

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

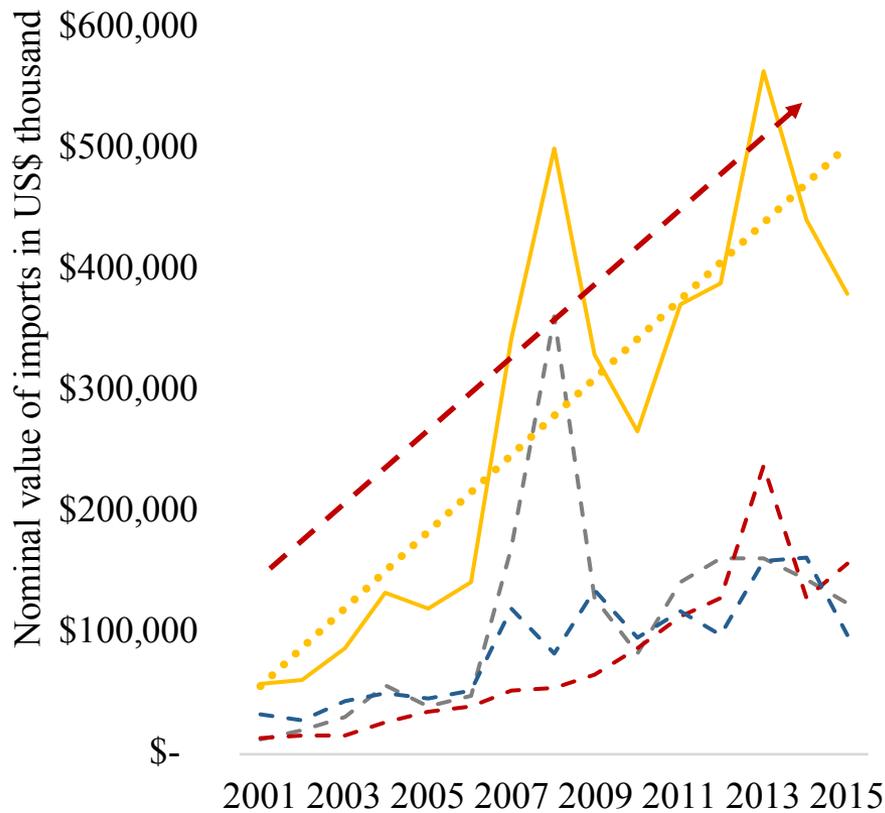
Outline of Presentation

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

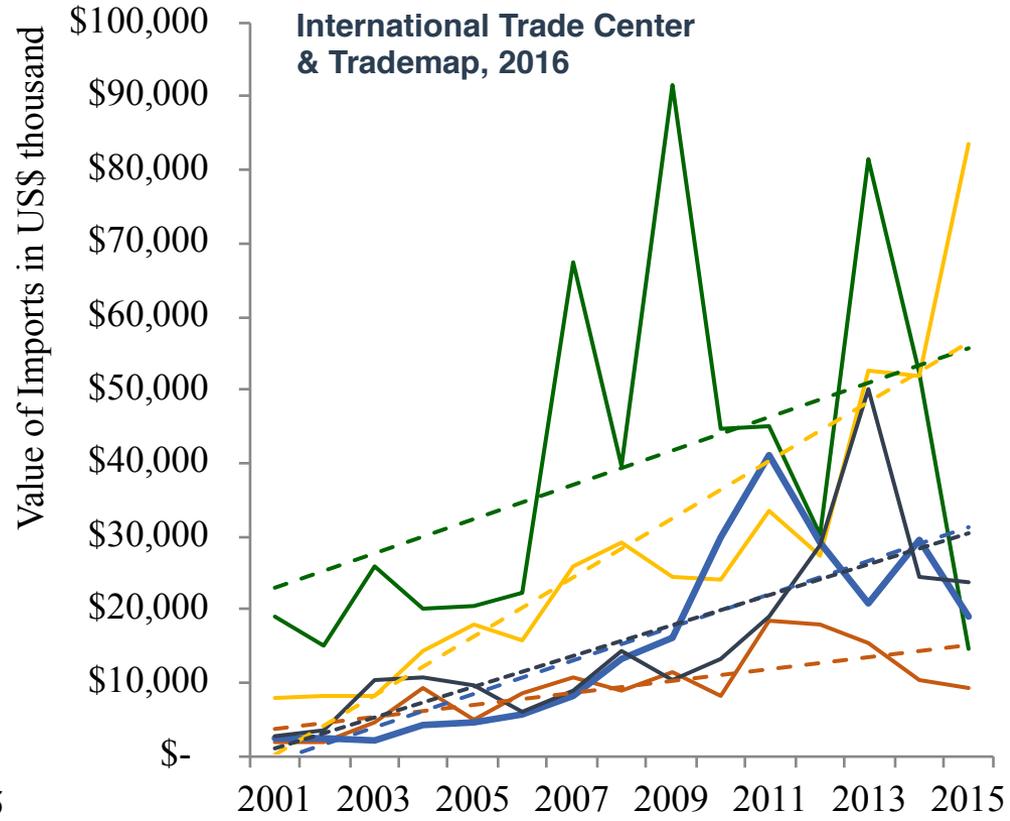
- Introduction
- Conceptual Framework: Causes of Rising Tractor Use in SSA
- Data & Methods
- Results:
 - Descriptive Statistics
 - Econometric Results:
 - Pooled GLM Probits
 - Mundlak-Chamberlain / CRE model
- Conclusions

