Rising Tractor Use in sub-Saharan Africa: Evidence from Tanzania

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Introduction

• The drivers of rising use of mechanization services on smallholder farms remain poorly understood

Objectives:

• To identify the factors behind the recent rise of mechanization use by small-holder farmers in Tanzania

• To evaluate whether evolving trends in factor use between labor and capital on smallholder farms in Tanzania is consistent with the Hayami-Ruttan Induced Innovation theory

• To explore the potential role of medium & large-scale farms in promoting a movement to more capital-intensive forms of farming, not only on larger farms but on smallholder farms as well
Outline of Presentation
Rising Tractor Use in Sub-Saharan Africa: Evidence from Tanzania

• Introduction
• Conceptual Framework: Causes of Rising Tractor Use in SSA
• Data & Methods
• Results:
  • Descriptive Statistics
  • Econometric Results:
    ➢ Pooled GLM Probits
    ➢ Mundlak-Chamberlain / CRE model
• Conclusions
Import Data shows an Increase in Tractor Demand
Nominal value of tractor imports into region is increasing

- Sub-Saharan Africa
- Southern Africa
- North Eastern Africa
- Western Africa

International Trade Center & Trademap, 2016
Conceptual Framework

Causes of Rising Tractor Use in SSA
Causes of Increased Tractor Use
Conceptual Framework: Hayami & Ruttan Induced Innovation

Supply:
• Cost of capital have declined in Africa since 2000, real interest rates lower & penetration of banking into rural areas has improved (Andrianaivo and Yartey, 2009; Ojah and Odongo Kodongo, 2015)
• Many medium-scale farmers own/use tractors. As these farmers expand, there is a growing presence of tractors in rural areas

Demand:
• Rising opportunity cost of farm labor, especially in areas experiencing economic dynamism (Tschirley et al., 2015; Yeboah and Jayne, 2018)
• Shifts in labor force into more diversified, off-farm activities associated with economic transformation (Yeboah & Jayne, 2018)
• Higher global food prices → Incentives to expand area under cultivation → Technologies to facilitate area expansion (AGRA, 2016; Jayne et al., 2016; Richards et al., 2016; UN Population prospects, 2017)
Data & Methods
Data & Methods

- Annual data on tractor importation for 40 sub-Saharan African countries from 2001 to 2015, sourced from the International Trade Centre’s Trademap Database
- The Tanzanian National Panel Survey (NPS) for 2008/09, 2010/11, 2012/13 and 2014/15, implemented by the National Bureau for Statistics with support from the World Bank (9,726 observations for pooled data & 1,672 for HH-level panel)
- To estimate a demand function for tractor rental services, we made use of two estimations techniques:

1) Pooled generalized linear model (GLM) probit which provides a flexible generalization of ordinary linear regression

2) Mundlak-Chamberlain device (Mundlak 1978; Chamberlain 1984), providing an estimator that Woolridge (2010) refers to as the Correlated Random Effects (CRE) model which address the issue of unobserved heterogeneity at household level
Data & Methods

Model specification

\[ P(Y_{tractor\text{rent}} = 1 \mid X_k) = f (X, C, R, Y) + \epsilon_i \]

\[ X = \text{exogenous household characteristics} \]
\[ C = \text{exogenous community characteristics} \]
\[ R = \text{region conditions} \]
\[ Y = \text{year dummy variables} \]

for panel estimation \( \epsilon_{it} = \alpha_i + \mu_{it} \)

- **X**: household land cultivated, gender & age of household head, asset wealth & market access conditions
- **C**: local wage rates, fertilizer prices, tractor rental rates, *share of MS farms as % of total number of farms in district*
- **R**: to regional dummy variables (30 regions)
- **Y**: survey year dummies (3 for pooled sample; 2 for household panel analysis)
Results:
Descriptive Statistics

- Changing tractor use in Tanzania
- Shift in rental markets, especially among small-scale producers
- Tractor rental use is concentrated in certain regions
Changing Tractor Use in Tanzania

