“The Benefits of Reduced Price Volatility for Agricultural Commodities”

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Agricultural Price Volatility: Prospects, Challenges and Possible Solutions.  
Session I: The Outlook for Food and Agricultural Prices an Overview of Policy Options in Response to Price Volatility.  
Barcelona, May 27, 2010
Surge in cereal and oil prices

Source: FAO 2009 and IMF 2009
Key points

- Spots and future move together but also futures cause spot
- Role of volatility in losses and in increasing returns for investment
- Price transmission to consumers not to producers
- Severe impacts over the poor
- Spikes because of export bans and restrictions and speculation
- Different solutions but mostly not targeting volatility
- First step is to identify extreme spikes
Spots and future move together

CORN
Weekly spot and futures prices, 1994 - 2009

HARD WHEAT
Weekly spot and futures prices, 1998 - 2009

CORN
Monthly volatility in spot and futures prices, 1994 - 2009

HARD WHEAT
Monthly volatility in spot and futures prices, 1998 - 2009

Note: Prices deflated by US CPI, January 1994 = 1.

Note: Monthly volatility based on weekly spot and futures prices.

Source: Hernandez & Torero (2009)
Granger causality tests

- Granger causality tests were performed to formally examine the dynamic relation between spot and futures markets.
- The following regression model is estimated to test if the return in the spot market ($RS$) at time $t$ is related to past returns in the futures market ($RF$), conditional on past spot returns,

$$RS_t = a_0 + \sum_{k=1}^{p} a_{1k} RS_{t-k} + \sum_{k=1}^{p} a_{2k} RF_{t-k} + e_t$$

where $H_0: a_{2k} = 0 \forall k = 1,...,p$ (i.e. $RF$ does not Granger-cause $RS$).
- Conversely, $RF_t$ is the dependent variable to evaluate the null hypothesis that spot returns ($RS$) does not Granger-cause futures returns ($RF$).
- Similar tests are performed to examine causal links in the volatility of spot and futures returns.

Source: Hernandez & Torero (2009)
**Linear causality test on returns**

Granger causality test of weekly returns in spot and futures markets, 1994 - 2009

<table>
<thead>
<tr>
<th># lags</th>
<th>H₀: Futures returns does not Granger-cause spot returns</th>
<th>H₀: Spot returns does not Granger-cause futures returns</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>167.47***</td>
<td>263.03***</td>
</tr>
<tr>
<td>2</td>
<td>116.20***</td>
<td>186.92***</td>
</tr>
<tr>
<td>3</td>
<td>77.58***</td>
<td>135.27***</td>
</tr>
<tr>
<td>4</td>
<td>58.56***</td>
<td>100.84***</td>
</tr>
<tr>
<td>5</td>
<td>48.65***</td>
<td>79.91***</td>
</tr>
<tr>
<td>6</td>
<td>40.63***</td>
<td>65.92***</td>
</tr>
<tr>
<td>7</td>
<td>34.76***</td>
<td>56.21***</td>
</tr>
<tr>
<td>8</td>
<td>30.95***</td>
<td>49.91***</td>
</tr>
<tr>
<td>9</td>
<td>27.62***</td>
<td>44.64***</td>
</tr>
<tr>
<td>10</td>
<td>24.80***</td>
<td>40.89***</td>
</tr>
</tbody>
</table>

*10%, **5%, ***1% significance. F statistic reported.

Note: The Schwartz Bayesian Criterion (SBC) suggests lag structures of 2, 3, 2 and 3 for corn, hard wheat, soft wheat and soybeans, respectively. The Akaike Information Criterion (AIC) suggests lag structures of 8, 3, 4 and 5, respectively.


*It appears that futures prices Granger-cause spot prices.*

Source: Hernandez & Torero (2009)
Additional linear causality tests

Tests were also performed on sample sub periods to analyze if the dynamic relation between spot and futures markets has changed across time.

1. Causality tests for separate 2-year periods.

2. Causality tests for each sample sub period corresponding to a different farm program (1990, 1996, 2002 & 2008 Farm Bills).

3. Rolling causality tests: repeated tests over 104-week periods by rolling the subsample period one week ahead until the available data is exhausted.

4. Nonparametric causality tests were performed to uncover potential nonlinear dynamic relations between spot and futures markets. The test proposed by Diks and Panchenko (2006) is implemented.

Overall, it appears that futures markets have generally dominated spot markets in the past years.

Source: Hernandez & Torero (2009)
Key points

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A simple model for producers' profit maximization

- Producers of agricultural commodities do not have market power. As a result, output decisions are made taking market price as given.
- Let $c(y; w)$ be the producer cost function, where $y$ denotes output and $w$ denote input prices and let marginal cost be denoted by $c'(y; w)$.
- $P$ is a random variable that denotes market price.
- $P$ has distribution given by $F_P$ with expected value $\mu_P = \int p \, dF_P(p)$ and variance $\sigma^2_P = \int (p - \mu_P)^2 \, dF_P(p)$.
- Profit maximization requires $\mu_P = c'(y^*; w)$.