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



- Ghana
- Kenya
- Nigeria
- Tanzania
- - - Linear (Ghana)
- - - Linear (Kenya)
- - - Linear (Nigeria)
- - - Linear (Tanzania)
- - - Linear (Zambia)

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

$$P(Y_{tractor_{rent}} = 1 \mid X_k) = f(X, C, R, Y) + \epsilon_i$$

X = exogenous household characteristics

C = exogenous community characteristics

R = region conditions

Y = 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)

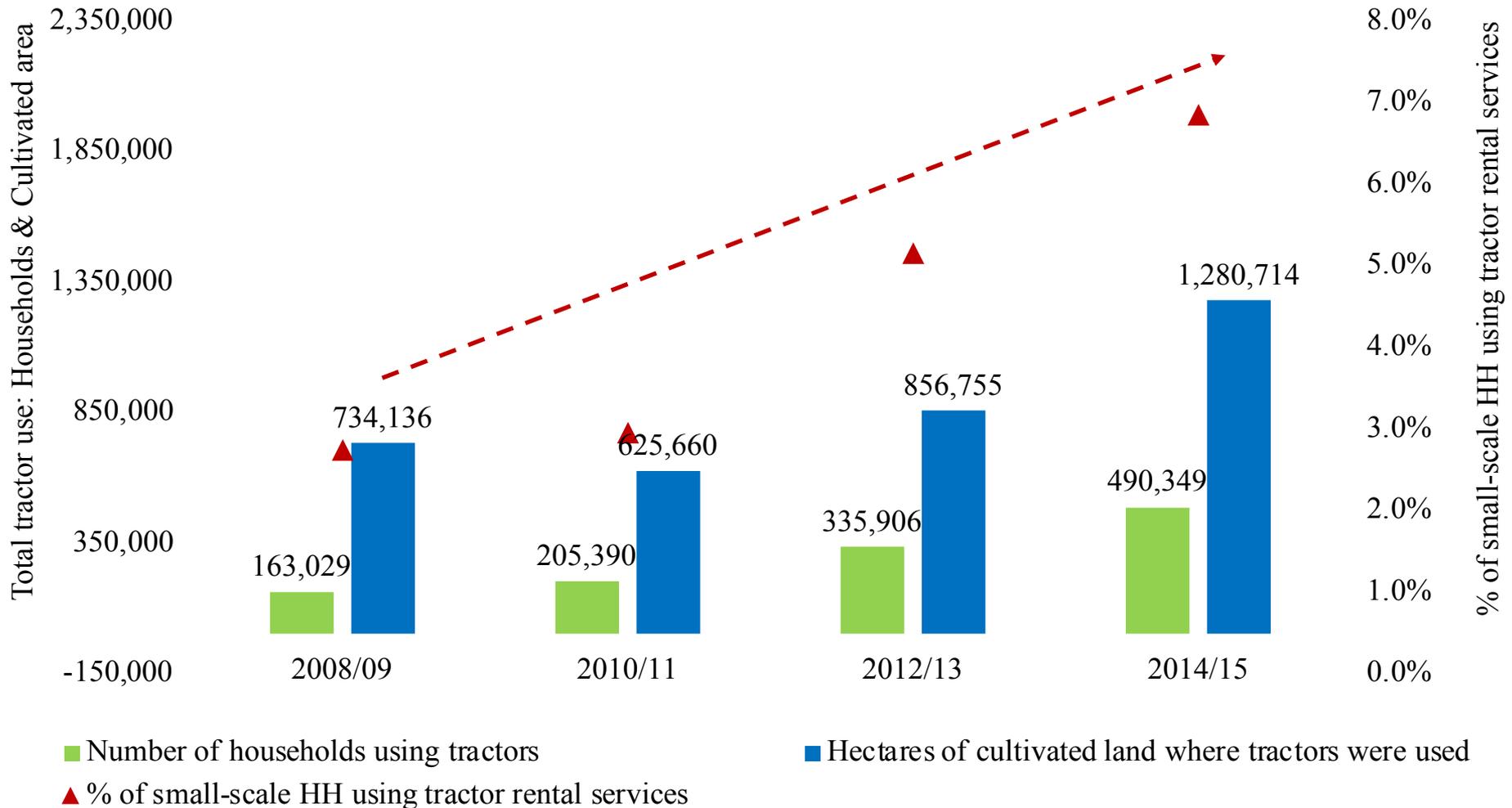
Results: Descriptive Statistics

- **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

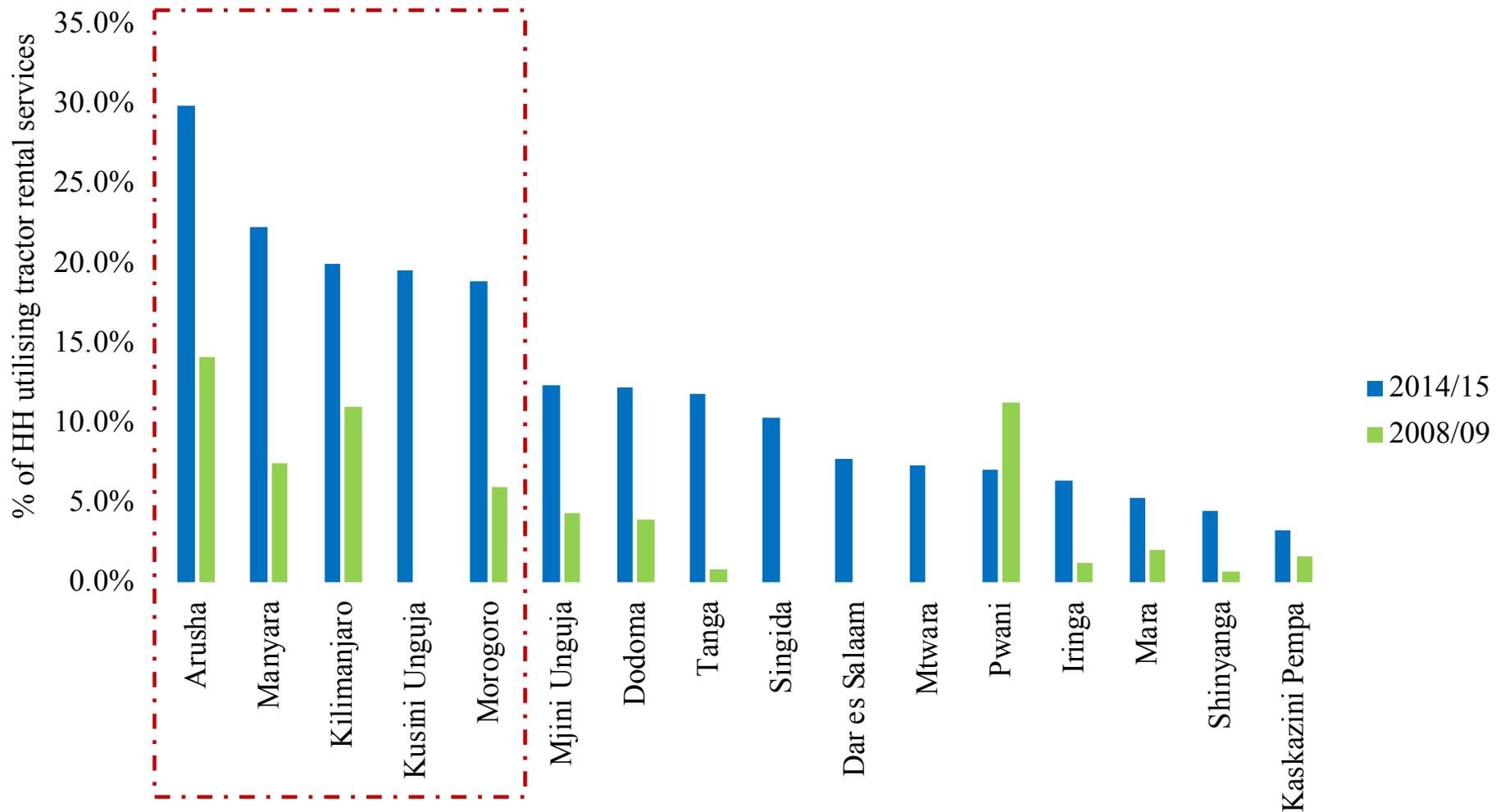
More households & area using tractors; **small-scale farms increasingly using rental services**



