How Does Output Price Risk Affect Smallholder Input Use Decisions? The Case of Kenya and Zambia

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Outline

• Introduction
• Why Kenya and Zambia?
• Significance of transient input use
• Modeling downside price risk
• Sequential decision framework
• Data and data sources
• Results
• Concluding remarks
Introduction

• Low productivity and productivity growth a source of concern in southern Africa
  – Low fertilizer and hybrid seed adoption rates

• Previous adoption studies have been static
  – One-time decisions to adopt or continue using existing technologies

• However, survey evidence suggests that smallholder farmers switch back and forth!
  – *Transient use* of improved technologies
Introduction (2)

• No study has addressed this issue:
  – Role of output price risk?
  – With cross-sectional data, lagged behavior is unobserved
  – Perceived expected sale price?
Two major objectives

• Develop a dynamic theoretical model capable of explaining transient use

• Apply the framework to Kenya and Zambia
Why Kenya and Zambia

- Kenya and Zambia present very good case studies
  - They both have a large maize sub-sector
  - Input use is relatively high in both countries
  - Political concern that sustainable intensification may be compromised by maize price instability
  - They have different levels and types of public sector involvement
Significance of transient input use

<table>
<thead>
<tr>
<th>Number of Seasons</th>
<th>Purchased Hybrid Seed</th>
<th></th>
<th>Fertilizer</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Kenya</td>
<td>Zambia</td>
<td>Kenya</td>
<td>Zambia</td>
</tr>
<tr>
<td>One Round</td>
<td>5.2</td>
<td>25.3</td>
<td>5.3</td>
<td>21.3</td>
</tr>
<tr>
<td>Two Rounds</td>
<td>24.8</td>
<td>19.7</td>
<td>25.7</td>
<td>15.8</td>
</tr>
<tr>
<td>Three Rounds</td>
<td>10.4</td>
<td>13.1</td>
<td>10.8</td>
<td>20.5</td>
</tr>
<tr>
<td>Four Rounds</td>
<td>28.2</td>
<td></td>
<td>25.5</td>
<td></td>
</tr>
<tr>
<td>Transient use (among users)</td>
<td>58.9</td>
<td>77.5</td>
<td>62.1</td>
<td>64.4</td>
</tr>
<tr>
<td>Consistent Non-users</td>
<td>31.4</td>
<td>41.8</td>
<td>32.7</td>
<td>42.4</td>
</tr>
</tbody>
</table>
Modeling downside price risk

\[
Risk = \text{Prob}\left(\text{Expected output price} < \text{Break - even unit cost}\right)
\]

\[
\text{Expected output price} = f\left(\text{Past prices; Farm & farmer characteristics}\right)
\]

\[
\text{Break - even unit cost} = \frac{\text{Cost (ZMK/ha)}}{\text{Estimated yield (kg/ha)}}
\]
### Sequential decision framework

<table>
<thead>
<tr>
<th>Decision 1</th>
<th>Decision 2</th>
<th>Decision 3</th>
</tr>
</thead>
<tbody>
<tr>
<td>Seed choice</td>
<td>Fertilizer use</td>
<td>Fert demand (How much)</td>
</tr>
<tr>
<td>Hybrid</td>
<td></td>
<td>No Fert</td>
</tr>
<tr>
<td>Non-hybrid</td>
<td></td>
<td>Fert</td>
</tr>
<tr>
<td><strong>Fertilizer use</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>No Fert</td>
<td></td>
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</tr>
</tbody>
</table>

#### Explanation
- **Decision 1:** Seed choice
  - Hybrid
  - Non-hybrid
- **Decision 2:** Fertilizer use
  - No Fert
  - Fert
- **Decision 3:** Fert demand (How much)
  - Fert
  - No Fert
Data and data sources

• Balanced panel data from nationally representative surveys
  — Zambia: 3 waves - 2001; 2004; 2008
  — Consistent maize growing households

• Focus Group Discussions
Key Results
Results - Zambia

• Downside output price risk, not predicted price, significantly influences decisions to use hybrid seed but not fertilizer

• Historical use of these technologies is important in all input use decisions

• Government fertilizer enhances hybrid use while significantly lowering the propensity to purchase fertilizer among hybrid seed users

• Access to extension enhances the propensity to use hybrid seed and fertilizer application rates but not the propensity to apply fertilizer
Results – Zambia (2)

• Membership to cooperatives and access to market information encourage use of purchased hybrid seed but do not affect fertilizer use decisions

• Asset ownership explains fertilizer use and rate decisions but not the propensity to use purchased hybrid seed

• Participation in maize markets as a net seller raises the propensity to use hybrid seed and fertilizer but not fertilizer rates

• Proximity to towns and roads enhances the propensity to use both hybrid seed and fertilizer but not fertilizer application rates
Results - Kenya

• Predicted prices have no effect on decision to adopt fertilizer
• Downside output price risk has no impact on fertilizer use
• History of fertilizer and hybrid use is a predictor of fertilizer use
• Fertilizer price reduces hybrid adoption but not vice versa
• Breakeven revenue is higher than predicted price
  – Suggesting failure to recover all costs of maize production
Comparing Breakeven Revenue and Predicted Price

Cumulative Distribution of Breakeven Revenue and Predicted Maize Prices

- **Predicted Price (P) (Kshs/kg)**
- **Breakeven revenue (B) (Kshs/kg)**
- **P minus B**

Graph showing the cumulative distribution of breakeven revenue and predicted maize prices. The graph compares breakeven revenue (B) and predicted price (P) over a range of Kshs/kg values, with the cumulative distribution function illustrating the probability of observing a price or revenue below a certain threshold.
Policy Implications (1)

• Inability to break even rather than price risk (even for subsistence farmers) may constrain commercialization.

• Food self provision comes at a steep cost due to poor market participation

• Investments to lower costs of or improve input use efficiency (improved land management)
  – Should be at the core of maize sector growth
  – Rather than relying on the distributionally ambiguous producer price policies.

Policy Implications (2)

• Efforts to reduce downside price risk are likely to significantly improve hybrid seed uptake
  – Making output prices more predictable:
  – Productivity-enhancing practices

• Farmers are aware of the importance of fertilizer
  – Extension needs to focus on improving application rate
  – Improved purchasing power and market participation key to adoption and extent of adoption

• Improved roads & market participation could enhance hybrid and fertilizer uptake
Murakoze!!

Thank You!!