Profitability of Fertilizer Use in Malawi (preliminary)

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Motivation

• Agricultural productivity in Malawi is low and erratic (MoAFS, 2011; Kilic et al., 2013)

Yield Gap = 38% to 53% for cereals (MoAFS, 2011)
Motivation

- Low productivity among smallholders primarily due to:

1. Limited utilization of modern farm inputs, particularly inorganic fertilizer and improved seeds (MoAFS, 2011; Daudi, 2007).

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<table>
<thead>
<tr>
<th>Year</th>
<th>Percentage</th>
<th>Year</th>
<th>Percentage</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003/04</td>
<td>48%</td>
<td>2004/05</td>
<td>31%</td>
</tr>
<tr>
<td>2005/06</td>
<td>29%</td>
<td>2006/07</td>
<td>13%</td>
</tr>
<tr>
<td>2007/08</td>
<td>26%</td>
<td>2008/09</td>
<td>38%</td>
</tr>
<tr>
<td>2009/10</td>
<td>44%</td>
<td>2010/11</td>
<td>58%</td>
</tr>
</tbody>
</table>
```

Limited use of inorganic fertilizer and improved seed could be because they are unprofitable or marginally profitable for many farmers.
Research Questions & Relevance

Questions

• Where is fertilizer (un)profitable?

• What are the factors that affect the profitability of fertilizer use?

Relevance:

1. Help the government to form policies to boost the adoption of fertilizer and hence improve agricultural productivity

2. Help in the geographical targeting of the Farm Input Subsidy Program (FISP)
Contribution

- Build upon Xu et. al (2009) and Sheahan et al. (2012)
  - Xu et al: Are recommended fert. application rates in Zambia profitable?
  - Sheehan et al: Relative and absolute profitability of fert. application in Kenya

- Estimate financial and economic profitability
- Consider both commercial and subsidized prices of fertilizer
Methodology

• Financial Profitability

\[ Y_{phc} = f(N_{phc}, C_{phc}, S_{phc}, L_{phc}, Soil_{phc}, D, D \times N_{phc}) \]

\[ MVCR = \frac{MP \times P_{maize}}{P_{fert.}} \]

\[ MP = \text{Marginal product of fertilizer} \]
\[ P_{maize} = \text{farm gate price of maize} \]
\[ P_{fert.} = \text{farm gate price of fertilizer} \]

\[ Y_{phc} = \text{output (in kilograms)} \]
\[ N_{phc} = \text{the amount of inorganic fertilizer applied} \]
\[ C_{phc} = \text{the amount of chemicals (e.g. pesticides)} \]
\[ S_{phc} = \text{kilograms of seed} \]
\[ L_{phc} = \text{the hours of labor} \]
\[ Soil_{phc} = \text{a vector of soil characteristics} \]
\[ D = \text{District dummies} \]

Profitable if \( MVCR > 1 \)
Data

- Data collected by NSO of Malawi with World Bank support
  - IHS3 – 2010/2011 ag. year
    - 12,271 HHs
  1. HH information
  2. HH agric. activities
  3. HH participation in farm input subsidy programs
  4. Community information
## Results: Descriptive Statistics

<table>
<thead>
<tr>
<th>Variables</th>
<th>Mean</th>
<th>Maximum</th>
<th>Minimum</th>
</tr>
</thead>
<tbody>
<tr>
<td>Yield (Kg/Ha)</td>
<td>1408.493</td>
<td>4980.733</td>
<td>0.806</td>
</tr>
<tr>
<td>Fertilizer (Kg/Ha)</td>
<td>163.880</td>
<td>988.420</td>
<td>0</td>
</tr>
<tr>
<td>Seed (Kg/Ha)</td>
<td>51.224</td>
<td>3372.651</td>
<td>0</td>
</tr>
<tr>
<td>NPK (23:20:0, + 4S) Price (MKW/Kg)</td>
