Does Farm Structure Matter?

The Effects of Farmland Distribution Patterns on Rural Household Incomes in Tanzania

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CIMMYT

Motivation

- Do differences in asset inequality explain part of the variation between ag productivity growth and poverty reduction?
- Longstanding view that land distribution patterns influence how agricultural productivity growth affects economic development
  - Johnston, Mellor, Lipton, Binswanger
  - Role of ‘multiplier’; egalitarian land distributions --> larger multiplier effects
- Evidence of rapid change in farm size distributions
  - Rise of ‘domestic investor’ farms

Table 1: Changes in farm structure in Tanzania (2009-2013), National Panel Surveys

Farm size	Number of farms (% of total)		% growth in number of farms between initial and latest year	% of total operated land on farms between 0-100 ha		
	2008	2012		2008	2012	
0 – 5 ha	5,454,961 (92.8)	6,151,035 (91.4)	12.8	62.4	56.3	-6.1%
5 – 10 ha	300,511 (5.1)	406,947 (6.0)	35.4	15.9	18.0	
10 – 20 ha	77,668 (1.3)	109,960 (1.6)	41.6	7.9	9.7	+6.1%
20 – 100 ha	45,700 (0.7)	64,588 (0.9)	41.3	13.8	16.0	
Total	5,878,840	6,732,530	14.5	100.0	100.0	

Main question:

- How does land distribution (inequality) condition how economic growth occurs in predominantly agrarian areas?
  - Focus on labor productivity in both agriculture and non-farm sectors

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Hypotheses:

- If concentration implies lower multipliers
  - Concentrated land ownership → lower incomes
- If larger farms facilitate access to inputs/svcs/mkts
  - Concentrated land ownership → higher incomes

Applied evidence

- Ravallion and Datt (2002)
  - the initial percentage of landless households significantly affected the elasticity of poverty to non-farm output in India.
- Vollrath (2007)
  - Rate of agricultural productivity growth inversely related to the gini coefficient of landholdings
- Gugerty and Timmer (1999)
  - (n=69 countries); in countries with an initial “good” distribution of assets, both agricultural and non-agricultural growth benefitted the poorest households
  - In countries with a “bad” distribution of assets, economic growth was skewed toward wealthier households

Our research approach

1. Get best data available on farm size distributions
2. Develop alternative measures of land concentration / inequality
3. Examine the degree of correlation
   - across measures
   - across available data sets
4. Develop and estimate labor productivity models
   - Assess influence of localized land concentration on labor productivity across time
   - Test for potential differential effects by asset wealth category

Data

- Nationwide data sets collected by Tanzania National Bureau of Statistics
  - National Panel Survey (a.k.a LSMS): 2009, 2011, 2013 (n=2,123) NPS
  - Agricultural Sample Census Survey: 2009 (n=52,636 + 1006) ASC
- NPS allows us to discern individuals' labor allocation between farm and non-farm activities, and to construct FTEs of labor time
- ASC includes large commercial landholdings

Farm level production function:

$$Y_{i,j,t} = \boldsymbol{\beta X}_{i,j,t} + \boldsymbol{\gamma C_j} + \theta G_{j,t-1} + \boldsymbol{\epsilon}_{i,j,t}$$

- Y is gross income per full-time equivalent (FTE) for farmer *i* in community *j* at time *t*;
- **X** is a vector of household-level characteristics,
- C is a vector of local geographic context characteristics,
- G is a measure of access to local public and private capital stocks in community j,
- ε is an idiosyncratic error term

(Unobservable) access to local public and private capital stocks is conditioned by the (observable) localized distribution of land control:

$$G_{j,t} = f(I_{j,t}, Z_{j,t})$$

- I is a measure of farmland structure in community j at time t,
- Z is a vector of other factors which influence G

Rewrite estimable production function:

$$Y_{i,j,t} = \boldsymbol{\beta X}_{i,j,t} + \boldsymbol{\gamma C_j} + \boxed{\delta I_{j,t-1}} + \gamma Z_{j,t-1} + \boldsymbol{\epsilon}_{i,j,t}$$

