Supply Response, Market Participation and Transaction Costs: Evidence from a Tanzanian Panel

Antonio Martuscelli
University of Sussex

University of Sussex - Economics DPhil Conference

November 11th, 2011
Motivation

- Welfare impact of policies/shocks depends on how hhds respond $\Rightarrow$ supply response.
- Widespread self-sufficiency in SSA’s rural areas.
- High transaction costs.
Research Questions

1. Is estimation of supply response affected by heterogeneity in market participation?
   - Buyers/Sellers vs Self-sufficient

2. What is the role of transaction costs?
Taking into account heterogenous market participation is important when estimating food supply response.

- positive price elasticity once accounting for irresponsiveness of self-sufficient hhds

Evidence that transaction costs induce self-sufficiency strategies and hinder specialization.
Literature Review — Main studies

- **Goetz, 1992** — Analizes marketing behaviour in Senegal’s grain market. Two-step Heckman procedure to control for selection into the market as buyer or seller. Marketed surplus elasticity. Fixed vs proportional transaction costs.

- **Key, Sadoulet and de Janvry, 2000** — Mexican maize market. Structural model of market participation and supply response.

- **Heltberg and Tarp, 2002** — Supply response in Mozambique. Control for selection into the market as sellers and estimate sale’s determinants.

- **Bellemare and Barret, 2006, Ouma et al., 2010**
Literature Review — Common features

- **Fixed vs Proportional transaction costs**
  - FTCs — affect discrete market participation decisions but not the continuous output decisions once entered the market ⇒ identification strategy for selection models
  - PTCs — affect both market participation and output decisions.
- **Ordered vs Unordered models**
- **Only cross-sections or “pooled” panels**
Theoretical framework — Key et al. 2000

- Standard household model augmented with transaction costs.
- Endogenous market participation decisions.
- Differentiate between buying and selling transaction costs.
The Model

\[ \max U(c_i; z^c) \]

s.t.:

\[ g(q_i; z^p) = 0 \] (1)
\[ q_i - m_i - c_i + T_i = 0 \] (2)

\[ \sum_{i=1}^{N} [(p^m - \tau^s_{pi}(z^s_t))\delta^s_i + (p^m + \tau^b_{pi}(z^b_t))\delta^b_i]m_i - \tau^s_{fi}(z^s_t)\delta^s_i - \tau^b_{fi}(z^b_t)\delta^b_i + E = 0 \] (3)

\[ L = U(c_i; z^c) + \]
\[ + \lambda \left[ \sum_{i=1}^{N} [(p^m - \tau^s_{pi}(z^s_t))\delta^s_i + (p^m + \tau^b_{pi}(z^b_t))\delta^b_i]m_i - \tau^s_{fi}(z^s_t)\delta^s_i - \tau^b_{fi}(z^b_t)\delta^b_i + E \right] \]
\[ + \phi g(q_i; z^p) + \eta_i(q_i - m_i - c_i + T_i) \]
The Model

- Two steps solution:
  - first maximise utility conditional on market participation regime;
  - second choose utility maximising market participation regime.

- From the FOCs we can define the decision price as:

\[
P_i = \begin{cases} 
(p^m - \tau_p^s(z^s_t)) & \text{if } m_i > 0, \text{ seller} \\
(p^m + \tau_p^b(z^b_t)) & \text{if } m_i < 0, \text{ buyer} \\
p_i^* = \frac{\eta}{\lambda} & \text{if } m_i = 0, \text{ self-sufficient}
\end{cases}
\]
Using the decision prices and comparing utility levels under alternative regimes we find the condition for the optimal regime choice:

\[
\text{Buy if } p^* > p_b \\
\text{Self-sufficient if } p_s < p^* < p_b \\
\text{Sell if } p^* < p_s
\] (5)

The role of fixed transaction costs is to increase the thresholds where hhds enter the market either as buyers or sellers. Once into the market they do not affect output decisions.
Theoretical framework

\[ p^* + \tau^s \]
\[ p^* - \tau^b \]

\[ S^a \]
\[ S^b \]

\[ S^s \]

\[ D \]
KHDS

- Kagera region — Tanzania
  - rural area; semi-subsistence farming
  - coffee/food dual production system
- KHDS longitudinal survey
  - long term panel 1991/1994 $\Rightarrow$ 2004
  - balanced version 733 interviewed in the five waves
  - information on socio-demographic characteristics, crop output
  - price survey, cluster infrastructures
- Focus on food market
Issues