<td>103.184</td>
<td>122.333</td>
<td>80</td>
</tr>
<tr>
<td>Maize Price (MKW/Kg)</td>
<td>23.823</td>
<td>31.869</td>
<td>18.018</td>
</tr>
</tbody>
</table>

### Dummy Variables

<table>
<thead>
<tr>
<th>Yes (%)</th>
<th>No (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic</td>
<td>12.547</td>
</tr>
<tr>
<td>Hired_labor</td>
<td>24.261</td>
</tr>
<tr>
<td>Irrigation</td>
<td>0.278</td>
</tr>
<tr>
<td>Female</td>
<td>23.205</td>
</tr>
<tr>
<td>Inorganic</td>
<td>75.383</td>
</tr>
</tbody>
</table>
## Results: OLS (preliminary)

<table>
<thead>
<tr>
<th>Independent Variable: Maize Equivalent Yield</th>
<th>Independent Variables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fertilizer (Kg/ha)</td>
<td>3.328*** (0.000)</td>
</tr>
<tr>
<td>Seed (Kg/ha)</td>
<td>0.244* (0.087)</td>
</tr>
<tr>
<td>Labor (days/ha)</td>
<td>0.743*** (0.000)</td>
</tr>
<tr>
<td>Hired_Labor ( = 1 if hired labor used)</td>
<td>143.2*** (0.001)</td>
</tr>
<tr>
<td>Legume ( = 1 if intercropped with legume)</td>
<td>199.1*** (0.000)</td>
</tr>
<tr>
<td>Chemicals (= 1 if chemicals were applied)</td>
<td>551.5*** (0.004)</td>
</tr>
<tr>
<td>hybrid ( = 1 if hybrid maize seed)</td>
<td>100.8*** (0.008)</td>
</tr>
<tr>
<td>Soil_quality_good ( = 1 if good soil quality)</td>
<td>452.1*** (0.000)</td>
</tr>
<tr>
<td>Soil_quality_fair ( = 1 if fair soil quality)</td>
<td>330.5*** (0.000)</td>
</tr>
<tr>
<td>Both_basal_and_topdress</td>
<td>87.47* (0.059)</td>
</tr>
<tr>
<td>District fixed effect</td>
<td>Yes</td>
</tr>
<tr>
<td>District x Fertilizer</td>
<td>Yes</td>
</tr>
<tr>
<td>N</td>
<td>2,677</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.719</td>
</tr>
</tbody>
</table>
**Results:** (preliminary)

**Distribution of yield (Kg/ha)**

- Highest in Mchinji, Dowa, Salama
- Lowest in Nsanje, Chikwawa, Mwanza
Results: (preliminary)

• Marginal Product of fertilizer

• Highest in Kasungu, Ntchisi, Dedza, Balaka

• Lowest in Nsanje, Chikwawa, Nkhatabay
Results: (preliminary)

Maize Price (farm gate price, MKW/Kg)
Results: (preliminary)

Fertilizer (NPK 23:21:0 + 4S) price (MKW/Kg)
Results: (preliminary)

- Profitability (commercial fert. Price)
- Not profitable in any district
- Highest in Kasungu, Ntchisi, Dedza, Balaka
- Lowest in Nsanje, Chikwawa, Nkhatabay
Results: (preliminary)

• Profitability (subsidized fert. Price – MKW 10/Kg)

• Profitable in every district
Next Steps

1. Add IHPS (Panel): Household and plot-level fixed effects
2. Disaggregated (plot and household) profitability measures
3. Endogeneity of subsidized fertilizer
4. Estimate economic profitability
5. Spatial Hierarchical Model (determinants of profitability)
   - Plot level variables
   - Household level variables
   - Community level variables
Conclusion

- Fertilizer use is not profitable on average at commercial fertilizer prices; but profitable on average at 88% subsidy.

- At commercial prices, fertilizer profitability is highest in:
  - Balaka: 0.914;
  - Mchinji: 0.719;
  - Mzimba: 0.679;
  - Kasungu: 0.631

- Profitability is driven by fertilizer response rate, because prices do not exhibit large spatial variation.
Thank you

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