changes in demand for agricultural goods and no negative shocks on supply). The OECD report on the economic assessment of biofuel support policies (OECD 2008b) precisely targets this gap. The baseline is taken from the 2008-2017 outlook above, assuming continuation of current policies and thus does not model the impacts of EISA 2007 (US) and EU-DRE, or blending mandates for biodiesel valid since 2008 in Brazil; oil prices are assumed to remain between 90 and 104 US$ for the decade to come. No second generation technologies are accounted for in the baseline.

Some additions were brought into the AGLINK/COSIMO model to look specifically at further markets such as the sugar market. Also modeled is a specific biofuel module, as well as 13 modules for biofuels in specific developing countries (DCs). Biofuel chains are very comprehensively described in the model, also accounting for 2nd generation biofuels (cellulosic ethanol and BTL biodiesel). The three scenarios developed simulate:

(1) The removal of all current biofuel support policies, which include tariffs, mandates and budget supplements (tax credits, direct payments, etc.). The impact of each of the three categories is determined by the order in which they are introduced and removed. Here we only present the overall impact.
(2) The combined effects of the current policies, including EISA 2007 and DRE, as well as 2nd-generation biofuels (for which the crucial assumptions lie in the amount of crop land dedicated to grow biomass for these technologies, which we believe is part of the two policy packages).
(3) 2nd-generation technologies replacing the growth coming from 1st- generation biofuels in the baseline. This hypothetical scenario aims to highlight the impact of the growing biofuel industry on commodity markets and the relative impact that equivalent quantities of 2nd-generation fuels would have. So all biofuels are first cut at their 2007 levels in the 4 countries which have a specific representation for 2nd-generation fuels, where these fuels then take over the baseline growth in biofuels thereafter.

For all three scenarios, the numbers represent the average variations of real prices over the period 2013-2017, compared to the baseline. In some cases prices go up and then down over the period, thus the numbers represent the impact over the whole period. Results are summarized in Table 2.

Projections by FAPRI using a PEM (FAPRI 2008b), under similar macroeconomic, trade and policy assumptions to the OECD-FAO model, forecast real world export prices at main ports of exit (US Golf Ports, Rotterdam, etc.) over the next decade of the outlook (up to the 2017/18 marketing year). The outlook makes no attempt to quantify the impact of biofuel policies on commodity prices. However, this is done in FAPRI 2008a, which simulates the impacts of the US EISA 2007 on average projected real prices (we assume in the US) between the seasons 2011/2012 and 2016/2017. The reasons behind the choice of these seasons are that several biofuel policies in the US are reaching their expiry date by the end of 2010. There are five scenarios which are compared in a pairwise manner and are as follows. Provisions of the EISA 2007 with respect to advanced biofuels (e.g. cellulose ethanol) are not considered in the projections. Scenarios: (1) No EISA, credits extended; (2) EISA, credits extended; (3) No EISA, credits expire; (4) EISA, credits expire; (5) EISA, credits expire, no biofuel mandate. Comparing results of (1) and (2) gives the impact of EISA provisions given that credits are maintained.

Comparing (3) and (4) gives the impact of EISA provisions given that credits expire. Comparing (1) and (3) gives the impact of extending the credits and tariffs under pre-EISA policies. Comparing (2) and (4) gives the impact of extending the credits and tariffs under selected EISA provisions. Comparing (4) and (5) isolates the impacts of the biodiesel mandate and waiver under EISA, given that credits expire. The results of these five comparisons are summarized in Table 2.

Edwards et al. (2008), in an EU Joint Research Center report, extrapolate on FAPRI projections (PEM) and forecast 2020 world prices for cereals, vegetable oils and oilseed meals resulting from the 10% blending of first generation ethanol and biodiesel in the EU. These prices are compared to the same prices in 2020 but projected under a scenario with no biofuels in the EU by 2020. This is only a side topic in the report, whose main purpose lie in the impacts of biofuels on climate change (GHG emissions), energy security and employment. The results show that the 10% blending targets for ethanol and biodiesel by 2020 would increase world cereal prices in 2020 by 4%, 24% for vegetable oils and decrease world oilseed meals by 24%. The report notes that the EU 10% blending target thus cannot be the major reason behind recent food price hikes, although it is acknowledged that similar aggressive biofuel policies by other countries could contribute to a much larger impact on global crop prices. Further, changing the assumptions about the long-term area response supply flexibility, which were chosen on the high end of the scale, could translate into much larger price effects.