Source: Martins-Filho, & Torero (2010)
A simple model for producers' profit maximization

- Producer output cannot be adjusted with the speed at which prices change, producers attain suboptimal profits \((L)\) whenever \(P \neq \mu_P\).
- Now, assume without loss of generality that the optimal level of output for price \(P\) is \(y > y^*\). Then lack of output adjustment produces a loss in profit given by

\[
L = -Pdy + \int_{y^*}^{y} c'(\alpha; w)d\alpha \quad \text{where} \quad dy = y - y^*. \quad (1)
\]

Source: Martins-Filho, & Torero,( 2010)
A simple model for producers' profit maximization

- If \( c'(y; w) = b(w) + 2c(w)y \) where \( b(w) \) and \( c(w) \) are constants, then

\[
L = -\frac{1}{4c(w)}(P - \mu_p)^2.
\]

- Expected loss in profits is

\[
E(L) = \frac{1}{4c(w)}E(P - \mu_p)^2 = \frac{1}{4c(w)}\sigma_P^2.
\] (2)

- There is, consequently, a monotonically increasing relationship between volatility \( \sigma_P \) and expected losses.

Source: Martins-Filho, & Torero , (2010)
A simple model for producers' profit maximization - Summary

1. Smaller price volatility reduces losses. In fact, if it were possible to attain $\sigma^2_P = 0$ there would be no loss in profits.

2. Since choosing output to maximize profit equates marginal cost to price, there is optimal allocation of inputs into the agricultural sector. Hence, misallocation is reduced by reducing price volatility. Large values of $\sigma^2_P$ produce increased misallocation of resources.

3. Increased price volatility through time generates the possibility of larger net returns $R_t = P_t/P_{t-1} - 1$, where $t$ indexes time. Potential larger returns create the possibility of constructing investment portfolios that previously did not contain agricultural commodities. As such increased price volatility may lead to increased (potentially speculative) trading.

Source: Martins-Filho, & Torero, (2010)
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Transmission from international to national prices

1. We try if there was evidence of co-integration between domestic and international prices

2. We test the existence of co-integration vectors using the Johansen test using as the VAR base model one that includes the domestic price, the international price, the exchange rate, and two lags in all models

3. Finally we use moving averages in first differences to test if the rate of growth of the international prices have explanatory power with respect to the rate of growth of domestic prices

\[
d\ln(P_t) = \alpha_0 + \beta_0 d\ln(P_t^*) + \cdots + \beta_4 d\ln(P_{t-4}^*) + \gamma d\ln(e_t) + \varepsilon_t \quad \varepsilon_t \sim \text{iid}
\]
Transmission from international prices to domestic prices- in Latin America – demand side

Source: Robles & Torero (2009)
Transmission from international prices to domestic prices - in Asia – demand side

Asia - Price transmission: from international wheat to domestic wheat

Asia - Price transmission: from international rice to domestic rice

Source: Robles (2010)
Transmission from international prices to domestic prices - in Sub Saharan Africa – supply side

<table>
<thead>
<tr>
<th>Result of test of long-run relationship</th>
<th>Johansen test</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yes</td>
<td>13</td>
</tr>
<tr>
<td>No</td>
<td>41</td>
</tr>
<tr>
<td>Stationary</td>
<td>8</td>
</tr>
<tr>
<td>Total</td>
<td>62</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results of test of long-run relationship by country</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prices with relationship</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>Ethiopia</td>
</tr>
<tr>
<td>Ghana</td>
</tr>
<tr>
<td>Kenya</td>
</tr>
<tr>
<td>Malawi</td>
</tr>
<tr>
<td>Mozambique</td>
</tr>
<tr>
<td>South Africa</td>
</tr>
<tr>
<td>Tanzania</td>
</tr>
<tr>
<td>Uganda</td>
</tr>
<tr>
<td>Zambia</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Results of test of long-run relationship by crop</th>
</tr>
</thead>
<tbody>
<tr>
<td>Prices with relationship</td>
</tr>
<tr>
<td>----------------------------</td>
</tr>
<tr>
<td>Maize</td>
</tr>
<tr>
<td>Rice</td>
</tr>
<tr>
<td>Sorghum</td>
</tr>
<tr>
<td>Wheat</td>
</tr>
<tr>
<td>Total</td>
</tr>
</tbody>
</table>

Source: Minot (2010)
Key points

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Severe impacts on poor

Purchasing power: 50-70% of income spent on food and wages do not adjust accordingly

Assets and human capital: distressed sale of productive assets, withdrawal of girls from school, etc.