More households & area using tractors; **small-scale farms increasingly using rental services**


- **Number of households using tractors**
- **Hectares of cultivated land where tractors were used**
- ▲ % of small-scale HH using tractor rental services
Tractor rental use is concentrated in certain regions

Some regions have experienced higher growth since 2008/09

Estimation Results

- Pooled GLM probit
- Mundlak-Chamberlain (MC) indicator / CRE model
- Predicted Probabilities
## Pooled GLM & MC-CRE Probit Results

Selective output for 4 approaches

<table>
<thead>
<tr>
<th>VARIABLES</th>
<th>Pooled GLM Probits</th>
<th>Mudlak-Chamberlain CRE probits</th>
</tr>
</thead>
<tbody>
<tr>
<td>2% tractor rental regions &amp; Restricted to HH located in 0-5 hectares cultivated land size categories</td>
<td>Full dataset</td>
<td>Restricted to HH located in 0-5 hectares cultivated land size categories</td>
</tr>
<tr>
<td>Land Size Distribution = 2 - 4.99 hectares</td>
<td>0.55***</td>
<td>0.56***</td>
</tr>
<tr>
<td>Land Size Distribution = 5 - 9.99 hectares</td>
<td>0.73***</td>
<td>-</td>
</tr>
<tr>
<td>Year = 2013</td>
<td>0.49***</td>
<td>0.53***</td>
</tr>
<tr>
<td>Year = 2014</td>
<td>0.44***</td>
<td>0.46***</td>
</tr>
<tr>
<td>Household head age = older than 60 years</td>
<td>-</td>
<td>-0.02</td>
</tr>
<tr>
<td>log_market_dist</td>
<td>-0.03</td>
<td>-0.02</td>
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<tr>
<td>log_wage_rate</td>
<td>0.22***</td>
<td>0.21***</td>
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<tr>
<td>log_trac_rent_cost</td>
<td>-0.22***</td>
<td>-0.28***</td>
</tr>
<tr>
<td>log_hh_5_20_ha</td>
<td>0.08***</td>
<td>0.09***</td>
</tr>
<tr>
<td>Region = Arusha</td>
<td>0.93***</td>
<td>0.97***</td>
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<tr>
<td>Region = Kilimanjaro</td>
<td>0.88***</td>
<td>0.92***</td>
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<td>Region = Morogoro</td>
<td>0.73***</td>
<td>0.84***</td>
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<tr>
<td>Region = Pwani</td>
<td>0.64***</td>
<td>0.70***</td>
</tr>
<tr>
<td>Region = Manyara</td>
<td>0.98***</td>
<td>1.01***</td>
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<tr>
<td>log_hh_5_20_ha_mean</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Constant</td>
<td>-1.63</td>
<td>-1.15</td>
</tr>
<tr>
<td>Observations</td>
<td>2,896</td>
<td>2,769</td>
</tr>
</tbody>
</table>

*pval in parentheses

*** p<0.01, ** p<0.05, * p<0.1
Predicted Probability Scenarios

Despite overall low success rate, results change quite substantially as we control for certain variables.

Tractor adoption – Regionally concentrated within specific groups

Predicted probabilities for land size group = 5-9.99; year = 2014 & head type = male

Conclusions
Conclusions

• The concentration of medium-scale farms in the district increases the probability of smallholder participation in tractor rental markets

• Landholding size is coupled with increased tractor rental use

• The increase in the number of households making use of tractors is not limited to larger-scale producers, but is also observed among small-scale agricultural households – through tractor rental markets

• The greatest increase in the adoption of tractor rental markets was observed in the 2-4.99 and 5-9.99 hectares’ land size categories

• Significant regional variation in tractor rental use & adoption

• Estimation results uphold the importance of relative changes in factor prices consistent with the induced innovation hypothesis

• Although overall tractor rentals remain low, it is rising particularly in rural areas experiencing economic transformation
THANK YOU

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