The agricultural projections to 2017 of the US Department of Agriculture (USDA 2008a) mostly contain projections of quantities (production, imports and exports) for the different crops worldwide. Nonetheless the report lays down all the assumptions which are then used for other USDA projections of the US food CPI, using the same model, but without specific analysis of the biofuels impact. Several assumptions are of particular importance in the context of this discussion paper. For instance, the US 2007 Energy Independence and Security Act was adopted after the report, which is then based on the Energy Policy Act 2005. In other countries, agricultural policies, trade reforms, technologies and changes in consumer preferences are assumed to stay on their current paths. For biofuels specifically, this translates into:

- In the EU: two thirds of the 5.65% blending target is achieved by 2010, still not quite reached by 2017; biodiesel accounts for 2/3 of total biofuels.
- In Brazil: the shift from grain and oilseeds to sugarcane continues, but slower; from 2008 mandates, biodiesel is set to increase sharply.
- In Canada: biodiesel production is to double between 2007 and 2017; ethanol (corn and wheat) production is to rise sharply over next 5 years.
- In Argentina: biodiesel production more than doubles between 2007 and 2017 (both from own crops and imported crops to be processed).
- In the rest Europe and the former USSR: producers respond to the EU demand, Russia and Ukraine more than triple rapeseed production by 2017.
- In China: because of food security policy, the focus is on sweet potato and cassava, no further growth in corn-ethanol.

- In Malaysia and Indonesia: only a moderate increase in their oil palm exports for biofuels, due to growing demand for human consumption.

The US food CPI is projected to increase by 4% in 2007, 3.2% in 2008, 2.9% in 2009, 2.5% in 2010 and 2.2% in 2011, its growth rate mostly stable around this value until 2017.

Banse and Grethe (2008) use a PEM (ESIM) in which all EU members are modeled in individually, as are Turkey and the US. The rest of the world is bundled into one aggregate. The model allows for set-aside land in EU to be used, as function of prices, direct payments and output prices (but production on set-aside land is not subject to biofuel subsidies). It also includes projected results of Doha negotiations, e.g. regarding EU tariff reductions. The paper projects the impact of EU biofuels only, on the EU and world market, by comparing a baseline 2020 scenario where biofuels reach 6.9% of total transport fuels, to a alternative 2020 scenario where this participation increases to 10% (following the proposal of the European Commission). The latter scenario is projected to increase world real prices by 7% for plant oils, 6% for oilseeds and 0.5% for wheat.

It is clear from the few results above and in Table 2 that predicted agricultural commodity prices significantly between sources. Attempting to reconcile the different figures may be a futile exercise and the different projections of prices and biofuels' impacts are probably better looked at as a whole to extract the common global trends. To that effect, it is worthwhile considering the above results in parallel with the opinions of a number of experts in commodity markets. These opinions are presented in the next section.