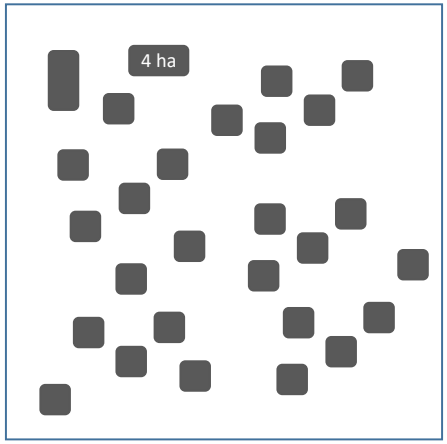
- Gini coefficient *2009 ASC*
- Skewness
- Coefficient of variation
- % of land on farms of 5-10 ha
- % of land on farms of > 10 ha

- NPS: three panel waves *NPS*
  n=6,704 HHs
- Geographic controls
  e.g. access, rainfall
- Mundlak-Chamberlain device

Outcomes of interest

- Dependent variables (household-level)
  - agricultural income/FTE
  - non-farm income/FTE
  - agricultural wage income/FTE
  - total household income/FTE
- All measured in real 2010 TZ shillings

Stylized landscapes

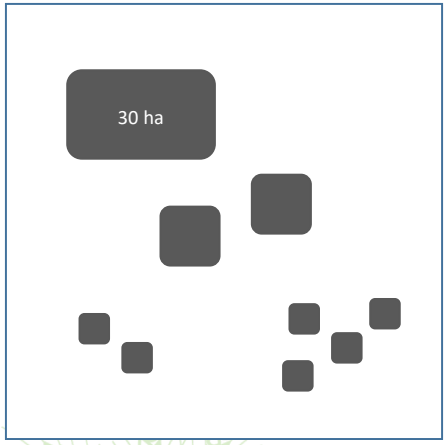


Landscape 1:
Total ha = 58
farms = 27

Concentration:
Gini = 0.064
Skewness = 3.253
CV = 0.248
%ha>10ha = 0.000

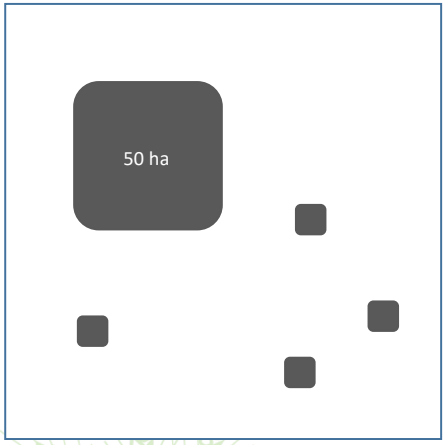
Landscape 2:
Total ha = 58
farms = 12

Concentration:
Gini = 0.302
Skewness = 0.173
CV = 0.597
%ha>10ha = 0.000



Landscape 3:
Total ha = 58
farms = 9

Concentration:
Gini = 0.544
Skewness = 2.132
CV = 1.429
%ha>10ha = 0.517



Landscape 4:
Total ha = 58
farms = 5

Concentration:
Gini = 0.662
Skewness = 1.500
CV = 1.851
%ha>10ha = 0.862

= 2 ha

Alternative measures are imperfectly correlated….

Correlation coefficients of alternative measures of land concentration

	Gini		Skewness		CV		% land under farms of 5-10ha	
Gini	1							
Skewness	0.4171	***	1					
CV	0.7119	***	0.8162	***	1			
% land in farms 5-10 ha	0.3567	***	0.0728		0.1279		1	
% land in farms > 10 ha	0.7331	***	0.3725	***	0.5576	***	0.5407	***

Data: Tanzania ASC, 2008/9.
Landholding based on land controlled (i.e. includes non-cultivated plots).
*** denotes significance at the 1% level

Estimation results:

Impacts of farm structure on per capita income

Impact of land concentration on income

Selected coefficients from baseline regression models

Dep. var.: household farm per-FTE gross income

	(1)	(2)	(3)	(4)	(5)	(6)
Land concentration						
Gini	2.620***					
	(4.64e-05)					
skewness		0.0248*				
		(0.0862)				
CV			0.295***			
			(0.00657)			
share land: farms 5-10 ha				1.951***		1.809***
				(0.00147)		(0.00683)
share land: farms >10 ha					0.466	0.143
					(0.113)	(0.656)

Dep. var.: household total per-FTE gross income

	(1)	(2)	(3)	(4)	(5)	(6)
Land concentration						
Gini	1.910***					
	(1.73e-05)					
skewness		0.0133				
		(0.266)				
CV			0.222***			
			(0.00528)			
share land: farms 5-10 ha				1.666***		1.658***
				(0.000971)		(0.00257)
share land: farms >10 ha					0.306	0.00803
					(0.177)	(0.974)

Notes: Dependent variables are inverse hyperbolic sine transformed per-FTE gross income measured in 2010 constant Tanzanian shillings. District-level land concentration measures from 2009 Ag. Sample Census. Dependent variables and other independent control variables are from the NPS. All models include the Mundlak-Chamberlain device. Full model results shown in Appendix A1. Robust pval in parentheses, with significance indicated by asterisks: *** p<0.01, ** p<0.05, * p<0.1.

Distribution of spillovers

- Interactions between land concentration & wealth terciles
- Spillover benefits increasing in wealth
- Zero or negative for poorest tercile

	(1)	(2)	(3)	(4)	(5)
Dep. var.: farm per-FTE gross income					
Land concentration					
Gini	0.941				
	(0.299)				
Gini * medium	1.841***				
	(0.00526)				
Gini * wealthiest	2.306***				
	(0.00148)				
Skewness		-0.0780*			
		(0.0766)			
Skewness * medium		0.111**			
		(0.0144)			
Skewness * wealthiest		0.124***			
		(0.00789)			
CV			-0.0801		
			(0.690)		
* medium			0.421**		
			(0.0344)		
* wealthiest			0.506**		
			(0.0183)		
share land: farms 5-10 ha				-2.948*	
				(0.0991)	
* medium				4.876***	
				(0.00602)	
* wealthiest				5.749***	
				(0.00172)	
share land: farms >10 ha					-0.514
					(0.387)
* medium					1.611**
					(0.0183)
* wealthiest					1.119*
					(0.0756)

Simulated **impacts of changes in land concentration** on total income and farm income

		(a)	(b)	(c)	(d)
		Average per-FTE income predicted for land concentration at 25th percentile	Average per-FTE income predicted for land concentration at 75th percentile	difference (b)-(a)	difference as % of mean per-FTE income
		(1000s of 2010 TSh)			
Total income	Gini	4,277	6,287	2,010	112%
	CV	7,686	8,033	347	19%
	% land: farms 5-10 ha	11,594	16,292	4,698	261%

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	% land: farms 5-10 ha	11,594	16,292	4,698	261%
Farm income	Gini	444	744	300	57%
	CV	804	851	46	9%
	% land: farms 5-10 ha	1,206	1,730	524	99%

Main results

1. Farmland concentration positively associated with rural household incomes
   - Farm, agricultural wage and non-farm income sources
2. Positive impacts in particular from share of land in the district under farms of 5-10 hectares
3. Benefits are smaller and less statistically significant in districts with a relatively high share of farmland under farms over 10 hectares in size
4. Poor rural households least able to capture the positive spillovers
   - greatest income benefits to households in upper 2/3 of the wealth distribution (includes the majority of rural HHs)

Underlying mechanisms

- Not explicitly identified in our study, but we can speculate and design further research
- Medium-scale farmers (Sitko and Jayne, 2014):
  - same social/ethnic backgrounds as small-scale farmers
  - more extensive social interactions with local community
- May hire in at higher rates?
- Use similar input & output channels?

Implications of this research

- Farm structure matters for shape of rural growth!
  - Rapid changes in farm structure in SSA
  - Land policies not articulated with ag growth strategies
- We need more empirical work!
  - Replication of our results in other contexts
  - Better understand mechanisms of spillovers
  - Implications for survey design
    - Standard sampling frames under-represent largest farms & do not allow calculation of local concentration metrics

Thanks! Comments are very welcome!

