Do Oil Price Increases Cause Higher Food Prices?

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*The views expressed in this presentation, or in my remarks, are my own, and do not necessarily represent those of the Bank of Canada.*
The Policy Debate in the World

FT (2007): “the world faces an unprecedented period of food price inflation”.

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 price volatility in food and agricultural markets

⇒ NBER (2013): Panel to study increases in food price volatility.
The Policy Debate in the United States

Chicago Tribune (2008): “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”

Typical headlines:
“26% increase in the retail price of milk in one year”
“15% increase in the retail price of bread in one year”

⇒ Resurgence of 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?

• Surge in food crop prices occurred at about the same time as a surge in the price of crude oil.

→ Tighter link because of increased reliance on biofuels?

➢ Statistical link between oil and food has strengthened after 2006 (e.g. Tyner, *AgrEc* 2010; Mallory, Irwin, and Hayes, *EnEc* 2012).

➢ Between 10% and 34% of crop price increases due to U.S. biofuel policies (e.g. Hausman, Auffhammer, and Berck, *EnvResEc* 2012; Carter, Rausser, and Smith, 2013).

➢ Wright (*JEP* 2014): Biofuel policies caused all of the food price increases because of substitution effects in production and consumption and because of stockpiling in expectation of rising demand for ethanol.
Our Objective in this Paper

• We are not concerned with the effects of biofuel policies.

• Oil prices affect food prices in a variety of ways.

• 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.

• What is the evidence for a link from oil prices to food prices?
Challenges

• Possible reverse causality
  
  Example: Shift toward more mechanized agricultural production in China in recent years.

• Oil price increases did not occur in isolation, but were the result of changes in the global economy. (Kilian, AER 2009)

• The pass-through from oil prices to food prices depends on the reaction of the domestic central bank. (Hamilton, IJCB 2012)
Cumulative Percent Growth in U.S. Consumer Prices for Food since 2006.5
U.S. Consumer Food Prices Relative to Non-Food Consumer Prices since 2006.5

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**Graph Title:**
U.S. Consumer Food Prices Relative to Non-Food Consumer Prices since 2006.5

**Graph Description:**
The graph illustrates the percent deviation from the CPI excluding food for various food categories from 2007 to 2013. The categories include:
- Food
- Cereals, Baked Goods
- Meat, Poultry, Fish, Eggs
- Dairy
- Fruits, Vegetables

The graph shows the percentage deviation from the CPI excluding food for each category over the years, highlighting the trends and changes in food prices relative to non-food prices.
<table>
<thead>
<tr>
<th>Category</th>
<th>1974.1-2006.4</th>
<th>2006.5-2013.5</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Average</td>
<td>Average</td>
</tr>
<tr>
<td></td>
<td>Annual Growth</td>
<td>Annual Growth</td>
</tr>
<tr>
<td>Energy Prices</td>
<td>Crude Oil</td>
<td>1.2</td>
</tr>
<tr>
<td></td>
<td>Diesel Fuel</td>
<td>NA</td>
</tr>
<tr>
<td>Farmer’s Prices</td>
<td>Fuel</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Fertilizer</td>
<td>NA</td>
</tr>
<tr>
<td>Paid</td>
<td>Animal Feed</td>
<td>NA</td>
</tr>
<tr>
<td>Farmers’ Prices</td>
<td>Corn</td>
<td>-5.2</td>
</tr>
<tr>
<td></td>
<td>Wheat</td>
<td>-5.6</td>
</tr>
<tr>
<td>Received</td>
<td>Soybeans</td>
<td>-4.8</td>
</tr>
<tr>
<td></td>
<td>Rice</td>
<td>-6.6</td>
</tr>
<tr>
<td>Urban Prices</td>
<td>Food</td>
<td>-0.6</td>
</tr>
<tr>
<td>Consumer Prices</td>
<td>Cereals/Baked Goods</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Meat/Poultry/Fish/Eggs</td>
<td>-1.4</td>
</tr>
<tr>
<td></td>
<td>Dairy</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>Fruits/Vegetables</td>
<td>0.3</td>
</tr>
</tbody>
</table>
Price of Crude Oil and U.S. Food CPI Relative to U.S. Non-Food CPI

1974.1 – 2013.5
Real Prices Received by U.S. Farmers and Real Price of Crude Oil

1974.1 – 2006.4
Real Prices Received by U.S. Farmers and Real Price of Crude Oil

2006.5 – 2013.5
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 prices paid by farmers’ for agricultural inputs? (animal feed, fertilizer, diesel)

⇒ Response of farmers’ crop prices? (wheat, soybeans, corn)
Case Study of Farm Input Prices during 1990
Case Study of Farm Crop Prices during 1990
Have U.S. Biofuel Policies Changed the Link Between Oil and Food Prices?