Table 2: projected impacts of biofuel policy scenarios

<table>
<tr><th>Study</th><th>Period</th><th>Price impact</th></tr>
<tr><td>Rosegrant et al. 2006</td><td>1997-2020</td><td>% increase of real prices, scenarios (1) to (3)
<table>
<tr><th>Crops</th><th>(1)</th><th>(2)</th><th>(3)</th></tr>
<tr><td>Cassava</td><td>135</td><td>89</td><td>54</td></tr>
<tr><td>Maize</td><td>41</td><td>29</td><td>23</td></tr>
<tr><td>Oilseeds</td><td>76</td><td>45</td><td>43</td></tr>
<tr><td>Sugarbeet</td><td>25</td><td>14</td><td>10</td></tr>
<tr><td>Sugarcane</td><td>66</td><td>49</td><td>43</td></tr>
<tr><td>Wheat</td><td>30</td><td>21</td><td>16</td></tr>
</table></td></tr>
<tr><td>von Braun 2008a</td><td>1997-2020</td><td>% increase of real prices, scenarios (1) and (2)
<table>
<tr><th>Crops</th><th>(1)</th><th>(2)</th></tr>
<tr><td>Cassava</td><td>11</td><td>27</td></tr>
<tr><td>Maize</td><td>26</td><td>72</td></tr>
<tr><td>Oilseeds</td><td>18</td><td>44</td></tr>
<tr><td>Sugarcane</td><td>12</td><td>27</td></tr>
<tr><td>Wheat</td><td>8</td><td>20</td></tr>
</table></td></tr>
<tr><td>Rosegrant 2008</td><td>2007-2010</td><td>% change of real prices, scenarios (1) and (2)
<table>
<tr><th>Crops</th><th>(1)</th><th>(2)</th></tr>
<tr><td>Cassava</td><td>-2</td><td>-14</td></tr>
<tr><td>Maize</td><td>-6</td><td>-20</td></tr>
<tr><td>Oils</td><td>-2</td><td>-1</td></tr>
<tr><td>Sugar</td><td>-1</td><td>-11</td></tr>
<tr><td>Wheat</td><td>-2</td><td>-8</td></tr>
</table></td></tr>
<tr><td>Rosegrant 2008</td><td>2007-2015</td><td>% change of real prices, scenarios (1) and (2)
<table>
<tr><th>Crops</th><th>(1)</th><th>(2)</th></tr>
<tr><td>Cassava</td><td>-5</td><td>-19</td></tr>
<tr><td>Maize</td><td>-14</td><td>-21</td></tr>
<tr><td>Oils</td><td>-6</td><td>-1</td></tr>
<tr><td>Sugar</td><td>-2</td><td>-12</td></tr>
<tr><td>Wheat</td><td>-4</td><td>-11</td></tr>
</table></td></tr>
<tr><td>OECD 2008b</td><td>2013-2017</td><td>% average variations of real prices between 2013-2017, three scenarios compared to same averages in OECD2008a
<table>
<tr><th>Crops</th><th>(1)</th><th>(2)</th><th>(3)</th></tr>
<tr><td>Wheat</td><td>-5</td><td>8</td><td>-4</td></tr>
<tr><td>Coarse grain</td><td>-7</td><td>14</td><td>-9</td></tr>
<tr><td>Oilseeds</td><td>-3</td><td>7</td><td>1</td></tr>
<tr><td>Vegetable oils</td><td>-16</td><td>36</td><td>-9</td></tr>
<tr><td>Oil meals</td><td>8</td><td>-11</td><td>8</td></tr>
<tr><td>Sugar</td><td>2</td><td>0</td><td>-22</td></tr>
</table></td></tr>
<tr><td>FAPRI 2008a</td><td>2011/2012-2016/2017</td><td>% change in 2011/12-2016/17 average real US prices, in each case the baseline being the first scenario mentioned
<table>
<tr><th>Crops</th><th>(1)-(2)</th><th>(3)-(4)</th><th>(1)-(3)</th><th>(2)-(4)</th><th>(4)-(5)</th></tr>
<tr><td>Corn</td><td>8.6</td><td>18.6</td><td>-9.6</td><td>-1.1</td><td>-0.7</td></tr>
<tr><td>Soybean</td><td>9.2</td><td>17.3</td><td>-7.4</td><td>-0.5</td><td>-8.4</td></tr>
<tr><td>Wheat</td><td>3.3</td><td>7</td><td>-3.9</td><td>-0.5</td><td>-0.7</td></tr>
<tr><td>Soybean meal</td><td>-17</td><td>-23.2</td><td>8.3</td><td>0.2</td><td>32.1</td></tr>
<tr><td>Soybean oil</td><td>35.8</td><td>72.1</td><td>-21.7</td><td>-0.8</td><td>-36.4</td></tr>
</table></td></tr>
<tr><td>Wiggins et al. 2008</td><td>2007-2020</td><td>% change of real average regional FOB export prices caused by biofuel policies, baseline 2007 prices
<table>
<tr><th>Crops</th><th>EU 27</th><th>NAFTA</th><th>Brazil</th><th>SSA</th></tr>
<tr><td>Rice</td><td>-2</td><td>-0.6</td><td>-0.8</td><td>0.2</td></tr>
<tr><td>Wheat</td><td>-2.6</td><td>-0.7</td><td>0.2</td><td>0.1</td></tr>
<tr><td>Grains</td><td>14.9</td><td>21.3</td><td>4.8</td><td>10.8</td></tr>
<tr><td>Oilseeds</td><td>53.2</td><td>71.8</td><td>25.2</td><td>24.9</td></tr>
<tr><td>Sugar</td><td>-0.7</td><td>1.6</td><td>-0.5</td><td>2.5</td></tr>
<tr><td>Veg. oil & fat</td><td>5.1</td><td>22</td><td>-1.4</td><td>3</td></tr>
</table></td></tr>
</table>

