Food vs. fuel five years on

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Overview

• Biofuel was introduced with many good intentions
  – Reduce green house gas emission
  – Increase fuel security
  – Increase farm income: the main reason for ag support policies in the 20th century – was excess food supply
    • low food prices that required subsidies and let to land set aside

• However biofuel was introduced during a period of transition
  • Increase income and demand for food/
  • Slow growth of supply

• That led to concerns about food vs. fuel
Economists have develop several approaches to understand this issue

• The basic partial equilibrium model
• World bank approach
• Relationship between food and fuel prices
• Storage considerations
• Conclusions
Biofuel And the Food Market - partial equilibrium short term analysis

Market for Food and Energy Crops

- Food Demand
- Joint Demand
- Supply
- Supply w/ GMO
- Biofuel Demand
- Ag Expansion
- Crop Quantity

Quantity

$
The Basic Economics of Biofuel

• Introduction of Biofuels:
  – Increased food prices; and
  – Reduces food availability

• The effects can be countered by:
  – Increased agricultural and conversion productivity
  – Second generation biofuels
  – Ag Biotech
The importance of elasticities - measures of responses of Changes

• When it come to food commodities
  – 1% increase in price will lead to a .3%-.5% increase in demand and a small change in supply
  – 1% increase of income in developing countries will increase the consumption by 1% -

• Thus
  – a 1% reduction in quantity may increase prices by 1.5-3% in the shirt run
  – Economic growth in Asia and elsewhere contribute to increase food prices
Early study: Simulating the impact of US biofuel on food and gas prices

- Average US gasoline price in 2007 - $2.84 per gallon
- Average US corn price in 2007 - $4.72 per bushel
- Average US soybean price in 2007 - $10.34 per bushel

<table>
<thead>
<tr>
<th></th>
<th>High</th>
<th>Mid</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in gas price</td>
<td>-2.3%</td>
<td>-1.8%</td>
<td>-1.4%</td>
</tr>
<tr>
<td>Change in corn price</td>
<td>18%</td>
<td>24%</td>
<td>39%</td>
</tr>
<tr>
<td>Change in soy price</td>
<td>11%</td>
<td>15%</td>
<td>24%</td>
</tr>
</tbody>
</table>

Changes show what actual prices were compared to a scenario that would have existed if there were no biofuels.
Commodity price trends: The big picture

During the 21st century, commodity prices spiked to new highs.
This report focuses on crop prices from 2002 to 2007.

Data source: IMF primary commodity price database

World Bank, March 2010
Crop price trends

Cumulative increase in world price (in 2005 US$) with respect to 2001

<table>
<thead>
<tr>
<th></th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
</tr>
</thead>
<tbody>
<tr>
<td>corn</td>
<td>11%</td>
<td>17%</td>
<td>25%</td>
<td>10%</td>
<td>35%</td>
<td>82%</td>
<td>149%</td>
</tr>
<tr>
<td>soybean</td>
<td>11%</td>
<td>34%</td>
<td>60%</td>
<td>32%</td>
<td>30%</td>
<td>81%</td>
<td>163%</td>
</tr>
<tr>
<td>rapeseed</td>
<td>-15%</td>
<td>3%</td>
<td>40%</td>
<td>99%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>rice</td>
<td>11%</td>
<td>13%</td>
<td>38%</td>
<td>64%</td>
<td>75%</td>
<td>89%</td>
<td>293%</td>
</tr>
<tr>
<td>wheat</td>
<td>16%</td>
<td>15%</td>
<td>24%</td>
<td>22%</td>
<td>54%</td>
<td>103%</td>
<td>166%</td>
</tr>
</tbody>
</table>

Since 2008 we have cycled but 2008 was the peak
Is biofuel the culprit?*

<table>
<thead>
<tr>
<th>Source</th>
<th>Estimate</th>
<th>Commodity</th>
<th>Time period</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>21-22 %</td>
<td>rice &amp; wheat</td>
<td>2000 – 2007</td>
</tr>
<tr>
<td>OECD-FAO (May 2008)</td>
<td>42 %</td>
<td>coarse grains</td>
<td>2008 – 2017</td>
</tr>
<tr>
<td></td>
<td>34 %</td>
<td>vegetable oils</td>
<td>2008 – 2017</td>
</tr>
<tr>
<td></td>
<td>24 %</td>
<td>wheat</td>
<td>2008 – 2017</td>
</tr>
<tr>
<td>Collins (June 2008)</td>
<td>25-60 %</td>
<td>corn</td>
<td>2006 – 2008</td>
</tr>
<tr>
<td></td>
<td>19-26 %</td>
<td>US retail food</td>
<td>2006 – 2008</td>
</tr>
<tr>
<td>Glauber (June 2008)</td>
<td>23-31 %</td>
<td>commodities</td>
<td>April 2007 – April 2008</td>
</tr>
<tr>
<td></td>
<td>10 %</td>
<td>global food index</td>
<td>April 2007 – April 2008</td>
</tr>
<tr>
<td></td>
<td>4-5 %</td>
<td>US retail food</td>
<td>January – April 2008</td>
</tr>
<tr>
<td></td>
<td>3 %</td>
<td>global food index</td>
<td>March 2007 – March 2008</td>
</tr>
<tr>
<td>Rajagopal et al. (2009)</td>
<td>15-28%</td>
<td>Corn</td>
<td>2007</td>
</tr>
<tr>
<td></td>
<td>10-20%</td>
<td>soybean</td>
<td></td>
</tr>
</tbody>
</table>
World bank model (MITCHEL)