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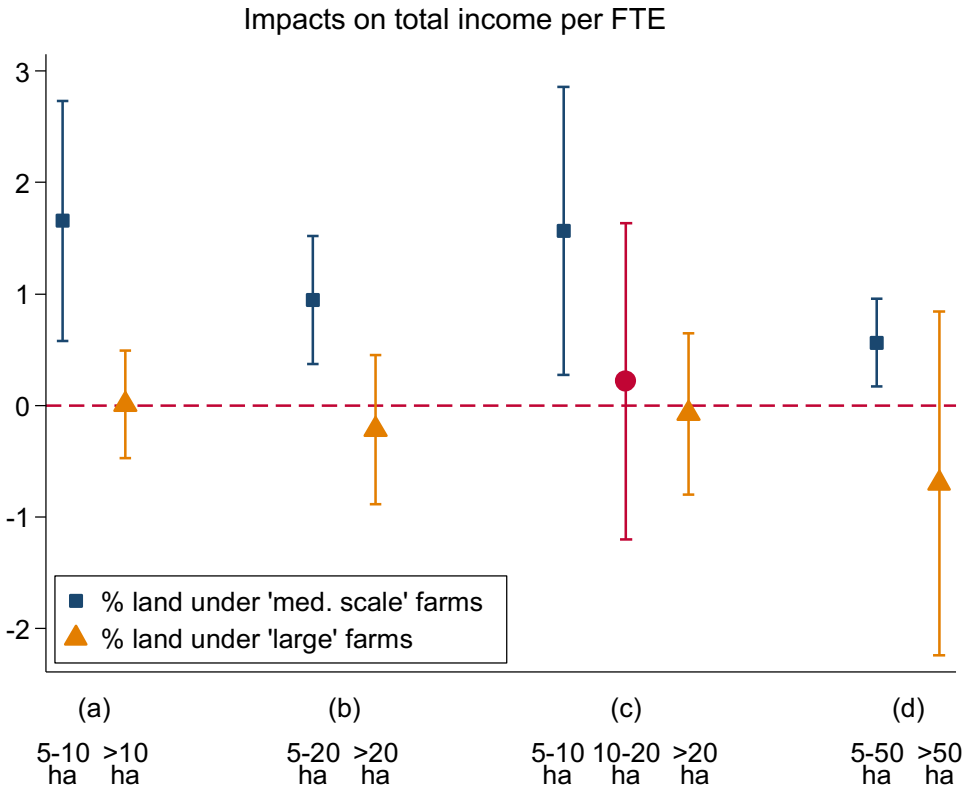
Alternative med/lg farm categories

