The International Rice Market:
Market Integration and Import Demand Analysis

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Motivation

- Global CGE models used for trade analysis
- No better than the theory and data underpinning it
- Econometric critique of parameters used in CGE models
- This paper contributes to on-going effort of providing an econometric foundation for the parameters used in GTAP
- Limited scope:
  - Elast. of subst. between imports from different sources
  - Rice
Analytical Approach

**Step 1:** Is the Armington structure appropriate?

Cointegration analysis to determine integration of submarkets → homogenous or heterogenous goods
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**Step 2:** Elast. of subst. estimated for key importers

**Step 3:** Simple illustration of implications for trade lib.
Background

- International rice market: Thin and volatile
Background

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Traded volumes as a percentage of world production

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Source: FAOSTAT (2001)
Background

- International rice market: Thin and volatile
  - Sellers and buyers enter the market depending on their domestic crop situation
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  - Sellers and buyers enter the market depending on their domestic crop situation

• Six major exporters account for 85% of world market:
  - Thailand  30%
  - Vietnam   18%
  - China     10-11%
  - USA       10-11%
  - India     10-11%
  - Pakistan  7%
Background

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• Six major exporters account for 85% of world market:
  - Thailand 30% (largest exporter for a long time)
  - Vietnam 18% (re-entered the int’l mkt in 1989)
  - China 10-11%
  - USA 10-11%
  - India 10-11%
  - Pakistan 7%
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  - China 10-11%
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• A few large and many smaller importers:
  - Indonesia, Bangladesh, Philippines, Malaysia
  - Middle East, Sub-Saharan Africa
  - Latin America and Caribbean
  - European Union
Background

Rice policies

- Rice: staple food in almost all rice-producing Asian cntrs
- Key policy obj: self-sufficiency and stable domestic prices

Restrictive trade policy instruments

- State trading enterprises
- *Ad valorem* tariffs, specific t’s, combin. t’s, variable levies
- Import and export quotas, seasonal bans, TRQs
- Export subsidies
- Preferential trade agreements, govt to govt contracts
Cointegration analysis

- Determine validity of Armington assumption of product heterogeneity

- Law of One Price (LOP)
  Test for $\beta_1 = 1$ in equation $\ln(p_1) = \beta_0 + \beta_1 \ln(p_2) + \varepsilon_t$

- Prices are non-stationary. To avoid invalid inference and spurious regressions → use cointegration to identify stable long-run relations between prices

- Vector Autoregressive (VAR) model in VECM form:
  \[ \Delta X_t = \Pi X_{t-1} + \Gamma_1 \Delta X_{t-1} + \ldots + \Gamma_{k-1} \Delta X_{t-k} + \Phi D_t + \varepsilon_t \]

  where $X_t$ is a vector of $p$ endogenous variables, ie. prices
<table>
<thead>
<tr>
<th>Law of One Price</th>
<th>Products</th>
</tr>
</thead>
<tbody>
<tr>
<td>Accepted</td>
<td>Perfect substitutes</td>
</tr>
</tbody>
</table>
## Hypothesis testing

<table>
<thead>
<tr>
<th>Law of One Price</th>
<th>Long run exclusion</th>
<th>Products</th>
</tr>
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<tbody>
<tr>
<td>Accepted</td>
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Hypothesis testing

Also test for weak exogeneity: response to disequilibrium

<table>
<thead>
<tr>
<th>Classification of markets:</th>
<th>Long run exclusion</th>
<th>Weak exogeneity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Long run segmented markets</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Long run leader markets</td>
<td>✗</td>
<td>✓</td>
</tr>
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<td>Long run follower markets</td>
<td>✗</td>
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Data

Monthly price series: Rice type/quality

Very high quality:  
- US 2/4
- Thai 100

High quality:  
- Thai 5%
- Vietnamese 5%
- Indian 5%

Low quality:  
- Thai 25%
- Vietnamese 25%
- Indian 25%

Very low quality:  
- Thai A1 Super

Available for 1990:01 – 2001:12, i.e. 144 observations
Except India 1996:01 – 2001:12, i.e. 72 observations

Deflated by relevant CPI
### Data

**Monthly price series:** Rice type/quality | Avg. (real) price USD/ton
---|---
**Very high quality:**
- US 2/4
- Thai 100 | 291
- Thai 100 | 213

**High quality:**
- Thai 5%
- Vietnamese 5%
- Indian 5% | 205
- 112
- 220

**Low quality:**
- Thai 25%
- Vietnamese 25%
- Indian 25% | 167
- 90
- 198

**Very low quality:**
- Thai A1 Super | 86

Available for 1990:01 – 2001:12, i.e. 144 observations
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Deflated by relevant CPI
Nesting structure for the test of the Law of One Price on the int’l rice market

The international and inter-quality rice market

- High quality
  - US 2/4
  - Thai100
  - 5% brokens
- Low quality
  - 25% brokens
  - Thai A1

  Thailand
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# Results

- **LOP is rejected in most cases**

## Summary of results: Validity of the Law of One Price and classification of markets

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Note: The circles indicate the markets for which there is evidence that the Law of One Price holds.

