Biofuels And Food Prices: A Review Of Recent And Projected Impacts

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Abstract

The various calculations of the impacts of biofuel production on food and commodity prices to-date and on their 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.

Agreed upon by all sources is the fact that between 2005 and 2007 many agricultural commodity prices increased sharply. The impact of this increase on household food expenditures is less clear. Also debated is the actual impact of biofuels on the price increase. To project the mid-term commodity prices, all factors affecting the supply and demand of food commodities must be integrated in the simulations, which can then be subjected to different biofuel production scenarios.

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 price impact on vegetable oils over the mid term, the price increase for commodities such as wheat, corn and soybean should be smaller, whilst the price of oilseed meals is widely predicted to decline. However, the magnitude of the impacts could be much contrasted at regional levels. Overall, a freeze of biofuel production at the 2007 levels predicts a decline in food commodity prices by less than 10% between 1997 and 2020.

Keywords: Biofuel production; biofuel policies; food prices; agricultural commodity prices; projections.

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 in 2007 and several increases have been observed in 2008.

In that context, ambitious fossil fuel replacement targets, primarily in the US and the EU, 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.

In this 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 (commodity) prices.

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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.

Firstly, researchers at IFPRI (see Rosegrant 2008 and von Braun 2008b) have produced a study where 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*. This reveals that the sharp change in biofuel production 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 in the price increase is calculated as follows: $\%share = \frac{p_{2007}^{actual} - p_{2007}^{simulated}}{p_{2007}^{actual} - p_{2000}^{actual}} * 100$ with $p_{2007}^{actual} > p_{2007}^{simulated} > p_{2000}^{actual}$.[1] 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 calculated as $\Delta price = \frac{p_{2007}^{actual} - p_{2007}^{simulated}}{p_{2007}^{simulated}} * 100$. 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. Note that several more increases have been recorded in 2008 and are not part of the data referred to in these studies. Thus the numbers cited above may be increased substantially in a 2000-2008 comparison.

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 (Mitchell 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[2] and 20% coming from a weak dollar.[3] 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

[1] 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).

[2] 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.

[3] 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%.

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 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.

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.

Five other reports mention and loosely investigate the causes of recent hikes in food and commodity prices (World Bank 2008, IMF 2008, OECD-FAO 2008, OECD 2008a, USAD 2008b). The impacts of biofuel production are not quantified, but these studies illustrate the fact that 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.

3. Projections

A crucial aspect of 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. *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 their impact is passed on to the commodity prices. For medium term projections, a CGE model (by nature cross-sectoral) might portray a more accurate picture of the actual price adjustment. Yet, a CGE approach is difficult to implement in a multi-country context. Some of these points are discussed in the Gallagher Review (Gallagher 2008). In practice, some of the PEMs cited here allow for considerable cross-sectoral adjustment and CGE models can have several groups of countries. Further, the extent of the commodity or food price variations in both types of models will depend more crucially on the macroeconomic assumptions and trade regimes under which the models operate. An example in the case of biofuels is the inclusion or exclusion of the most recent policies such as the EU Directive on Renewable Energy (DRE) or the US Energy Independence and Security Act (EISA) 2007. 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 scenario and projected prices under various biofuel policy scenarios. To illustrate the variety of results (and assumptions/methodologies) we have selected figures from some of the more reputed institutes with established know-how in agricultural commodity markets projections.

The IFPRI IMPACT model (PEM) was used to compute results mentioned in Rosegrant (2008) and von Braun (2008a). The latter forecasts 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 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 two studies above are summarized in Table 1.

The OECD-FAO Agricultural outlook 2008-2017, using their in-house combination of PEMs (AGLINK/COSIMO), projects commodity prices under the assumption of "business-as-usual" (i.e. all trends and policies as off 2007). The OECD report on the economic assessment of biofuel support policies (OECD 2008b) quantifies the impact of biofuel policy. The baseline is taken from the 2008-2017 outlook and thus does not model the impacts of EISA 2007 and EU-DRE, or blending mandates for biodiesel valid since 2008 in Brazil. No second generation biofuel technologies are accounted for in the baseline, but biofuel chains are comprehensively described in the model. The three scenarios developed simulate: (1) the removal of all current biofuel support policies, which include tariffs, mandates and budget supplements; (2) the combined effects of the current policies, including EISA 2007 and DRE, as well as 2^{nd}-generation biofuels; (3) 2^{nd}-generation technologies replacing the growth coming from 1^{st}- generation biofuels in the baseline. For all three scenarios, the numbers represent the average variations of real prices over the period 2013-2017, compared to the baseline. Results are summarized in Table 1.