4 The Experts' Opinion

Many agricultural commodity market experts concur in listing the main factors behind the current food price crisis. These factors are interlinked for the most part, and thus opinions differ in the prevalence of specific factors or in the sequence in which they may have aggravated the impacts on food commodity prices.

Some authors view the expansion of food crops usage in response to increased demand for biofuels as the major cause behind the crisis (ISTA Mielke 2008, focusing only on oilseeds and biodiesel production), most see it as one of the factors (for instance Bruentrup 2008, European Commission 2008, FAO 2008, Greenpeace 2008, Oxfam 2008), and others see it as an almost irrelevant factor (Toepfer International 2008). It is difficult to disentangle the arguments behind each opinion, yet some facts cannot be by-passed. As off 2007, the share of feedstocks absorbed by the biofuel sector still represented the smaller part of the total demand for feedstocks. Fodder (36%) and food and seeds (60%) accounted for over 90% of the total demand for grain, whilst meeting the increase in non-biofuel demand for grain and oilseeds would require increasing production by 2% per year over the next 8 years (Toepfer International 2008).

Yet, the recent increase in demand for specific crops can be largely attributed to the biofuel sector. This is the figure painted in the Mitchell (2008) report, where the author reports that of the 55 million tons increase in US maize production between 2004 and 2007, 50 millions were absorbed by the biofuel sector. For the same period, the global increase in vegetable oil use for biodiesel is estimated at 6.6 million tons, representing 34% of the increase in global vegetable oil consumption.

In a period where the non-biofuel increase in demand would itself unlikely be covered by an equivalent increase in supply, and in markets notorious for their thinness[3] (Bruentrup 2008), the biofuel sector has no doubt proved to be an aggravating factor. The fact that several international commodity stocks have been at long term lows in the same period - either because of a stream of supply shocks, the lack of market responsiveness to sustained supply shortages, or agricultural policies – made for an unprecedented circumstantial mix leading to the current food price crisis.

This crisis is widely viewed as a short term shock (see for instance the forecasts of FAPRI 2008b and USDA 2008a) and the markets will eventually adjust. Nonetheless, the general consensus is that the more lasting demand and supply trends will slow down the adjustment process and ensure that agricultural commodity prices will stabilize above their pre-crisis levels (Bruentrup 2008) and will likely remain more volatile then in the past (Oxfam 2008). In that context it is worth noting that real food prices were at their all time lows during the late nineties and until 2005. The FAO (2008) clearly identifies the direction of price effects flowing from energy markets towards agricultural markets, energy prices dictating biofuel and biofuel feedstock pricing. This relationship has become stronger in recent times, as is evidenced in the report (Figure 14, p. 40, FAO 2008). The report further notes that the impact of energy prices will not stop at biofuel feedstocks, but will extend to all agricultural commodities which are relying on the same resource base. Crucially, this means that focusing on non-food biofuel feedstocks will not be enough to remove the competition between food and fuel production.

The longer term trends affecting agricultural markets from the demand side in recent times have been identified as the structural change in the demand for food commodities - stemming mostly from population and economic growth in developing countries as well as biomass demand from the energy sector. On the supply side, the prospect of a decreasing growth in agricultural production – the causes of this decline range from technological limits to sustained high energy costs, global natural resources degradation and climate volatility – also impedes on the stabilization of the agricultural markets. Governments' responses have so far not facilitated the adjustment and in several instances aggravated the speculative bubble around food prices by setting price ceilings in the case of maize in Mexico or export limitations and bans for different crops in India, Vietnam and China among others.

