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Farmland Concentration and Rural Labor Productivity: evidence from Tanzania

Work in progress – not for citation

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(this ppt draws on analysis involving Felix K. Yeboah, Nicholas Sitko, Ayala Wineman, and Milu Muyanga)

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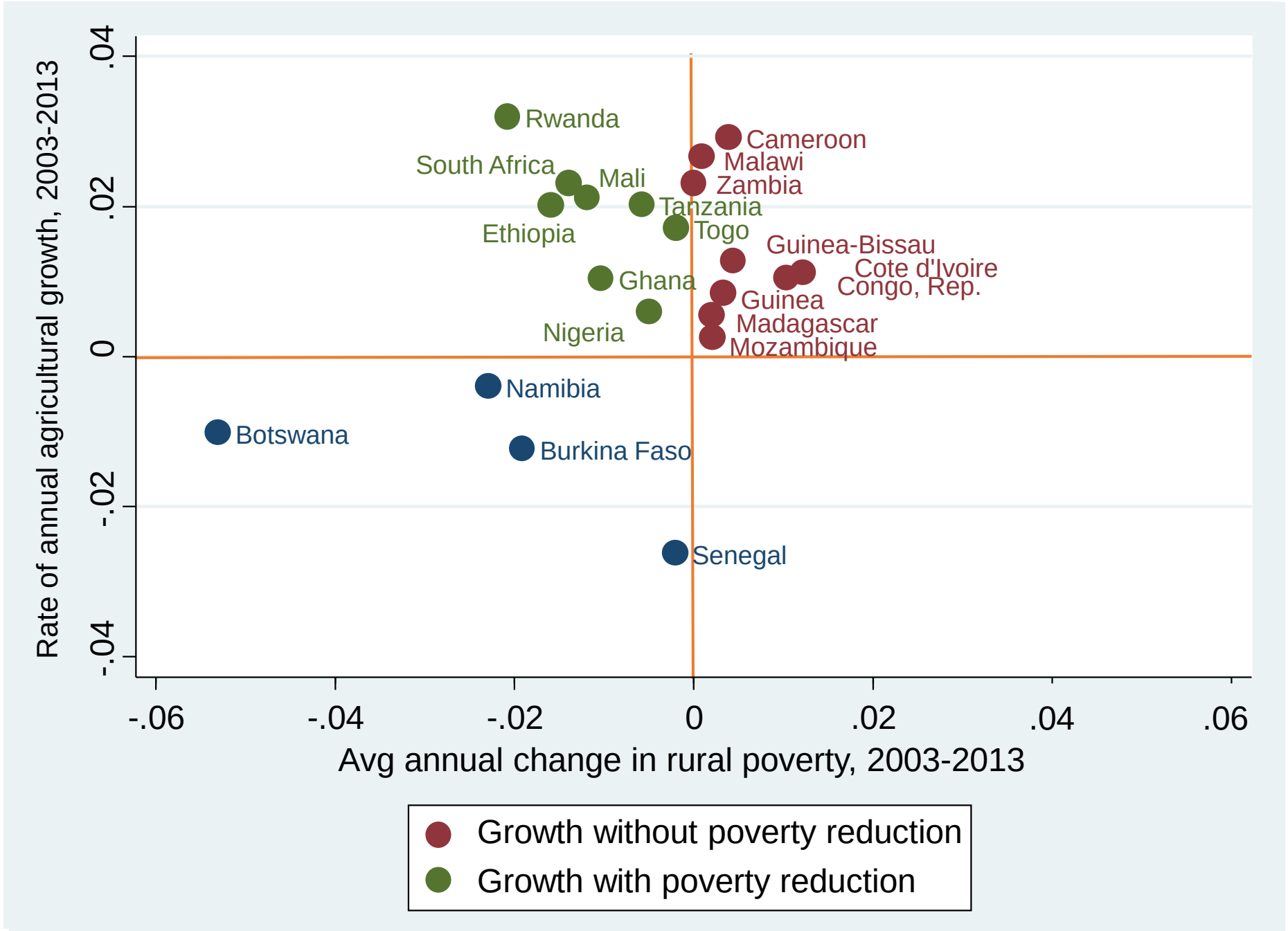