Based on economic logic:

• Analyzed the rapid food price rises between 2002-2008
• Found that higher energy prices (leading to higher fertilizer and transport costs), as well as the weak dollar, caused food prices to rise by about 35-40 percentage points from January 2002 until June 2008, and that explains 25-30 percent of the total price increase.
• Most of the remaining 70-75 percent increase in food commodities prices was due to biofuels and the consequences of low grain stocks, large land use shifts, speculative activity and export bans.
The debate

• There was an agreement that
  – biofuel increase agricultural commodity prices
  – Much less final consumer prices in developed nations
  – Has negative impact on the poor

• But how much?

• The world bank study (the 75% effect) fueled strong anti biofuel sentiment yet

• it was not based on data analysis

• Scholars tried to take alternative direction looking at price data
Two bodies of literature asked two related question

- What are the Relationship between food and fuel prices
- How Biofuel affect food prices

- We will look at the results of studies on relationship between prices first
- And then return to studies on the impact of biofuel on food prices
Serra et-al Studies of time series of prices

- They investigated the relationship between oil, gas, ethanol and corn and found
- Two basic equilibrating systems
  - The refinery system: gasoline prices leads oil prices
  - The biofuel system: ethanol price is increasing with the prices of gasoline and corn
There was a drastic increase in the price of oil after 2005 and we can see the two peaks of corn. The first had very little impact on the prices of fuel, but after 2000, the fuel and corn markets become interdependent.

Ethanol price is very volatile
Mostly follows gasoline price
But when corn is high follows corn prices
The ethanol market is close to dynamic equilibrium when the coefficient is close to zero. We have disequilibrium in the 21st century. Oil dominance in 2006 and corn dominance in 2008. People who entered the market in 2008 were in trouble.

Figure 2
Evolution of the value of the threshold variable over time

Notes: the values of the threshold variable that correspond to $G > 0.5$ are represented by the solid thick line. The solid thin line is used for the threshold values corresponding to $G \leq 0.5$. 

Ethanol oil and sugarcane in brazil

- Oil price and sugar cane price lead biofuel prices
- Increases in sugar prices found to increase ethanol price levels and volatility.
- Crude oil and sugar prices are moving independently in the long run –
  - but are related in the short run through ethanol and fuel markets.
Multi-fuel and food prices (Zhang 2010)

- Monthly price data for corn, rice, soybean, sugar and wheat as well as ethanol, gasoline and oil between 1981 to 2007,
- There are Long-run relationships between
  - the prices of gasoline and oil and the prices of ethanol and gasoline,
  - as well as three consistent long-run relationships between the prices of agricultural commodities
- No significant link between fuel and food prices
Correlations between commodity prices in the US and EU between 2003 and 2008

- Corn ethanol prices related to energy and food prices
- Sugar ethanol prices were mostly related to energy prices.
- Food prices and fuel prices are linked among themselves
- Time matters: Different results for weekly, monthly and quarterly data
- Geography matters: Prices are more correlated within regions
Conclusion of food and fuel price models

- Ethanol prices are related to food and fuel prices
- They do not affect significantly either
- Does it mean that ethanol does not affect food prices? NO
- Biofuel price may change for many reasons-increase refining capacity, high fuel prices, and the directional relationship between the prices vary
- Biofuel pricing is not determined by competitive markets-there are subsidies etc.
biofuel food and fuel

Increase in biofuel because of more refining will reduce its price and increase food price.

Increase in biofuel supply because of higher fuel price will increase biofuel price and increase food price.
Dynamic vs. static consideration

- When you have the finite acreage in the short run there is substitution—more fuels in less food.
- But in the long run—things change—increase in food price may lead to investments that will increase productivity.
- If acreage can expand—as in sugar cane—there is no reason to have food vs. fuels in the longer run.
Recent studies on impact of biofuel on food prices

- Roberts and Schlenker
  - Foods are substitutes – calories matter
  - Study demand for calories rather than specific food
  - Suggested that biofuel led to 30% increase in price of calories
  - But if you consider DGGs the impact is 20%
Byproduct of indirect land use analysis.

