U.S. Ethanol Demand and World Hunger: Is there any Connection?

Michael Wetzstein
Na Hao
Peter Pedroni
Gregory Colson

biofuel-goals-could-require-all-the-worlds-crops/

Question:
Are U.S. government ethanol-fuel incentive mechanisms leading to greater developing-country food insecurity?

- Higher commodity prices and inelastic demand.
- Majority of developing countries with a high proportion of the world’s food-deficit population are net food importers.
International markets are a major destination of U.S. agricultural commodities.

- U.S. maize exports comprise 1/3 of world maize trade.
- Maize net-import countries comprise most of the developing world.

With increased maize-ethanol production potentially crowding out export, U.S. ethanol could be a driver of increased global food price volatility.
But wait. Not every country is experiencing the same maize-price increase with U.S. ethanol expansion.

Nicaragua: maize-price declined.

For effective policy mechanisms to mitigate price volatility, country-specific effects should be understood.

Limited empirical evidence:
  • Food importation.
  • U.S. trade effects.
  • Geographically diverse countries.

The underlying hypothesis is: U.S. ethanol production has differential impacts on maize prices in developing countries.

To explore this hypothesis, a recently developed panel structural vector autoregression (SVAR) approach is utilized.

Model is populated with:
- U.S. ethanol production.
- U.S. maize prices.
- Maize prices in 38 developing countries.
Two key features:

1. Market interdependencies
   • Countries are linked cross-sectionally with common global and regional shocks.

2. Responses are both dynamic and heterogeneous across developing countries.

Panel time-series methods.
Why not a standard time series analysis?

1. Many countries exhibit short time series data.

2. Data from many countries are noisy.

These empirical challenges are addressed by expanding the panel dimension of the data to increase the reliability of the inferences.
Why not ignore cross-country heterogeneity?

1. Inconsistent estimation of coefficients
2. Precludes studying the pattern of heterogeneous responses.

Why not ignore the interdependencies among countries?

1. Does not address the dynamics of a single large economy (United States)
2. Risks drawing inconsistent inferences concerning intercountry relationships.
A special case:

• Common shocks originating from the U.S.

• Developing countries are impacted by U.S. shocks, but are too small to affect the U.S.

Rather than using cross-sectional averages of the panel of countries to infer the common shocks, the U.S. data are employed to infer the common shocks.

This allows examining the developing country-specific responses.
Panel SVAR Model

Q: U.S. ethanol production.
P: first differenced log transformed of U.S. real maize price.
PC: first differenced log transformed real maize price in a developing country.

\[
\begin{bmatrix}
Q_t \\
Pt \\
PC_t \\
\end{bmatrix} = A(1) \begin{bmatrix}
\varepsilon_{1t} \\
\varepsilon_{2t} \\
\varepsilon_{3t} \\
\end{bmatrix}
\]

- \(\varepsilon_{1t}\): an unexpected ethanol supply shock to the U.S. ethanol market (renewable fuel-ethanol mandate).
- \(\varepsilon_{2t}\): an unexpected ethanol demand shock to the U.S. maize market (increase in E85 fuel stations).
- \(\varepsilon_{3t}\): an unexpected developing country-specific shock (abnormal weather).

A(1) is 3×3 matrix containing the long-run impulse responses, with zero upper diagonal elements.
Q is only affected by its own innovations.
P is affected by its own and Q’s innovations.
PC is affected by all the three’s innovations.
Positive Demand Shock

United States

Developing Country

Positive Supply Shock

United States

Developing Country
Hypotheses:

Maize prices in a developing country will respond positively (negatively) to a U.S. maize demand (supply) shock.

How to test the hypotheses?

- **Impulse response functions:** Measure the change in a developing country prices in response to a U.S. demand or supply shock.

- **Variance decompositions:** Measure the forecast error variance explained by a U.S. demand or supply shock.

