Do Oil Price Increases Cause Higher Food Prices?

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The Policy Debate in the World

International Food Policy Research Institute (2008): “Rising prices for agricultural crops are causing food riots in many developing countries”; “37 countries are facing food crises”

World Bank (2011): “Millions of people will be driven into poverty by higher food prices in the absence of policy changes”

2011 Interagency Report to the G20: Causes and policy implications of increased price volatility in food and agricultural markets
The Policy Debate in the United States

Chicago Tribune: “increases in the prices of the basic commodities … have resulted in a tighter squeeze on American families as they face the fastest rise in food prices in 20 years”

Sacramento Bee: “things like hamburger that used to be everyday food are becoming luxuries”

⇒ Resurgence in academic research on the pass-through from agricultural commodity prices to the retail price of food
Are Food Price Increases an Unintended Consequence of Biofuel Policies?

- Sustained price increases can be found in oil as well as in agricultural commodity markets. Is there a link?

- A common view is that this link was created or strengthened by biofuel policies.

- Biofuels are produced from food commodities such as corn, grains, oil seeds, or sugar.

- Do we need to reduce (or even terminate) biofuel production in the interest of affordable food?
The Academic Literature on Effect of Bio Fuel Policies

Hausman, Auffhammer & Berck (EnvResEc2012), Carter, Rausser & Smith (mimeo 2013):

Between 10% and 34% of crop price increases due to U.S. biofuel policies.

Wright (JEP 2014):

Biofuel policies caused all of the food price increases because of substitution effects in production and in consumption and because of stockpiling in expectation of rising demand for ethanol.
A Brief Review of Changes in U.S. Biofuel Policies

High octane gasoline = low octane gasoline (refined crude oil) + additive (MTBE or ethanol)

After it was discovered that MTBE leakage contaminates the ground water, the U.S. Congress failed to grant liability waivers for using MTBE in 2005, making ethanol the only available gasoline additive after May 2006.

Since then Congress has mandated the use of ever higher quantities of ethanol in U.S. gasoline production since May 2006.

Engine technology limits the degree of substitutability between ethanol and low-octane gasoline: The ethanol share increased from 3% in 2006 to 10% in 2011.
Our Objective in this Paper

- We are not concerned with the effects of biofuel policies.
- We are interested in understanding the dynamic relationship between oil prices and food prices, especially after the change in U.S. biofuel policies in 2006.

Challenges:
1. Important distinction between agricultural commodity prices and retail food prices
2. Oil prices and food prices are jointly determined.
3. Unanticipated oil price increases do not occur all else equal (Kilian AER 2009).
4. The pass-through from oil prices to food prices depends on the reaction of the central bank (Hamilton IJCB 2012).
5. Only U.S. has detailed agricultural and food price data.
Food Price Increases in Historical Perspective

1. How do average changes in the real price of food compare with changes in the real prices paid and received by farmers?

2. How do they compare with changes in the price of crude oil and of oil products such as diesel fuel?

\[ \Rightarrow \text{Has this relationship tightened after May 2006?} \]

\[ \Rightarrow \text{Has the volatility in the real price of food increased?} \]

\[ \Rightarrow \text{Has the correlation in the growth rates of real oil prices and real food prices increased?} \]
Percent Growth Rates of Selected Prices before and after May 2006

1999.5-2006.4

Real Price of Oil

Real Price of Corn

Real Price of Food

2006.6-2013.5

Real Price of Oil

Real Price of Corn

Real Price of Food
Understanding the Discrepancy between Crop Price Increases and Retail Food Price Increases

Facts:
Growth in real food CPI: 0.9% per annum.
Growth in real crop prices: Between 7% and 15% per annum.

Explanation:
Overall agricultural products account for less than 20% of the cost of food to retail consumers.

Example:
The share of wheat in the cost of bread historically has been about 5% (Economic Research Service of the USDA).

⇒ A doubling of the wheat price implies a 5% increase in the retail price of bread: \(0.95 \times 1 + 0.05 \times 2 = 1.05\).
Was there a Causal Relationship between Oil Price Shocks and Crop Prices Prior to May 2006?

Case study:
The invasion of Kuwait in 1990 resulted in a large oil price spike that is exogenous with respect to agricultural markets.

⇒ Response of farmers’ crop prices (wheat, soybeans, corn)?
Case Study of Farm Crop Prices during 1990
A Structural Change in May 2006?