• Important changes in U.S. biofuels legislation:
  - 2005 Energy Policy Act:
    Ethanol becomes the only available gasoline additive.
    Minimum levels of ethanol production become mandatory.

• After May 2006: The probability that the real price of oil and the real price of corn move in the same direction is 60%.
Quantifying the Channels of Transmission

• Bivariate VAR models estimated in log-levels

• Identification assumption:
  Real price of oil treated as predetermined with respect to U.S. agricultural and food prices. (Kilian and Vega, *REStat* 2011)

• Oil price shocks are associated with an unanticipated 1% increase in the real price of oil on impact.

• To allow for structural change, we split the sample in two subperiods:
  ➢ 1974.1 to 2006.4
  ➢ 2006.5 to 2013.5
Pass-Through from Oil Prices to Food Prices

\[
\begin{pmatrix}
\frac{p_{t}^{\text{crude/CPI}}}{p_{t}^{\text{food CPI/CPI ex food}}}
\end{pmatrix} \sim VAR(6)
\]
Controlling for the Response of Gasoline Prices

\[
\begin{pmatrix}
  p_t^{\text{crude}/\text{CPI}} \\
  p_{t,\text{food CPI}/\text{CPI ex food and energy}}
\end{pmatrix} \sim VAR(6)
\]
Understanding the Channels of Transmission

- Different stages in the production of food:
  
  A. Higher *input prices* of raw agricultural products driven by higher oil prices.
  
  B. Higher costs of *food marketing* as a result of higher oil prices.
A. The Role of Agricultural Crop Prices in the Transmission of Oil Price Shocks

- Corn is most tightly linked with crude oil because of the production of gasoline.
  \[\implies\] Gasoline producers blend low-octane gasoline with high-octane ethanol in approximately fixed proportions.

- Effect on corn will depend on why the real price of oil rose.
  - Supply disruption: higher oil price BUT slower growth \[\implies\] lowers demand for gasoline and hence, corn
  - Booming world economy: gasoline demand expands \[\implies\] derived demand for corn and oil increases because of common macroeconomic determinant
A. The Role of Agricultural Crop Prices in the Transmission of Oil Price Shocks

- Effects on other agricultural commodities:
  - Macroeconomic determinants are expected to raise also the real price of wheat and soybeans, as higher real incomes in emerging economies alter food consumption patterns.
  - Indirect channel: Competition for scarce resources

- Cost channel: Increases in the cost of producing agricultural products (independent of the source of the oil price shock)
  - Cost of farm fuel: effect bounded by cost share (∼ 5%)
  - Cost of fertilizer

Scope for transmission of real oil price shocks to the real price of agricultural commodities seems limited. ➞ Evidence?
Responses of Prices Received by U.S. Farmers

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
Responses of Prices Paid by U.S. Farmers

2006.5 – 2013.5
B. Quantifying the Effect of Higher Costs of Food Marketing

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

- Retail food prices might be sensitive to the price of oil because of the cost of food processing, packaging, advertising, transportation and distribution.

- 2 layers:
  - Spread between items in CPI and PPI captures cost of transportation and distribution.
  - Spread between items in CPI and prices received by farmers also incorporates the cost of processing.
Response of CPI/PPI Spread to a 1% Real Oil Price Shock by Dairy Product

2006.5 – 2013.5
Response to a 1% Real Oil Price Shock of Farm to Retail Price Spread by Dairy Product

2006.5 – 2013.5
Response to a 1% Real Oil Price Shock of Wheat-Related Products

2006.5 – 2013.5
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

- Unanticipated changes in the real price of oil may simply reflect higher demand for oil in a booming economy.

- Two pieces of evidence:
  - Given that the production of fertilizer relies on natural gas rather than oil, the cost-push effect from higher oil prices must be negligible.
  - Response of real price of rice is similar to response of real price of corn even though rice production differs from corn production (water-intensive, geographically concentrated).
Are Crop Price Increases Associated with Shifts in Global Real Activity?