+ Level of diet (low) and nutritional deficiencies (high)
+ Level of inequality below the poverty line (high)
Negative effects of a 10% price increase in domestic food prices

<table>
<thead>
<tr>
<th>Country/group</th>
<th>% households negatively affected</th>
<th>Average Income loss</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guatemala</td>
<td>97%</td>
<td>3.5%</td>
</tr>
<tr>
<td>20% poorest households</td>
<td>94%</td>
<td>4.3%</td>
</tr>
<tr>
<td>Peru</td>
<td>97%</td>
<td>3.3%</td>
</tr>
<tr>
<td>20% poorest households</td>
<td>97%</td>
<td>4.2%</td>
</tr>
<tr>
<td>Bangladesh</td>
<td>91%</td>
<td>4.8%</td>
</tr>
<tr>
<td>20% poorest households</td>
<td>93%</td>
<td>5.6%</td>
</tr>
</tbody>
</table>
## Effects over calorie intake

<table>
<thead>
<tr>
<th>Country/group</th>
<th>Average % change in calorie intakes (per capita, per day)</th>
<th>Guatemala: Households with 0-2 years old kids (blue before and red after)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Guatemala</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20% poorest households</td>
<td>-8.7</td>
<td></td>
</tr>
<tr>
<td>Peru</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20% poorest households</td>
<td>-18.7</td>
<td></td>
</tr>
<tr>
<td>Indonesia</td>
<td>In 1999, households switched away from fruits and vegetables, resulting in significantly lower income elasticity for vitamin A and vitamin C compared to 1996</td>
<td></td>
</tr>
</tbody>
</table>

Source: Robles & Torero (2009)
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Two explanations for the spike

**Explanation 1:** Export bans and restrictions

- Because of highly concentrated markets
- Simulations based on MIRAGE model showed that this explains around 30% of the increase of prices in basic cereals

**Explanation 2:** Speculation in the futures markets

- Significant increase of volume of globally traded grain futures & options
- Governments increasingly curb hoarding (e.g. India, Pakistan, Philippines)
- Non-commercial share in future transactions increase
- etc
E2: Evidence of causality

Evidence of speculation influencing commodity prices
(positive numbers on vertical axis shows evidence of influence)

“Changes in supply and demand fundamentals cannot fully explain the recent drastic increase in food prices.”

Source: Robles, Torero, and von Braun (2009)
Evidence of causality – data frequency

Evidence of speculation influencing commodity prices
(positive numbers on vertical axis shows evidence of influence)

Index = F statistic - F critical value


Rice: ratio non-commercial long positions
Corn: ratio non-commercial short positions
Soybeans: ratio non-commercial short positions
Wheat: Volumen/open interest

food crisis period

120-weeks period
Oil speculation

Oil speculation is back in the news. Last year I was skeptical about claims that speculation was central to the price rise, because what I considered the essential signature of a speculative price rise — physical withholding of oil from the market, in the form of high inventories — just wasn’t showing.

This time, however, oil inventories are bulging, with huge amounts held in offshore tankers as well as in conventional storage. So this time there’s no question: speculation has been driving prices up.
More on financial activity and/or speculation in futures markets...

$ Corn price index against U.S. stocks-to-use, September 1990 to December 2008

Source: Phillip Abbott (2009)
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What are the proposed options

ER = Emergency reserves
ICGR = International coordinated grain reserves
RR = Regional reserves
CR = Country level reserves
VR = Virtual reserves
DFIF = Diversion from industrial and animal feed uses
IS+IFA = Better information on storage and international food agency
IGCA = International grain clearance arrangement
FIFF = Food Policy Financing facility
On market volatility and speculation: What to do?

**Option 1**: Should physical, public, globally managed grain reserves be developed?

Answer: Probably no

Why:

Three main challenges in maintaining strategic reserves:

- **determination of optimum stock, which is politically loaded**,  
  - Predicting supply and demand and where the potential shortfalls in the market may be can be extremely difficult  
  - Reserves are dependent on transparent and accountable governance

- **level of costs / losses**  
  - Reserves cost money and stocks must be rotated regularly  
  - The countries that most need reserves are generally those least able to afford the costs and oversight necessary for maintaining them  
  - The private sector is better financed, better informed, and politically powerful, putting them in a much better position to compete

- **uncertainties that strategic reserves can bring about in the market place**.  
  - Reserves distort markets and mismanagement and corruption can exacerbate hunger rather than resolving problems
On market volatility and speculation: What to do?

Option 2: Should we reform commodity exchanges by:
- limiting the volume of speculation relative to hedging through regulation;
- making delivery on contracts or portions of contracts compulsory; and/or
- imposing additional capital deposit requirements on futures transactions.