Sources: FAOSTAT, World Bank Development Indicators

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’
- Evidence of rapid change in farm size distributions
- Rise of ‘domestic investor farms

Table 1: Changes in farm structure in Tanzania (2008-2012), 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
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
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

Purpose of study:

- To explore the role of land inequality in affecting how economic growth occurs (in regions that are still primarily agrarian)
    - Distinguish between farmland ownership and operated farm size
- To explore how land inequality affects labor productivity in agriculture and non-farm sectors

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Main hypothesis:

- the initial distribution of assets affect labor productivity in both ag and rural non-farm economy
- Asset distribution also affects the poverty-reducing effects of the growth that does occur

Theory

- Why should land concentration affect the link between ag growth and poverty reduction?
  - Concept of “multiplier effects”

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

GINI coefficients in farm landholding

	Period	Movement in Gini coefficient:
Ghana (cult. area)	1992 → 2013	0.54 → 0.70
Kenya (cult. area)	1994 → 2006	0.51 → 0.55
Tanzania (landholdings)	2008 → 2012	0.63 → 0.69
Zambia (landholding)	2001 → 2012	0.42 → 0.49

Source: Jayne et al. 2014 (JIA)

Procedure:

1. Develop alternative measures of land concentration / inequality
2. Using two different data sets for Tanzania
3. Examine the degree of correlation
   - across measures
   - across 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 panel data sets from Tanzania
  - National Panel Survey (a.k.a LSMS): 2009, 2011, 2013 (n=2,123)
  - Agricultural Sample Census Survey: 2009
- Both collected by Tanzania National Bureau of Statistics
- NPS/LSMS makes it possible to discern individuals' labor allocation between farm and non-farm activities, to construct FTEs of labor time

Methods

- Dependent variables: (household-level)
  - agricultural output per FTE adult labor time on farm (15-64 yrs)
  - non-farm output per FTE adult labor time in non-farm activities
  - total household income per FTE adult labor
- All three measures: TZ shillings per FTE labor per year in household