- We quantify this effect by fitting a distributed lag model with intercept to the percent change in the real price of crops:

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

where \( u_t \) denotes the flow demand shock recovered from the structural oil market model of Kilian and Lee (*JIMF* 2014).

- The response of the real price of corn to a flow demand shock is obtained by cumulating the regression coefficients:

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

2006.5 – 2013.5
How much of the Changes in Crop Prices is Accounted for by the Global Business Cycle?

- Fitted values of the distributed lag model imply that flow demand shocks explain the following variation in growth rates of real crop prices:
  - 17% of wheat price
  - 19% of soybean price
  - 27% of corn price
  - 24% of rice price

- Far from dominant, but not negligible
What Explains the Remaining Variation?

Correlation of residual growth rates in real grain prices after controlling for cumulative effect of flow demand shocks

<table>
<thead>
<tr>
<th></th>
<th>Real corn price</th>
<th>Real wheat price</th>
<th>Real soybean price</th>
<th>Real rice price</th>
</tr>
</thead>
<tbody>
<tr>
<td>Real corn price</td>
<td>1</td>
<td>0.50</td>
<td>0.61</td>
<td>0.06</td>
</tr>
<tr>
<td>Real wheat price</td>
<td>-</td>
<td>1</td>
<td>0.40</td>
<td>-0.04</td>
</tr>
<tr>
<td>Real soybean price</td>
<td>-</td>
<td>-</td>
<td>1</td>
<td>0.08</td>
</tr>
<tr>
<td>Real rice price</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>1</td>
</tr>
</tbody>
</table>

- Speculation in agricultural crop markets?
- Idiosyncratic supply shocks: droughts and floods?
- Competition for water and land in response to U.S. biofuel policies?
Real Price of Rice and Crude Oil

2006.5 – 2013.5
Implications of Higher Crop Prices for 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.
Implications of Higher Crop Prices for Industrialized Countries

Percent change in consumer food prices relative to overall CPI  
2006.5 – 2013.5

<table>
<thead>
<tr>
<th>Country</th>
<th>Cumulative Growth</th>
<th>Average Annual Growth</th>
</tr>
</thead>
<tbody>
<tr>
<td>United States</td>
<td>6</td>
<td>0.8</td>
</tr>
<tr>
<td>Canada</td>
<td>9</td>
<td>1.2</td>
</tr>
<tr>
<td>Euro area</td>
<td>3</td>
<td>0.4</td>
</tr>
<tr>
<td>France</td>
<td>2</td>
<td>0.2</td>
</tr>
<tr>
<td>Germany</td>
<td>7</td>
<td>1.0</td>
</tr>
<tr>
<td>Italy</td>
<td>3</td>
<td>0.4</td>
</tr>
<tr>
<td>United Kingdom</td>
<td>15</td>
<td>2.0</td>
</tr>
<tr>
<td>Japan</td>
<td>2</td>
<td>0.3</td>
</tr>
</tbody>
</table>

- No reason to be concerned about the welfare implications of higher crop prices.
Implications of Higher Crop Prices for Developing Countries

- Consumers in poor countries:
  - do not eat as much highly processed food.
  - spend a higher fraction of their income on food.

- Fluctuations in the U.S. dollar relative to local currencies imply that the real price of food in domestic consumption units may be lower or higher.

- Urban consumers versus farmer in rural areas: net effect? (Ivanic and Martin, AgEc 2008)

- Welfare effects also depend on domestic agricultural policies.
Implications of Higher Crop Prices for Developing Countries

- Trade barriers to shield poor countries from fluctuations in food commodity prices may have magnified international price instability associated with exogenous shocks. (e.g., Martin and Anderson, *AJAE* 2012; Ivanic and Martin, *JIMF* 2014)

- Economic success of emerging economies has contributed to rise in oil prices as well as agricultural crop prices.

- Calls for ending biofuel programs might not have the desired effect of lowering global food prices.
Conclusion

• U.S. real retail food prices have remained stable and there is no evidence that they closely track oil prices.
• Real prices of major agricultural commodities have increased considerably.
  ⇨ This distinction matters for the policy debate.
• After May 2006 unexpected increases in the real price of oil have been followed by systematic increases in some U.S. crop prices.
• These responses should not be interpreted as the causal effects of higher oil prices, however, because real oil price shocks mainly reflect shifts in global demand.