Carter, Rausser, & Smith (mimeo 2013):
40% of U.S. corn production used for ethanol in 2012 compared with 14% in 2005.

Informed market participants would have been well aware by late 2006 of the impending boom of ethanol production.

Tyner (AgrEc 2010):
Oil and food prices more closely linked in recent years.

Mallory, Irwin & Hayes (EnEc 2012):
Change in statistical relationship between corn and ethanol futures prices in mid-2006.
Quantifying the Channels of Transmission

- Responses to real oil price innovation in bivariate VAR(6) model with intercept estimated by least squares.

- Real price of oil treated as predetermined with respect to the other variables (see Kilian & Vega REStat 2011).

- Results robust to the inclusion of seasonal dummies and to increasing the lag order to 12.

- Focusing on the real price of food (or on price spreads) helps control for monetary policy responses to fluctuations in the price of imported commodities.
Response to a 1% Real Oil Price Shock of Consumer Food Prices
Relative to Consumer Prices Excluding Food and Energy

NOTES: Estimates from monthly bivariate vector autoregressions under the identifying assumption that the real price of oil is predetermined with 90% bootstrap confidence bands.
Why this Response to Real Oil Price Shocks?

Two potential transmission channels:

A. Oil price shocks affect agricultural crop prices

B. Oil price shocks affect cost of food marketing
A. The Role of Agricultural Crop Prices in the Transmission of Oil Price Shocks

1. Gasoline producers blend low-octane gasoline with ethanol in approximately fixed proportions.

⇒ Reduced oil supply causes reduction in demand for ethanol

⇒ Increased oil demand associated with global business cycle causes increase in demand for ethanol
It also raises real incomes, which affects demand for corn (and other crops)
Increased competition for land, water, fertilizer induces cost-push for related crops (but not across the board).
2. To the extent that there is substitution between low-octane gasoline and ethanol, higher oil prices increase demand for ethanol:

⇒ Limited flexibility except during transition period.

3. Cost push as higher oil prices raise the cost of fuel used in agriculture:

⇒ A doubling of diesel fuel prices would be associated with a 5% increase in farm production costs, approximately.
Response of Grain Prices to a 1% Real Oil Price Shock

1974.2-2006.4
Real Price of Corn

Real Price of Wheat

Real Price of Soybeans

Real Price of Rice

2006.5-2013.5
Real Price of Corn

Real Price of Wheat

Real Price of Soybeans

Real Price of Rice

NOTES: Estimates from monthly bivariate vector autoregressions under the identifying assumption that the real price of oil is predetermined with 90% bootstrap confidence bands.
Do the Crop Price Responses Reflect Cost Push or Demand Pull?

**Natural experiment:**
- Nitrogen fertilizer is produced from natural gas, not crude oil.
- The wellhead price of natural gas fell sharply in the United States in recent years, while the price of crude oil surged.

⇒ How different is the response of the real price of fertilizer from that of animal feed and fuel?
Response to a 1% Real Oil Price Shock
2006.5-2013.5

NOTES: Estimates from monthly bivariate vector autoregressions under the identifying assumption that the real price of oil is predetermined with 90% bootstrap confidence bands.
B. Oil Price Shocks and the Cost of Food Marketing

- Agricultural raw products are a small share of the cost of food. The larger share is the cost of food marketing.

- Food marketing includes:
  Processing, storage (including refrigeration), packaging (plastics), advertising, transportation (trucking), local distribution.

- Price spreads for different stages of marketing allow us to assess the effects of oil price shocks on various components of the retail price of food.
Response of Pork and Beef Price Spreads to a 1% Real Oil Price Shock
2006.5-2013.5

NOTES: Estimates from monthly bivariate vector autoregressions under the identifying assumption that the real price of oil is predetermined with 90% bootstrap confidence bands.
Tentative Summary

1. Small response of crop prices to a 1% real oil price shock:
   ⇒ Peak response: 0.5%

2. Negligible response of retail food prices:
   ⇒ Peak response: 0.05%

3. Higher oil prices are not driving retail food prices by raising the cost of food marketing.

4. Crop price responses cannot be explained based on cost push effects of oil price shocks.
   ⇒ Crop price increases are driven by demand.
   ⇒ Many possible sources of demand (e.g., biofuel subsidies, biofuel policies, substitution effects, global business cycle)
The Identification Problem Revisited

- Do higher crop prices just reflect the global business cycle?

- An unanticipated expansion in global industrial activity is associated with increased demand for industrial raw materials to be used in the production of industrial goods (“flow demand”).

