Assessing Complementarities Among Farm Machineries Through Farmers' Investment Behaviors Under An External Capital Injection – Implications on Agricultural Mechanization and Tractorization In Sub-Saharan Africa

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Assessing Complementarities Among Farm Machineries Through Farmers' Investment Behaviors Under An External Capital Injection – Implications on Agricultural Mechanization and Tractorization In Sub-Saharan Africa

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1. Background issue

• Challenge in supporting sophisticated farm machineries (tractors) in developing countries like Nigeria
• Scale of required financial support, public sector capacity
• Low level of current farm mechanization
• Rare use of not only tractors but also draft animals
• Potentially high demand for hand tools (hoe, cutlass)
• Literature indicating the role of less sophisticated farm tools
• Higher demand for intermediate tools (draft animals, processing machines)
• Potential pattern of mechanization (Rijk, 1999):
  • Hand tools → draft animals → mechanization of stationary operation (processing machines) → motive operation (tractors)

2. Descriptive statistics

2.1. Farmers who owned these tools in 2005

<table>
<thead>
<tr>
<th>Farmers who owned these tools in 2005</th>
<th>All</th>
<th>Hand</th>
<th>Draft</th>
<th>Milling</th>
<th>Other</th>
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<td>Household size</td>
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<td>Household expenditure in 2005 ($)</td>
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<td>% primary activity is non-farm activity</td>
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</table>

2.2. Key factors

2.2.1. Ownership of j is complement to ownership of k

Ownership of j affects relationship between j and k

Ownership (more xj) increases when ∆j is positive
Ownership (more xj) decreases when ∆j is negative

3. Conceptual framework

Utility maximization under liquidity constraint and production risk

Risk
• L = E{[t, s]}
• s = p + f / (xj), gj – g – wj, xj, wj

Exogenous factors:
• p: hand tools
• f: draft animals
• g: milling machine

Formulation of optimality (subject to liquidity constraint)

Definition
• Utility maximization under liquidity constraint and production risk
• In perfect market: ∆j = µj / µj
• In imperfect market: ∆j = µj / µj

4. Empirical results and policy implications

4.1. Empirical specification

• First difference panel using data from 2005 and 2006

\[ \begin{align*}
    \Delta Y_t = \beta_0 + \beta_1 \Delta X_t + \beta_2 \Delta T + \beta_3 \Delta Z_t + \beta_4 \Delta R_t + \epsilon_t
\end{align*} \]

**Endogenous due to self-selection**

where:

- Y: variable of interest
- X: explanatory variables
- T: time trend
- Z: control variables
- R: random error

4.2. Estimation results (all agro-ecological zones combined with dummy for agro-ecological zones)

<table>
<thead>
<tr>
<th>Dependent variable</th>
<th>Hand tools</th>
<th>Draft animals</th>
<th>Milling machine</th>
<th>Tractor / power tiller</th>
<th>Other</th>
</tr>
</thead>
<tbody>
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4.3. Summary of findings

• Ownership of less sophisticated farm machineries ⇒ no positive effect on the investment into more sophisticated machineries
• Farmers tend to continue investing in the same type of farm machinerys
• Though we cannot say much about the mechanization patterns, we may say:
• Farm mechanization may evolve along 1) hand tools ⇒ 2) draft animal⇒ 3) stationary operation ⇒ 4) motive operation but not at the individual farmer level

5. Implications of preliminary results

1. Farmers prefer to invest in specific farm machineries
2. Their aversion risk for investing in other complementary farm machineries may be greater than the potential benefits
3. Targeting of farmers is more important when supporting adoptions of farm machineries
• Program like Fadama II may be more appropriate as farmers have ranges of farm machineries to choose from
4. Nigerian government's continued focus on tractorization makes some sense
• Supporting adoptions of supposedly complementary machineries do not encourage adoptions of tractors
• Although supporting less sophisticated complementary machineries is more feasible, direct support for tractor adoptions should remain substantial

Selected reference

Competing hypotheses

Farmers who own certain (less sophisticated) tools are more, or less, likely to invest in more sophisticated tools than other farmers.

If
- Tools are more complementary
  • Less risk / less risk-averse to adopting new tools

If
- Tools are less complementary
  • More risk / more risk-averse to adopting new tools