- 38 developing country maize prices.
- U.S. maize prices and ethanol production levels.
- Sources: EIA, FAO, USDA.
Impulse responses of a U.S. ethanol supply shock on maize prices in developing countries
Impulse responses of a U.S. demand shock on maize prices in developing countries
What is causing these heterogeneous price responses?

- U.S. food aid.
- Food imports.
- Coastal/continental.
Results:

\[ \text{U.S. Food Aid } \rightarrow \text{ A U.S. supply shock on developing county’s maize price} \]

\[ \text{Food Import Dependency} \rightarrow \text{ A U.S. demand shock on developing county’s maize price} \]

Coastal countries ↓

\[ \text{A U.S. demand shock on developing county’s maize price} \]

Table 2. Regression results\(^a\)

<table>
<thead>
<tr>
<th></th>
<th>First Month</th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Impulse Responses</td>
<td>Variance Decompositions</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Supply</td>
<td>Demand</td>
<td>Supply</td>
</tr>
<tr>
<td>Food Import Dependency</td>
<td>0.0002</td>
<td>-0.0004(^{***})</td>
<td>0.0005(^*)</td>
</tr>
<tr>
<td></td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0002)</td>
</tr>
<tr>
<td>U.S. Food Aid Dependency</td>
<td>0.0003(^*)</td>
<td>0.0001</td>
<td>0.0003(^{***})</td>
</tr>
<tr>
<td></td>
<td>(0.0001)</td>
<td>(0.0001)</td>
<td>(0.0002)</td>
</tr>
<tr>
<td>African</td>
<td>0.0047</td>
<td>-0.0006</td>
<td>-0.0050</td>
</tr>
<tr>
<td></td>
<td>(0.0052)</td>
<td>(0.0056)</td>
<td>(0.008)</td>
</tr>
<tr>
<td>Coastal</td>
<td>-0.0054</td>
<td>0.0175(^{***})</td>
<td>-0.0090</td>
</tr>
<tr>
<td></td>
<td>(0.0068)</td>
<td>(0.0073)</td>
<td>(0.0110)</td>
</tr>
<tr>
<td>F(4, 31)</td>
<td>5.68(^*)</td>
<td>2.39(^{***})</td>
<td>5.14(^*)</td>
</tr>
<tr>
<td>R(^2)</td>
<td>0.4229</td>
<td>0.2355</td>
<td>0.3986</td>
</tr>
<tr>
<td>Adjusted R(^2)</td>
<td>0.3484</td>
<td>0.1368</td>
<td>0.3210</td>
</tr>
</tbody>
</table>

\(^a\) Standard errors are in the parentheses with \(^*\), \(^*\), and \(^{***}\) denoting 1%, 5%, and 10% level of significance, respectively. Food import dependency is the average of yearly ratio of cereal import dependency ratio from FAO (FAO, 2015). U.S. food aid dependency is U.S. maize aid over domestic supply. Africa is a dummy variable with 1 equaling an Africa country and 0 otherwise, and Coast is a dummy variable with 1 equaling a coastal country and 0 otherwise. Missing data resulted in Cabo Verde and Burundi being excluded from the analysis.
Conclusions:

• Developing countries are not homogeneous in their response to market shocks.

• Global demand and supply shocks generate different impacts.

• Market interdependencies are far more complex than previous modeling efforts have considered.
What about free trade?

• Greater exposure to global agricultural commodity markets yields heightened susceptibility to price shocks from abroad.

• A country may want to consider mitigating this susceptibility.

• Diversify the agricultural sector with more country-specific traditional commodities.
Variance decomposition of a U.S. supply shock on developing countries’ maize prices
Variance decomposition of a U.S. demand shock on developing countries’ maize prices
Results:

- A U.S. ethanol demand shock increases maize prices in approximately 75% of the developing countries. This increase is also persistent.

- In contrast, an ethanol supply shock has mixed results. Slightly fewer than 50% of the countries experience no increase or a decline in their prices.

- Developing countries’ price flexibility to U.S. supply shock is less responsive than to say a U.S. ethanol demand shock.