Share of land under farms of different size categories



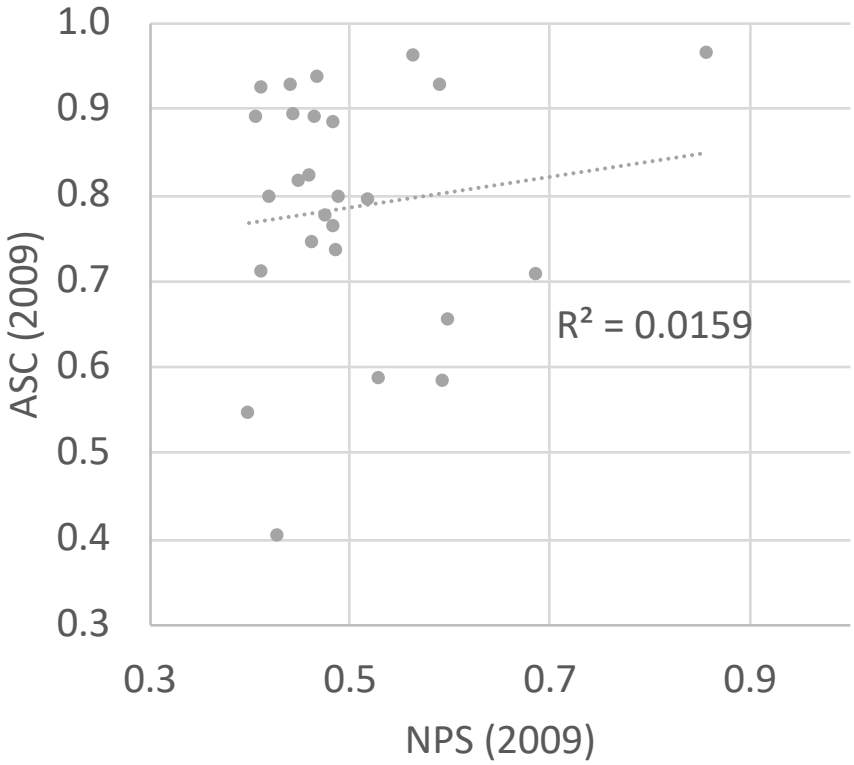
	(a)	(b)	(c)	(d)
Land share: 5-10 ha farms	1.658***		1.567**	
	(0.00257)		(0.0177)	
Land share: 10+ ha farms	0.00803			
	(0.974)			
Land share: 5-20 ha farms		0.945***		
		(0.00129)		
Land share: 10-20 ha farms			0.218	
			(0.764)	
Land share: 20+ ha farms		-0.216	-0.0746	
		(0.527)	(0.840)	
Land share: 5-50 ha farms				0.563***
				(0.00484)
Land share: 50+ ha farms				-0.699
				(0.374)

Measures of land concentration

- Gini coefficient
- skewness
- coefficient of variation
- % of farmland† in farms of 5-10 ha
- % of farmland† in farms of 10+ ha

† farmland = controlled land (includes fallow, virgin, woodlots, pasture)

Scatterplot of regional Gini coefficients on landholdings from ASC and NPS



Standard sampling frames under-represent land concentration….

Distribution of landholding sizes

	Hectares per farm holding at the xth percentile of weighted sample distribution								
	5th	**10th**	**25th**	**50th**	**75th**	**90th**	**95th**	**99th**	**mean**
controlled land (NPS)	0.1	0.3	0.6	1.3	2.4	4.5	6.7	14.6	2.3
controlled land (NPS) – excluding landless HHs	0.3	0.4	0.8	1.4	2.6	4.5	6.8	15.1	2.4
controlled land (ASC: large-scale module included	0.4	0.4	0.8	1.6	2.8	4.9	8.1	20.2	2.7
controlled land (ASC: large-scale module excluded	0.4	0.4	0.8	1.6	2.8	4.9	8.1	19.8	2.5

Income growth, by farm size

	landholding size category	2009	2011	2013	avg annual growth	sample size in 2013
		Values in 1000s of real 2013 TSh				
agricultural income per-FTE	<2 ha	119	104	115	-1%	1,673
	2-5 ha	202	187	233	4%	688
	> 5 ha	290	336	320	3%	347
non-farm income per-FTE	<2 ha	423	514	594	10%	1,673
	2-5 ha	443	461	526	5%	688
	> 5 ha	426	413	578	9%	347
agricultural wage income per-FTE	<2 ha	92	113	123	8%	1,673
	2-5 ha	82	105	137	17%	688
	> 5 ha	43	118	78	20%	347
Total per-FTE gross income	<2 ha	554	639	719	7%	1,673
	2-5 ha	682	694	881	7%	688
	> 5 ha	784	838	1,077	9%	347

Source: NPS. Landholding size categories are based on the controlled area, which includes all plots which are reported as cultivated, fallow, virgin, forest and pasture. The sample is restricted to rural areas and households with at least one reported plot. The top 1% of income values are dropped as outliers. Zero-valued income is included.

