Measuring food price transmission

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Outline

- What is price transmission?
- Why does price transmission occur?
- What is an elasticity of price transmission?
- How do we measure price transmission?
  - Simple percentage changes
  - Correlation analysis
  - Regression analysis
  - Non-stationarity and co-integration analysis
- Summary
What is price transmission?

- Price transmission is when changes in one price cause another price to change.

- Types of price transmission:
  - Spatial: Price of maize in South Africa → price of maize in Maputo.
  - Vertical: Price of wheat → price of flour.
  - Cross-commodity: Price of maize → price of rice.

Why does price transmission occur?

- **Spatial price transmission** occurs because of flows of good between markets.

- If price gap > marketing costs, trade flows will narrow gap.

- If price gap < marketing cost, no flows.

- Therefore, price gap <= marketing cost.
Why does price transmission occur?

- **Vertical price transmission** occurs because of flows of goods along marketing channel.

Maize grain and maize meal prices in Kitwe, Zambia

Why does price transmission occur?

- **Cross-commodity price transmission** occurs because of substitution in consumption and/or production.

Price of maize and rice in Maputo
Why might price transmission not occur?

- High transportation cost makes trade unprofitable
- Trade barriers make trade unprofitable
- Goods are imperfect substitutes (e.g. imported rice and local rice)
- Lack of information about prices in other markets
- Long time to transport from one market to another (lagged transmission)

What is an elasticity of price transmission?

- Price transmission elasticity: % change in one price for each 1% increase in the other price

- Example: if a 10% increase in the world price of maize causes a 3% increase in the local price of maize, then price transmission elasticity is $0.03/0.10 = 0.3$
What is an elasticity of price transmission?

- Elasticity of 1.0 is not always “perfect transmission”
  
  Example:
  - World price = $200/ton
  - Local price = $400/ton
  - $100 increase in world price causes $100 increase in local price
  - But transmission elasticity is \( \frac{100}{400} \div \frac{100}{200} = 25\%/50\% = 0.50 \)
  
- For imports, perfect transmission elasticity can be less than 1.0
- For exports, perfect transmission elasticity can be more than 1.0

How do we measure price transmission?

- Ratio of percentage changes between two time periods
- Correlation coefficient
- Regression analysis
- Co-integration analysis
- Other methods
Ratio of percentages

- Ratio of percentage changes between two time periods

<table>
<thead>
<tr>
<th></th>
<th>Price of US No 2 yellow maize in US$/ton</th>
<th>Price of maize in Dar es Salaam wholesale US$/ton</th>
</tr>
</thead>
<tbody>
<tr>
<td>June 2007</td>
<td>120</td>
<td>165</td>
</tr>
<tr>
<td>June 2008</td>
<td>239</td>
<td>287</td>
</tr>
<tr>
<td>Percent change</td>
<td>99%</td>
<td>75%</td>
</tr>
</tbody>
</table>

- Elasticity of transmission is 1.32 (=.99/.75)

**Very crude method: only uses two points in time, does not take trends into account**
Correlation coefficient

- Correlation coefficient measures the degree of relatedness of two variables
- In Excel: =correl(range1, range2)
- Advantage: easy to calculate and understand
- Disadvantage: only considers relationship between prices at the same time, does not take into account lags

Exercise
1) In “correlation” worksheet, change b9 and look at effect on correlation in graph
2) In “Data” worksheet, calculate correlation coefficient of two prices
Regression analysis

- Multiple regression analysis finds equation that best fits data: \( Y = a + bX_1 + cX_2 \ldots \)
- Advantages
  - Gives information to calculate transmission elasticity
  - Can test relationships statistically
  - Can take into account lagged effects, inflation, and seasonality; can analyze relationship of >2 prices
- Disadvantages
  - Awkward to do in Excel (easier with Stata or SPSS)
  - Misleading results if data are non-stationary

Regression analysis

- Using Excel 2007 for regression analysis (method 1)
  1) Mark columns with two prices
  2) Insert/Scatter graph
  3) Chart tools/Layout/Trendline/More trendline options
  4) Click box for “Display equation on chart”

- Using Excel 2003 for regression analysis (method 1)
  1) Mark columns with two prices
  2) Insert/Chart/XY(Scatter) / Finish
  3) Chart/Add trendline/Linear
  4) Click “Options”, then “Display equation”