* The Indian prices could not be included due to the short length of these time series relative to the number of parameters to be estimated in this model.
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<td>Thai 100</td>
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Qualifications and conclusions of coint. analysis

Qualifications:

- Relatively short time series: may not be capturing the long run integration relations accurately
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Conclusions:

1. Int’l markets are highly segmented since LOP rejected in most cases
2. The Thai markets take on a long run leader role
3. Vietnamese rice is considered to be of a lower quality compared with rice of similar grading from other cntrs
Conclusion and next steps in the analysis

Step 1: Is the Armington structure appropriate? ✓

Step 2: Elast. of subst. estimated for key importers

Step 3: Simple illustration of implications for trade lib.

Armington assumption of heterogenous goods is valid
→ Proceed to estimate elasticities of substitution among different sources
Estimating Armington elasticities

• Method
  • Literature
  • Basic model:
  • ECM specification

\[ \sigma_{ij} = \frac{\partial \ln( q_i / q_j)}{\partial \ln( p_j / p_i)} \]

\[ \Delta Q_{ij}(t) = a_{ij} + \gamma_{ij}^1 \Delta P_{ij}(t) + \gamma_{ij}^2 Q_{ij}(t-1) + \gamma_{ij}^3 P_{ij}(t-1) + u_{ij}(t) \]

• Data
  • monthly series on import values/quantities for semi- and wholly-milled rice (HS-6 level)
  • available for USA, JPN, EU, BRA and IDN
  • series length differs;
  • many small partners and many zero observations
Estimation results

- Generally robust estimates for short-run elas., but not for long-run ones
- Lower values, compared to those used in standard GTAP
- but consistent with co-integration analysis

### Table. Estimated subsitution elasticities for USA

<table>
<thead>
<tr>
<th>partner pairs</th>
<th>estimated elas.</th>
<th></th>
<th></th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>estimated elas.</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>short-run</td>
<td>long-run</td>
<td>GTAP</td>
<td></td>
</tr>
<tr>
<td>India-EU</td>
<td>0.835***</td>
<td>0.675***</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>India-Pakistan</td>
<td>0.962***</td>
<td>0.921**</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>India-Thailand</td>
<td>0.962***</td>
<td>0.868**</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>India-China</td>
<td>1.65***</td>
<td>1.526***</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>EU-Pakistan</td>
<td>0.886***</td>
<td>0.726*</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>EU-Thailand</td>
<td>0.692***</td>
<td>0.472</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>EU-China</td>
<td>1.997***</td>
<td>2.055***</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Pakistan-Thailand</td>
<td>0.905***</td>
<td>0.67</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Pakistan-China</td>
<td>2.11***</td>
<td>2.33***</td>
<td>4.4</td>
<td></td>
</tr>
<tr>
<td>Thailand-China</td>
<td>1.925***</td>
<td>1.922***</td>
<td>4.4</td>
<td></td>
</tr>
</tbody>
</table>
Armington Structure in GTAP

composite goods

ESUBD

composite imported  domestically produced

ESUBM

source 1  source 2  source n
Illustrative trade liberalization scenarios: 100% tariff cut for rice under alternative parameters

- **Exp1** — default GTAP parameter values for *ESUBD* and *ESUBM*
- **Exp2** — average of estimated *ESUBM*; default GTAP *ESUBD*
- **Exp3** — average of estimated *ESUBM*; *ESUBD* set to half of *ESUBM*

**Table. Parameters used in the experiments**

<table>
<thead>
<tr>
<th>Regions</th>
<th>Exp1 (GTAP value)</th>
<th>Exp2</th>
<th>Exp3</th>
</tr>
</thead>
<tbody>
<tr>
<td>ESUBD</td>
<td>all</td>
<td>2.2</td>
<td>2.2</td>
</tr>
<tr>
<td>ESUBM</td>
<td>Indonesia</td>
<td>4.4</td>
<td>1.632</td>
</tr>
<tr>
<td></td>
<td>USA</td>
<td>4.4</td>
<td>1.343</td>
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<tr>
<td></td>
<td>EU</td>
<td>4.4</td>
<td>1.413</td>
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<tr>
<td></td>
<td>Brazil</td>
<td>4.4</td>
<td>0.94</td>
</tr>
<tr>
<td></td>
<td>other</td>
<td>4.4</td>
<td>1.23</td>
</tr>
</tbody>
</table>
Experiment results:
changes in trade shares by sources

Imports into Japan

Note: Changes are based on the shares from GTAP database; the differences are multiplied by 100
Experiment results: changes in trade shares by sources

Imports into USA

Note: Changes are based on the shares from GTAP database; the differences are multiplied by 100
Experiment results: total rice imports

% changes in total imports

Exp1
Exp2
Exp3
Concluding remarks

• Conclusions
  – Co-integration analysis accepts the Armington assumption of heterogeneous rice products
  – Estimation confirms co-integration results and finds lower values of \( ESUBM \)
  – Trade liberalization experiment using estimated \( ESUBM \) leads to persistent trade shares by sources, although total trade flows not affected much

• Further efforts
  – Further econometric investigation to get better estimates for long run elas.
  – Longer time series
  – Trade modeling structure that can accommodate pair-wise ESUBM (?)