- Estimates of such flow demand shocks, $u_t$, may be recovered from structural global oil market models such as the models in Kilian & Murphy (JAE 2014) and Kilian & Lee (JIMF 2014).

- Distributed lag model:

  $\Delta p_{t}^{\text{corn/CPI}} = \alpha + \beta_0 u_t + \beta_1 u_{t-1} + \ldots + \beta_{12} u_{t-12} + \varepsilon_t$

  $\partial \Delta p_{t+h}^{\text{corn/CPI}} / \partial u_t = \beta_h, \quad h = 0,1,2,...,12.$
Responses of Grain Prices to Global Flow Demand Shocks: 2006.5-2013.5

NOTES: Estimates from distributed lag models relating the growth rate in each real grain price to exogenous flow demand shocks obtained from an update of the model of Kilian and Lee (2014) with 1-standard error bootstrap confidence bands.
<table>
<thead>
<tr>
<th>Crop</th>
<th>Percent of Variation</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>27</td>
</tr>
<tr>
<td>Wheat</td>
<td>17</td>
</tr>
<tr>
<td>Soybeans</td>
<td>19</td>
</tr>
<tr>
<td>Rice</td>
<td>24</td>
</tr>
</tbody>
</table>

NOTES: Estimates recovered from fitted distributed lag models.
Growth Rate in Grain Prices Unexplained by Flow Demand Shocks
2006.5-2013.5

Growth of Real Price of Corn Unexplained by Flow Demand Shock

Growth of Real Price of Wheat Unexplained by Flow Demand Shock

Growth of Real Price of Soybeans Unexplained by Flow Demand Shock

Growth of Real Price of Rice Unexplained by Flow Demand Shock

NOTES: Residuals from distributed lag models relating the growth rate in each real grain price to flow demand shocks obtained from an update of the model of Kilian and Lee (2014).
### Correlation of Residual Growth Rates in Real Grain Prices after Controlling for Cumulative Effect of Flow Demand Shocks: 2006.5-2013.5

<table>
<thead>
<tr>
<th></th>
<th>Corn</th>
<th>Wheat</th>
<th>Soybeans</th>
<th>Rice</th>
</tr>
</thead>
<tbody>
<tr>
<td>Corn</td>
<td>1</td>
<td>0.50</td>
<td>0.61</td>
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</tr>
<tr>
<td>Wheat</td>
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<tr>
<td>Soybeans</td>
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<td>-</td>
<td>1</td>
<td>0.08</td>
</tr>
<tr>
<td>Rice</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

**NOTES:** Authors’ computations based on residuals from distributed lag models relating the growth rate in each real grain price to exogenous flow demand shocks obtained from an update of the model of Kilian and Lee (2014).
Implications of Higher Crop Prices for the United States

There is no food crisis in the United States:

⇒ No increase in retail food price volatility.
⇒ No large increase in food prices relative to other consumer goods (average price increase under 1% per annum).
⇒ No domestic welfare implications.
Implications of Higher Crop Prices for Other Industrialized Countries

- High share of processed foods. The low share of agricultural commodities in the cost of producing processed foods implies a small effect of crop price fluctuations on retail food prices.

- Low share of food expenditures in income.

  - One would expect similar results for European countries
  - Problem: No disaggregate farm and food price data
  - Indirect evidence from overall increase in real food CPI consistent with U.S. evidence.
Implications of Higher Crop Prices for Developing Countries

- Low share of processed foods, so crop price fluctuations have larger impact on retail food prices.

- High share of food expenditures in income means consumers are more vulnerable.
Implications of Higher Crop Prices for Developing Countries: Caveats

• Retail food price data for staple foods in LDCs do not exist:
  ⇒ Survey data (e.g., Ivanic et al. WD 2012)
  ⇒ Global commodity price data (e.g., Giordani et al. 2012)

• Fluctuations in the exchange rate matter (in either direction)

• Welfare effects depend on domestic agricultural policies:
  e.g., Vietnam gained from food price increases

• Food price increases are also caused by export restrictions in developing countries. Policies intended to insulate the domestic economy end up amplifying rising food prices. (e.g., Martin & Anderson AJAE 2012; Anderson et al. NBER 2013; Giordani et al. 2012).
Conclusion

- Biofuel policies are only one of many explanations of global crop price increases.
- There is no compelling evidence of independent causal effects of oil price shocks on crop or retail food prices.
- A more nuanced analysis is called for than is embodied in some recent policy statements.