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

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**



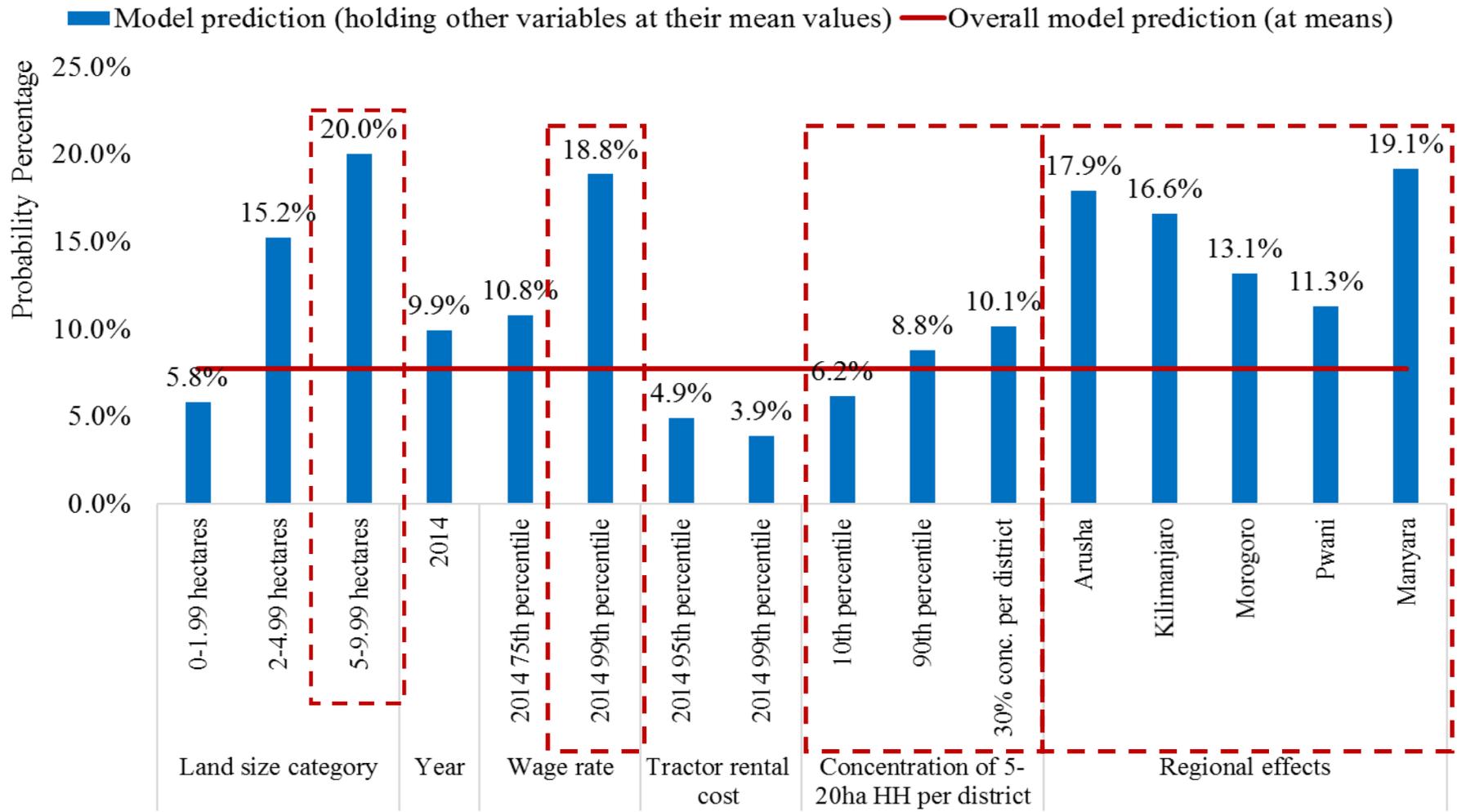
Pooled GLM & MC-CRE Probit Results

Selective output for 4 approaches

VARIABLES	Pooled GLM Probits		Mudlak-Chamberlain CRE probits	
	2% tractor rental regions	2% tractor rental regions & Restricted to HH located in 0-5 hecates cultivated land size categories	Full dataset	Restricted to HH located in 0-5 hecates cultivated land 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	-0.02	-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				