Note: only one “x” allowed with this method
Regression analysis

- Using Excel for regression analysis (method 2)
  1) =linest(y range, x range,1,1)
  2) Mark 5x2 block around formula
  3) F2 shift-control-enter

Note: Can use multiple x’s with this method

<table>
<thead>
<tr>
<th>b</th>
<th>a</th>
</tr>
</thead>
<tbody>
<tr>
<td>Coef</td>
<td>0.999</td>
</tr>
<tr>
<td>SE</td>
<td>0.354</td>
</tr>
<tr>
<td>R2</td>
<td>0.119</td>
</tr>
<tr>
<td>7.98</td>
<td>58.00</td>
</tr>
<tr>
<td>155</td>
<td>1,112</td>
</tr>
</tbody>
</table>
Regression analysis

- Calculating transmission elasticity from regression coefficient
  - Regression coefficient $b = \frac{\Delta P_2}{\Delta P_1}$
  - Transmission elasticity is $\frac{(\Delta P_2/P_2)}{(\Delta P_1/P_1)}$
  - So transmission elasticity = $b \times \frac{P_1}{P_2}$
    where $b =$ regression coefficient
    $P_2 =$ price on left side (Y variable)
    $P_1 =$ price on right side (X variable)

- Exercise
  - In “Regression” worksheet, change green cells and examine effect on results and graph
  - In “Data” worksheet, use regression analysis to analyze relationship between two prices

Non-stationarity - definition

- What is a non-stationary variable?
  - A variable that does not tend to go back to a mean value over time, also called “random walk”

<table>
<thead>
<tr>
<th>Stationary variable</th>
<th>Non-stationary variable</th>
</tr>
</thead>
<tbody>
<tr>
<td>Tends to go back toward mean</td>
<td>Does not tend to go back to mean</td>
</tr>
<tr>
<td>Finite variance</td>
<td>Infinite variance</td>
</tr>
<tr>
<td>Regression analysis is valid</td>
<td>Regression analysis is misleading</td>
</tr>
</tbody>
</table>

![Graph of stationary and non-stationary variables](image)
Non-stationarity - problem

- Why are non-stationary variables a problem?
  - If prices are non-stationary, regression analysis will give misleading results
  - **With non-stationary variables, regression analysis will say there is a statistically significant relationship even when there is NO relationship**

- **Exercise**
  - Use worksheet “Non-stationarity 1” to see that regression gives a high t statistics when there is no relationship

Non-stationarity - diagnosis

- How do you identify non-stationarity?
  - Several tests, most common one is the Augmented Dickey-Fuller test
  - Cannot easily be done in Excel, but Stata and SPSS can do it easily
  - Price data are usually non-stationary
    - Of 62 staple food prices tested, most (60%) were non-stationary
Non-stationarity - solution

- How do you analyze non-stationary prices?
  - Simple approach (with Excel)
    - First differences ($\Delta P = P_t - P_{t-1}$) are generally stationary
    - Regress $\Delta P_1$ on $\Delta P_2$, possibly with lags
  - Co-integration analysis (with Stata)
    - Test to see if prices are co-integrated, meaning that $P_2 - b*P_1 - a$ is stationary
    - If prices are co-integrated, run error correction model (ECM)
    - ECM gives estimates of
      1) Long-run transmission
      2) Short-run transmission
      3) Speed of adjustment to long-run equilibrium

Non-stationarity - solution

- Exercise
  - Use “Stationarity 2” worksheet to see that regressing $\Delta P_1$ and $\Delta P_2$ correctly shows no relationship
  - Examine “Stationarity 3” to see how regressing $\Delta P_1$ and $\Delta P_2$ correctly shows a relationship that exists
  - Use “Data” to calculate first differences in two price and regress $\Delta P_2$ on $\Delta P_1$
Summary

- Price transmission occurs between markets, between stages of a market channel, and between commodities... but not always
- Correlation coefficient is easy but gives limited info
- Regression analysis
  - Can be done in Excel but easier in Stata
  - Gives estimate of price transmission
  - Can take into account lagged effects
  - But is misleading if prices are non-stationary
- Non-stationarity
  - Means prices follow a “random walk”
  - Can be tested with Stata
  - If prices are non-stationary, need to
    - At minimum, regress first-differences (can be done in Excel)
    - Preferably, carry out co-integration analysis (requires Stata)