• CHAKRAVOTY SURVEY Food price may increase (the price of food commodities) by 65–75% by the year 2020 because of biofuel.

• When more advanced second-generation biofuels that use less land are introduced, these figures decline to 45–50%.
Policy and technology matter

• De Gorter Just- import tax on Brazilian biofuel increase food prices
• Khanna- RFS food prices rise faster with than with LCFS
Multimarket analysis

• biofuel standards are important contributors to the rise of food prices, they are not the dominant one.
• two thirds of the increase in food prices will come from increased food demand because of economic growth,
• biofuel mandates will contribute only one third.
Multifactor analysis

- Hochman et-al considered the impact of growth, biofuel high energy prices and exchange rate
- Model storage demand as well
- Without storage prices would have risen faster between 2001-2007
- But in 2008 storage was low and it caused panic
Total explained price increase from 2001 to 2007 (for inelastic scenario)

- Inventory kept prices lower than they would have been otherwise-long term effect
- But, as inventory declined it added to price increase-short term effect
- We will simulate the impact of low inventory
- Regress relative impacts of all factors

Net effect of four shocks, namely, biofuel, income growth, energy price and exchange rate

<table>
<thead>
<tr>
<th></th>
<th>With inventory</th>
<th>Without inventory**</th>
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</thead>
<tbody>
<tr>
<td>Corn</td>
<td>84%</td>
<td>92%</td>
</tr>
<tr>
<td>Soybean</td>
<td>55%</td>
<td>73%</td>
</tr>
<tr>
<td>Rapeseed</td>
<td>98%</td>
<td>120%</td>
</tr>
<tr>
<td>Rice</td>
<td>47%</td>
<td>116%</td>
</tr>
<tr>
<td>Wheat</td>
<td>63%</td>
<td>71%</td>
</tr>
</tbody>
</table>

*Inventory
**Without inventory
Comparing baseline: Change in prices in 2007 with respect to 2001

<table>
<thead>
<tr>
<th>Biofuel</th>
<th>Baseline* scenario</th>
<th>Inelastic** scenario</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>20%</td>
<td>25%</td>
</tr>
<tr>
<td>Soybean</td>
<td>7%</td>
<td>8%</td>
</tr>
<tr>
<td>Income</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Corn</td>
<td>30%</td>
<td>38%</td>
</tr>
<tr>
<td>Soybean</td>
<td>29%</td>
<td>31%</td>
</tr>
<tr>
<td>Rice</td>
<td>30%</td>
<td>31%</td>
</tr>
<tr>
<td>Wheat</td>
<td>24%</td>
<td>40%</td>
</tr>
</tbody>
</table>

* - Uses elasticities from FAPRI databases of elasticities
** - Elasticities based on Gardner (1987) which are more inelastic

Elasticity matters
Lower the elasticity higher the impact of shocks
From 2008-2011

• Story has not changed much – biofuel is an important contributor to high corn prices
  – If biofuel will be eliminated today's corn prices will be decline by 33% (de Gorter Rausser)

• Productivity growth in agriculture—much relate to GM will contribute to reduce food prices

• Need to worry about climate change and adaptation
The impacts of GMO

• Impact on GMO on output
  – Cotton 21-34% increase
  – Corn 8%-17% increase
  – Rapeseed 6-18% increase
  – Soybean 14-36 % increase in supply

• Without biotechnology,
  – corn prices would have increased by 12-40%
  – Soybean by 22-45 % (Cotton 30-50%)

• If the ban on biotech in Europe is removed- it is adopted in EU and Africa and with wheat- price reductions are larger than the impact of biofuel
conclusions

• Biofuel that replace crop affect food prices in the short run—quite substantially
  — But other factor have larger impacts on food prices
  — Good inventory management can affect price dynamics

• In the longer run the price effect can be lower
  — Higher prices trigger innovation
  — Yet -Regulation can stifle these innovation

• The impacts of biofuel on prices vary across crops
  — When land and technology is available impact is smaller
Some perspective

• Biofuel is one factor –
  – climate change and population and income growth are much more important factor affecting food prices

• Biofuel increased Ag R&D and investment
  – Led to increase productivity
  – Adaption to climate change and population growth depend on technology and innovation
    • Development of optimal regulation is a challenge

• Expanded Sugar cane in Brazil and second generation biofuels can provide much more fuel without much conflict.