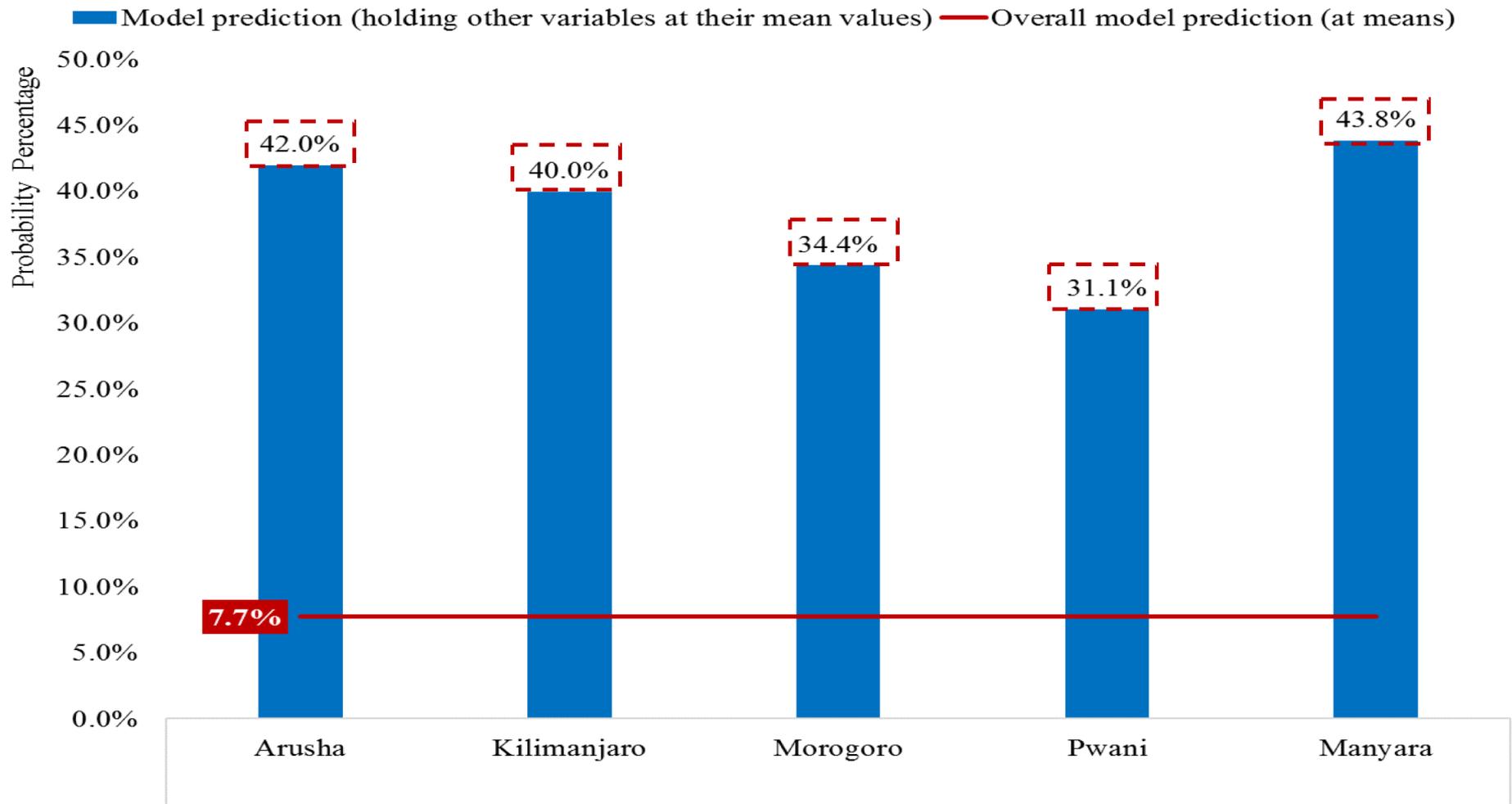
Predicted Probability Scenarios

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



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

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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