A European Commission report (EU 2008) gives a good qualitative analysis of the factors behind current high agricultural prices, for each specific agricultural commodity markets, and offers a comprehensive overview of all issues. In order to determine if recent food price increases are transitory or more permanent, the report sets out to differentiate between structural and temporary factors. The former will have lasting impacts on food prices, which is not necessarily the case for the latter. However, as the report shows, such analysis is itself subject to debate, as factors such as atypical weather patterns and high transport costs are difficult to classify in either category. In the first case, global climate change is presently modifying scientists' definitions of atypical weather patterns. On the other hand, transport costs are clearly affected by high oil prices, a factor which is itself to some degree both temporary and structural, as well as increased volumes of international trade and freight of all goods, which is likely to be structural. On the whole, the report concludes that structural factors, including biofuel production, are expected to sustain agricultural commodity prices at high levels. As already mentioned in other reports, these levels should be lower than currently observed once markets readjust as the effects of temporary factors start to fade. Nonetheless, the prognosis varies among commodities (see Figure 26, p. 33 in EU 2008). Medium term projections of oilseeds and corn prices are for instance not expected to decrease much from current highs. On the contrary, rice and wheat prices are expected to decrease significantly over the next 2 to 3 years, the decrease in rice prices lagging that of wheat by about a year. This is probably due to the fact that the recent gaps between wheat supply and demand were largely due to temporary weather shocks, something that is understood not to be projected for the coming seasons. Wheat and rice are substitutes in many cases and many projections assume a release of national rice export bans following better international wheat harvests.

[3] Thin markets are characterized with a low number of transactions, called volume of trade. The consequence is that it is difficult to trade the good without substantially affecting its price.

5 Conclusions

The different projections of the impact of biofuel production on food prices are difficult to reconcile. This is due to the specific assumptions underlying each model, the scope of the studies (national/international), their time horizon, the choices of different policy scenarios, or even more simply the definition of "food prices" and of aggregate commodity prices. Yet, it is clear that the current demand for biofuels is largely policy-driven and as such policy scenarios are very relevant to analyse their impact on specific feedstock prices. It is also natural that "regional" institutes test specific scenarios which are of "regional" interest.

Overall, the future impact (i.e. beyond the short-term crisis) of the current biofuel policies and inherent production trends on food bills should decrease (2007/08 should be the peak of food price growth) and most food CPIs are predicted to get back to "normal" annual growth rates over the next couple of years (USDA 2008a: by 2011 US food CPI ~2.2%).

The results of the various projections are probably better looked at as a whole to extract the global consensus on future agricultural commodity price trends. For most experts, the sudden increase in biofuel production (in combination with other "shocks") seems to have caused a relatively short term crisis in markets which were already affected by long-term trends leading to excess demand and slow supply responses. The combination of factors that recently affected the agricultural commodity markets and led to the crisis is unique, though its impacts will be felt over the mid- to long term, as longer lasting trends will prevent rapid adjustments and prices should remain above pre-crisis levels. The "non-biofuel" sources behind the current food price crisis (demand shift, supply shocks and stock and trade regimes) probably together account for a larger share of the price increase than biofuels alone, though some of them may be linked to the increased demand for biofuel.

Meanwhile, the impacts of the food price crisis are not distributed evenly. Large consequences have affected and will continue to burden specific segments of the world population and particular regions (net food buyers and importers), especially in DCs. Whilst shocks on commodity prices in the ranges mentioned above (+20 to +60% for specific crops over the past 3 to 7 years) have been shown to increase food CPIs annual growth rates by a couple of percents in industrialised countries, there are no known figures on their specific impacts on food CPIs in DCs. There, given the lower share of processed food in the household food expenditures, high commodity prices are likely to be passed more directly onto the consumers.

So, given the current crisis, biofuel policies ought to be designed very carefully, as other demand trends are not policy-driven and thus are not likely to reverse in the future. With this in mind, the CGIAR Science Council points to more research in next generations technologies for bioethanol and biodiesel large scale production, whilst simultaneously holding back on the implementation of current mandates for biofuel blends in the transport sector. Current technologies should be targeting small-scale production in and for rural economies in DCs, focusing on the use of biofuels for power generation.

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