National measures of farm structure from alternative data sources

measure of land concentration	NPS	NPS (landless excluded)	ASC (excl. large farm module)	ASC (incl. large farm module)
Gini	0.58	0.56	0.53	0.57
Skewness	25.5	25.1	15.8	512.8
Coefficient of variation	3.19	3.12	1.77	17.95
Share of land held by farms 5-10 ha	0.17	0.17	0.16	0.15
Share of land held by farms > 10 ha	0.24	0.24	0.23	0.38

Impact of land concentration on income

Selected coefficients from baseline regression models

Dep. var.: household non-farm per-FTE gross income

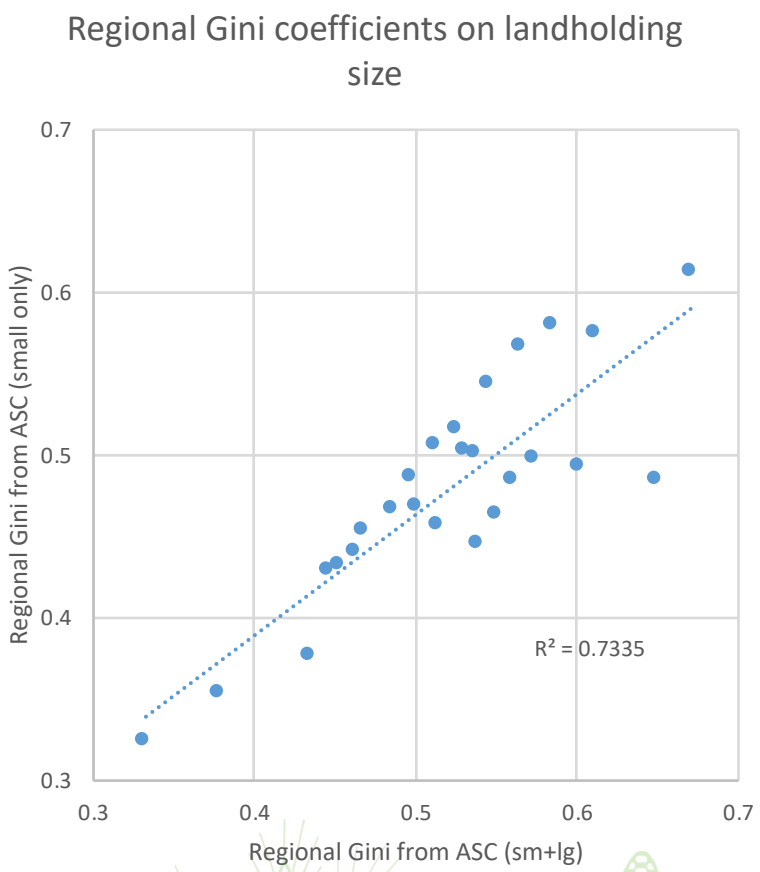
	(1)	(2)	(3)	(4)	(5)	(6)
Land concentration						
Gini	1.297					
	(0.288)					
skewness		0.0214				
		(0.498)				
CV			0.147			
			(0.470)			
share land: farms 5-10 ha				4.393***		5.827***
				(0.00109)		(7.56e-05)
share land: farms >10 ha					-0.416	-1.467**
					(0.503)	(0.0308)

Dep. var.: household ag. wage per-FTE gross income

	(1)	(2)	(3)	(4)	(5)	(6)
Land concentration						
Gini	-0.959					
	(0.390)					
skewness		-0.0208				
		(0.485)				
CV			-0.177			
			(0.360)			
share land: farms 5-10 ha				1.696		2.858**
				(0.181)		(0.0414)
share land: farms >10 ha					-0.670	-1.188*
					(0.249)	(0.0645)

Notes: Dependent variables are inverse hyperbolic sine transformed per-FTE gross income measured in 2010 constant Tanzanian shillings. District-level land concentration measures from 2009 Ag. Sample Census. Dependent variables and other independent control variables are from the NPS. All models include the Mundlak-Chamberlain device. Full model results shown in Appendix A1. Robust pval in parentheses, with significance indicated by asterisks: *** p<0.01, ** p<0.05, * p<0.1.

Checking implications of dropping large farm component of ASC



- Scatterplot of Gini coefficients on landholdings from Agricultural Sample Census with and without large farm sample, region level
- Regressions included dummies for regions where leaving out large farm component changes Gini by >10%

Main results

1. How you measure matters!
   Alternative measures of farm structure…
   - Correlate imperfectly
   - Suggest different analytical conclusions