Answer: probably NO – we have seen triggers were not activated and also not clear incentives
On market volatility and speculation: What to do?

We propose a new global institutional arrangement

This arrangement consist of two prongs:

**Prong 1: A minimum physical grain reserve for humanitarian assistance** (emergency reserve of around 300,000 metric tons of basic grains—about 5 percent of the current food aid flows), and

**Prong 2: A safeguard mechanism to manage risk through the implementation of a virtual reserve** backed up by a financial fund to calm markets under speculative situations
Prong 2: A virtual global food commodity exchange

• A coordinated commitment by the group of participating countries. Each of the countries would commit to supplying funds if needed for intervention in grain markets.

• Determining the size of this fund will require further analysis as commodity futures markets allow for high levels of leverage. For example, a fund of US$12 to 20 billion might cover 30 to 50 percent of normal grain trade volume.

• These resources would be promissory, or virtual, not actual budget expenditures.
How the virtual reserves will work

- The intervention will take place in the futures market => A signal of a potential intervention will be announced

- Intervention will happen when the “global intelligence unit” triggers the alarm that prices are significantly above (95th percentile of its conditional value at risk) based on market fundamentals

- The potential intervention would consist of executing a number of silent short sells over a specific period of time in futures markets around the world at a price lower than the current future price.

- The global intelligence unit would recommend the price or series of prices to be offered in the short sales
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Identifying spikes to trigger more detail analysis

TWO-STEP CONDITIONAL $\alpha$-QUANTILE ESTIMATION VIA ADDITIVE MODELS OF LOCATION AND SCALE

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May, 2010
Identifying spikes to trigger more detail analysis

• We have used the estimator described in Martins-Filho, Torero, & Yao (2010) to estimate conditional quantiles for log returns of future prices (contracts expiring between one and three months) of hard wheat, soft wheat, corn and soybeans.

• For these empirical exercises we use the following model:

\[
r_t = m_0 + m_1(r_{t-1}) + m_2(r_{t-2}) + (h_0 + h_1(r_{t-1}) + h_2(r_{t-2}))^{1/2} \varepsilon_t.
\]

• For each of the series of log returns we select the first \(n = 1000\) realizations and forecast the 95% conditional quantile for the log return on the following day. This value is then compared to realized log return. This is repeated for the next 500 days with forecasts always based on the previous 1000 daily log returns.

• We expect to observe 25 returns that exceed the 95% estimated quantile.

• Based on an asymptotic approximation of the binomial distribution by a Gaussian distribution, we calculate p-values to test the adequacy of our model in forecasting the conditional quantiles.
**Soybeans**: We expect 25 violations, i.e., values of the returns that exceed the estimated quantiles. The actual number of forecasted violations is 21 and the p-value is 0.41, significantly larger than 5 percent, therefore providing evidence of the adequacy of the model.

![Figure 1: Estimated 95% conditional quantile and realized log returns for soybeans](source)

Source: Martins-Filho, Torero, & Yao (2010)
**Hard wheat:** We expect 25 violations, i.e., values of the returns that exceed the estimated quantiles. The actual number of forecasted violations is 21 and the p-value is 0.41, significantly larger than 5 percent, therefore providing evidence of the adequacy of the model.

![Graph showing estimated 95% conditional quantile and realized log returns for hardwheat.](image)
**Soft wheat:** We expect 25 violations, i.e., values of the returns that exceed the estimated quantiles. The actual number of forecasted violations is 25 and the p-value is 1, significantly larger than 5 percent, therefore providing evidence of the adequacy of the model.

![Graph showing estimated 95% conditional quantile and realized log returns for soft wheat](image)

*Figure 3: Estimated 95% conditional quantile and realized log returns for soft wheat*

Source: Martins-Filho, Torero, & Yao (2010)
Corn: We expect 25 violations, i.e., values of the returns that exceed the estimated quantiles. The actual number of forecasted violations is 34 and the p-value is 0.06, larger than 5 percent, therefore providing evidence of the adequacy of the model. However, in this case evidence is not as strong as in the case for soybeans, hard wheat or soft wheat.

Figure 4: Estimated 95% conditional quantile and realized log returns for corn

Source: Martins-Filho, Torero, & Yao (2010)
Final Remarks

- Markets are INTER-RELATED!
- We all understand that futures assets are zero-net-supply
- The point is whether movements in asset markets can have real effects or not
- As long as transactions by index traders in futures markets motivates transactions by others in the spot market there will be an impact in the spot price and on the real economy
- If there is a lesson from this financial crisis is that the financial sector (which is a market for paper, assets) can have large effects on real markets (goods, factors, etc.)
- We need to start in at least in better information and models to identify the extreme price spikes