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 driving recent rise of mechanization use by small-holder farmers in Tanzania
- 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
- 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

Import Data shows an Increase in Tractor Demand

Nominal value of tractor imports into region is increasing



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Causes of Rising Tractor Use in SSA





Causes of Increased Tractor Use

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Conceptual Framework: Hayami & Ruttan Induced Innovation

Supply:

- Cost of capital has 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



- Tractor importation data for 40 African countries Trademap
- Tanzanian National Panel Survey (NPS) for 2008/09, 2010/11, 2012/13 & 2014/15 (TNBS & World Bank) 9,726 observations for pooled data & 1,672 for HH-level panel)
- Demand function for tractor rental services:

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



- 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





- Number of households using tractors
- ▲ % of small-scale HH using tractor rental services

World Bank online data: Tanzania National Panel Survey, 2008/09, 2010/11, 2012/13 &

2014/15

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Hectares of cultivated land where tractors were used

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Tractor rental use is concentrated in certain regions

Some regions have experienced higher growth since 2008/09



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- Pooled GLM probit
- Mundlak-Chamberlain (MC) indicator / CRE model
- Predicted Probabilities



Pooled GLM & MC-CRE Probit Results

Selective output for 4 approaches

	Pooled GL <u>M P</u> robits		Mudlak-Chambe <u>rlain CRE prob</u> it <u>s</u>	
	2% tractor rental	2% tractor rental regions & Restricted to HH located in 0-5 hectares cultivated	Full dataset	Restricted to HH located in 0-5 hectares cultivated
	regions	ianu size categories	Full ualasel	ialiu size categories
Land Size Distribution = 2 - 4.99 hectares	0.55***	0.56***	0.36**	0.37***
Land Size Distribution = 5 - 9.99 hectares	0.73***		0.72**	
Year = 2013	0.49***	0.53***	0.54***	0.57***
Year = 2014	0.44***	0.46***		
Household head age = older than 60		'		
years			0.40**	-0.32*
log_market_dist	-0.03	<u>-0.0</u> 2	-0.17**	-0.15
log_wage_rate	0.22***	0.21***	0.19***	0.15***
log_trac_rent_cost	-0.22***	-0.28***	-0.38***	-0.43***
log_hh_5_20_ha	0.08***	0.09***		
Region = Arusha	0.93***	0.97***	1.12***	1.20**
Region = Kilimanjaro	0.88***	0.92***	1.06***	1.12**
Region = Morogoro	0.73***	0.84***	1.01***	1.12***
Region = Pwani	0.64***	0.70***	1.37**	1.44***
Region = Manyara	0.98***	1.01***	1.14*	1.19**
log_hh_5_20_ha_mean	-	-	0.14***	0.15***
Constant	-1.63	-1.15	-1.80	-2.21
Observations	2,896	2,769	3,902	3,495
pval in parentheses				
*** p<0.01, ** p<0.05, * p<0.1				

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Predicted Probability Scenarios

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



World Bank online data: Tanzania National Panel Survey, 2008/09, 2010/11, 2012/13 & 2014/15

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Tractor adoption – Regionally concentrated within specific groups

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



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300%



Mean of median changes in district-level factor prices

World Bank online data: Tanzania National Panel Survey, 2008/09, 2010/11, 2012/13 & 2014/15





Relative change in factor prices & implication on tractor use



Relative change in factor prices vs. change in share of farms renting tractors

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Linear Correlation Matrix



World Bank online data: Tanzania National Panel Survey, 2008/09, 2010/11, 2012/13 & 2014/15

Linear Correlation Matrix					
	Change in % of farms renting tractors	Change in ratio of wage rate to tractor rental cost			
Change in % of farms renting tractors per region	1	0.08			
Change in ratio of wage rate to tractor rental cost		1			

- Need more robust empirical validations re. induced innovation hypothesis
- Going forward: Consider the change in % share of HH renting tractors per district as where can include the relative change in factor prices (wage & tractor rental cost) over years





Conclusions



- Concentration of medium-scale farms per district coupled with increased tractor rental use by smallholders
- Landholding size coupled with increased tractor rental use
- Increase in # of households using tractors not limited to larger-scale producers
- Largest increase in tractor rental use was observed in the 2-4.99 and 5-9.99 hectares' land size groups
- 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: Requires further empirical validation
- Although overall tractor rentals remain low, it is rising particularly in rural areas experiencing economic transformation

THANK YOU



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Change in wage rate vs. tractor rental costs



Wage rate index: 10 highest rental use regions



Tractor rental cost index: 10 highest rental use regions