- Selectivity model for panel data.
  1. Ordered structure ⇒ Ordered probit
  2. Regime specific supply functions

- Heterogeneity

- Heckman type two-steps procedure not suitable

- Fixed effects not consistent for LDVs models
Issues

- Selectivity model for panel data.
  1. Ordered structure $\Rightarrow$ Ordered probit
  2. Regime specific supply functions
- Heterogeneity
- Heckman type two-steps procedure not suitable
- Fixed effects not consistent for LDVs models

How I tackle them:

1. Develop a Full Information Maximum Likelihood model (FIML) $\rightarrow$ Zabel, 1992
2. Use Maximum Simulated Likelihood (MSL)
3. Random effects with districts and time fixed effects
Econometric Specification

$$d_{it}^* = \gamma Z_{it} + r_i + u_{it}$$

$$d_{it} = \begin{cases} 
  0 & \text{if } -\infty < d_{it}^* \leq \mu_0 \quad \text{Buyer} \\
  1 & \text{if } \mu_0 < d_{it}^* \leq \mu_1 \quad \text{Self-sufficient} \\
  2 & \text{if } \mu_1 < d_{it}^* < +\infty \quad \text{Seller} 
\end{cases}$$

$$r \sim N(0, \sigma_{rj}^2) \quad u \sim N(0, 1)$$  \hspace{1cm} (6)
Econometric Specification

\[ d_{it}^* = \gamma Z_{it} + r_i + u_{it} \]

\[ d_{it} = \begin{cases} 
0 & \text{if } -\infty < d_{it}^* \leq \mu_0 \quad \text{Buyer} \\
1 & \text{if } \mu_0 < d_{it}^* \leq \mu_1 \quad \text{Self-sufficient} \\
2 & \text{if } \mu_1 < d_{it}^* < +\infty \quad \text{Seller} 
\end{cases} \]

\[ r \sim N(0, \sigma_{rj}^2) \quad u \sim N(0, 1) \tag{6} \]

\[ Y_{it}^B = \beta_B X_{itB} + v_{iB} + \varepsilon_{itB} \quad \text{if } d_{it} = 0 \]
\[ Y_{it}^A = \beta_A X_{itA} + v_{iA} + \varepsilon_{itA} \quad \text{if } d_{it} = 1 \]
\[ Y_{it}^S = \beta_S X_{itS} + v_{iS} + \varepsilon_{itS} \quad \text{if } d_{it} = 2 \]

\[ v \sim N(0, \sigma_{vj}^2) \quad \varepsilon \sim N(0, \sigma_{\varepsilon j}^2) \tag{7} \]

\[ (\varepsilon_{itj}, u_{it}) \sim N_2(0, 0; \sigma_{\varepsilon j}^2, 1; \rho_{j} \sigma_{\varepsilon j}^2) \Rightarrow (u_{it} | \varepsilon_{itj}) \sim N \left( \frac{\rho_{j} \varepsilon_{j}}{\sigma_{\varepsilon j}}; 1 - \rho_{j}^2 \right) \]
Maximum Simulated Likelihood

\[ L_i = \prod_t f(y_{it}) \times Pr(d_{it} = j|y_{it}) = \]

\[ = \int \int \prod_t \frac{\phi(t_{ij})}{\sigma_{\varepsilon j}} \left[ \Phi \left( \frac{\gamma Z + r_i + \rho_j t_{ij} - \mu_j - 1}{\sqrt{1 - \rho_j^2}} \right) - \Phi \left( \frac{\gamma Z + r_i + \rho_j t_{ij} - \mu_j}{\sqrt{1 - \rho_j^2}} \right) \right] \phi(v_{ij})\phi(r_i)dv_{ij}dr_i \] (8)

▶ Simulation → expectations over the random individual effects can be approximated with the average of a sufficient number of draws from the distribution generating \( r_i \) and \( v_{ij} \)

\[ \ln L^S = \sum_i \ln \frac{1}{G} \sum_g \prod_t \left\{ L_{it}^B \right\}^b \left\{ L_{it}^A \right\}^a \left\{ L_{it}^S \right\}^s \]
Simulation → 50 draws