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 over the decade of the outlook (up to the 2017/18 marketing year). The impact of biofuel policies on commodity prices is quantified in FAPRI (2008a), which simulates the impacts of the US EISA 2007 on average projected US real prices between the seasons 2011/2012 and 2016/2017. Five scenarios are compared. Advanced biofuels (e.g. cellulose ethanol) are not considered in the projections. Comparing results of scenarios (1) and (2) gives the impact of EISA provisions given that biofuels 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 1.

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 compared to a 2007 baseline level of biofuel production. The world is split in four specific regions - the EU27, 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). Results are summarized in Table 1.

Edwards et al. (2008) 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 projected 2020 prices under a scenario with no biofuels in the EU by 2020. 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.

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

Table 1: projected impacts of biofuel policy scenarios

The agricultural projections to 2017 of the US Department of Agriculture (USDA 2008a) mostly contain projections of production, imports and exports for crops worldwide. Nonetheless the report lays down all the assumptions which are then used for USDA projections of the US food Consumer Price Index (CPI) using the same model. The EISA 2007 was adopted after the report, which is 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 (assumed to be pre-2007). 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 which allows for set-aside land in EU to be used, as function of prices, direct payments and output prices. It also includes projected results of

Doha negotiations, e.g. regarding EU tariff reductions. The impact of EU biofuels on the EU and world market, using two scenarios where biofuels reach 6.9% and 10% of total EU transport fuels respectively, is projected to increase world real prices by 7% for plant oils, 6% for oilseeds and 0.5% for wheat.

4. The Experts' Opinion

Many agricultural commodity market experts concur in listing the main factors behind the current food price crisis. The current structural trends affecting agricultural markets from the demand side stem 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 – due to technological limits, sustained high energy costs, global natural resources degradation and climate volatility – also impedes on the stabilization of the agricultural markets. Governments' have in several instances aggravated the speculative bubble around food prices by setting price ceilings or export restrictions. Most of the factors above are interlinked and thus opinions differ in their prevalence or in the sequence in which they may have aggravated the impacts on food prices (ISTA Mielke 2008, Bruentrup 2008, European Commission 2008, FAO 2008).

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 (Toepfer International 2008). Yet, the recent increase in demand for specific crops can be largely attributed to the biofuel sector. Between 2004 and 2007, of the 55 million tons increase in US maize production, 50 millions were absorbed by the biofuel sector and the global increase in vegetable oil use for biodiesel represented 34% of the increase in global vegetable oil consumption (Mitchell 2008).

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[4] (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 generally viewed as a short term shock (see for instance the forecasts of FAPRI 2008b and USDA 2008a). Nonetheless, 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. Further, the FAO (2008) clearly identifies the direction of price effects flowing from energy markets towards agricultural markets. This relationship has become stronger in recent times (FAO 2008) and will extend to all agricultural commodities which are relying on the same resource base as biofuels. Thus focusing on non-food biofuel feedstocks will not be enough to remove the competition between food and fuel production.

A European Commission report (European Commission 2008) qualitatively analyzes the factors behind current high agricultural prices for each specific agricultural commodity markets. The report differentiates 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, factors such as atypical weather patterns and high transport costs are difficult to classify in either category: global climate change is modifying the definitions of

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

atypical weather patterns; transport costs are affected by (temporary and structural) high oil prices as well as structural increases in volumes of international trade and freight of all goods. The report concludes that structural factors, including biofuel production, are expected to sustain agricultural commodity prices at high levels. As already mentioned above, these levels should be lower than currently observed as the effects of temporary factors start to fade. Nonetheless, medium term projections of oilseeds and corn prices are for instance not expected to decrease much from current highs. On the contrary, wheat and rice prices are expected to decrease significantly over the next 2 to 3 years, the latter lagging the former by about a year. The reason is that the recent gaps between wheat supply and demand were largely due to temporary weather shocks, which are not 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.

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 and commodity prices.

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 and 2007/08 should be the peak of food price growth.

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 the US, there are no known figures of their 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.

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 Consultative Group on International Agricultural Research (CGIAR) Science Council (CGIAR 2008) points to more research in next generations technologies for bioethanol and biodiesel large scale production, whilst simultaneously holding back on the implementation of new 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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