Programmed in Stata; numerical derivatives

Final sample of 2438 obs excludes hhds buying and selling at the same time (1040 obs)

933 obs buy; 530 self-sufficient; 975 sell

Dependent variable is food output (quantity produced)

Covariates are:

- Prices: Food, Coffee, Kerosene, Wages
- Proxies for proportional transaction costs: Distance from road, Market dummy, Road impassable, Transport ownership
- Proxies for fixed transaction costs: Population density, Minority dummy, Information dummy
- Production and consumption shifters: Family size, Gender, Age, Education, Assets, Land, Rainfall, Exogenous income
<table>
<thead>
<tr>
<th>Variable</th>
<th>Buyer</th>
<th>Seller</th>
<th>Self-sufficient</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food P</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Other P</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Prod shifters</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>Cons shifters</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>PTCs</td>
<td>✓</td>
<td>✓</td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>FTCs</td>
<td></td>
<td></td>
<td></td>
<td>✓</td>
</tr>
<tr>
<td>District dummies</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Time dummies</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Season dummies</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
<td>✓</td>
</tr>
<tr>
<td>Dep. variable</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Food output</td>
<td></td>
<td></td>
<td></td>
<td>Market regime</td>
</tr>
</tbody>
</table>
## Price elasticity

<table>
<thead>
<tr>
<th>Variable</th>
<th>Buyer-Seller</th>
<th>Self-sufficient</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Food P</td>
<td>0.301***</td>
<td>.</td>
<td>-0.085</td>
</tr>
<tr>
<td>Coffee P</td>
<td>0.209***</td>
<td>0.253**</td>
<td>0.170</td>
</tr>
<tr>
<td>Kerosene P</td>
<td>-0.034</td>
<td>0.119</td>
<td>0.199</td>
</tr>
<tr>
<td>Wage</td>
<td>0.230***</td>
<td>0.293***</td>
<td>-0.008</td>
</tr>
</tbody>
</table>

N=2438. Controls: Age, Education, Gender, Size, Land, Assets, Rainfall, District, Season and Year effects.
### Transaction costs

<table>
<thead>
<tr>
<th>Variable</th>
<th>Buyer</th>
<th>Seller</th>
<th>Selection</th>
</tr>
</thead>
<tbody>
<tr>
<td>Market</td>
<td>-0.172**</td>
<td>0.038</td>
<td>-0.102</td>
</tr>
<tr>
<td>Road dist.</td>
<td>0.002</td>
<td>-0.023</td>
<td>-0.027</td>
</tr>
<tr>
<td>Road imp.</td>
<td>0.090</td>
<td>-0.086*</td>
<td>-0.146*</td>
</tr>
<tr>
<td>Transport own.</td>
<td>0.045</td>
<td>0.117**</td>
<td>0.058</td>
</tr>
<tr>
<td>Pop density</td>
<td>.</td>
<td>.</td>
<td>-0.313***</td>
</tr>
<tr>
<td>Minority</td>
<td>.</td>
<td>.</td>
<td>-0.459***</td>
</tr>
<tr>
<td>Info</td>
<td>.</td>
<td>.</td>
<td>-0.009</td>
</tr>
</tbody>
</table>

N=2438. Controls: Age, Education, Gender, Size, Land, Assets, Rainfall, District, Season and Year effects.
Conclusions

1. Small but positive food price elasticity for hhds in the market. Endogenising market participation decisions permits identifying the underlying supply elasticity as opposed to “pooled” estimates.

2. High transaction costs induce hhds towards self-sufficiency and hinder specialization. Food deficit hhds need to produce more food and food surplus hhds less than in absence of transaction costs.
   - Existance of a market $\rightarrow Q_b \downarrow 16$
   - Transport $\rightarrow Q_s \uparrow 12$
   - Road impassable $\rightarrow Q_s \downarrow 8$

3. Gains from lower transaction costs are not only static welfare gains. Also dynamic gains from higher specialization $\rightarrow$ productivity
Issues

1. Proxies for fixed transaction costs
2. Buy&Sell
3. More flexible form in the selection rule
   \[\Rightarrow\] Generalized Ordered Probit
4. Sensitivity analysis