Methods

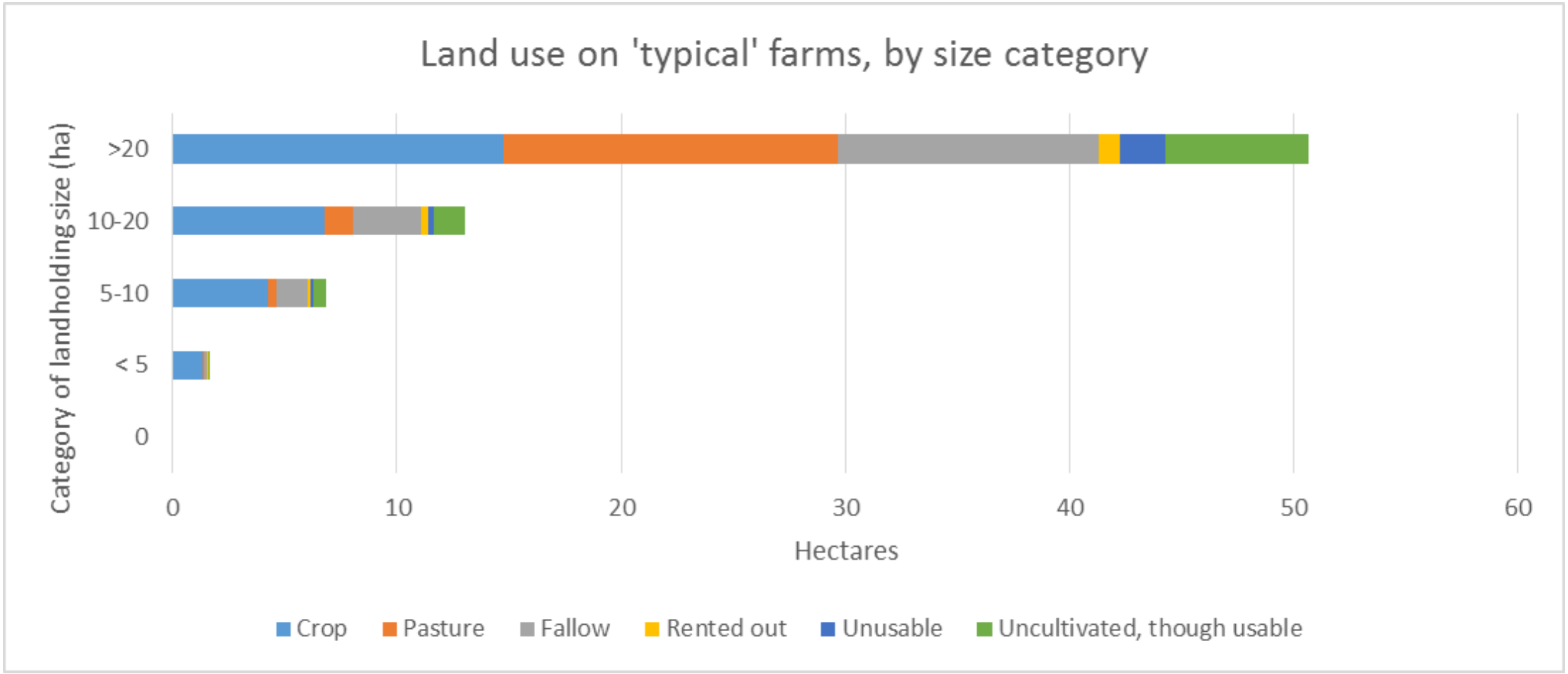
- Estimated reduced form models of labor productivity
  - Particular interest in the coefficient of land inequality measures at district-level
    - Gini coefficient
    - Measure of skewness
    - % of land on farms of > 10 ha

- $Y_{it} = f (X_{it}, C_{it}, LandIneq_{jt-1}) + e_{it}$

  - Y_{it} is household gross farm / non-farm revenue per FTE in farm/off-farm, hh *i* in year *t*
  - X_{it} is household socio-demographic-economic covariates
  - C_{it}, is community-level factors
  - $LandIneq_{jt-1}$ is the measure of land concentration in district *j*

- Correlated random effects applied to three waves of panel data (n=5,069 hhs)

Figure 2. Average land area allocated to each land use, by category of landholding size



Source: Agricultural Sample Census, 2008

Table 3. Proportion of land area allocated to each land use, by category of landholding size

	Category of landholding size				
Land use	0	< 5	5-10	10-20	>20
Crop	N/A	0.82	0.62	0.52	0.29
Pasture	N/A	0.01	0.05	0.10	0.29
Fallow	N/A	0.10	0.21	0.23	0.23
Rented out	N/A	0.01	0.02	0.03	0.02
Unusable	N/A	0.01	0.02	0.02	0.04
Uncultivated, though usable	N/A	0.04	0.09	0.11	0.13

Source: Agricultural Sample Census, 2008

Table 1: alternative indicators of land concentration

	Land concentration measure
1	Gini coefficient
2	Skewness (3rd moment)
3	Coefficient of variation
4	([top quartile] – [bottom quartile]) / [median]
5	Landless % of HHs
6	% land in farms < 2 ha
7	% land in farms > 5 ha
8	% land under largest 10% of farms

Correlation coefficients of alternative measures of land concentration, Tanzania, 2009, ASC

	Gini	Skewness	CV	Timmer's	Landless % of HHs	% land in farms < 2 ha	% land in farms 2-5 ha	% land in farms > 5 ha
Gini	1							
Skewness	0.7364	1						
CV	0.8923	0.8064	1					
Timmer's	0.6192	0.3008	0.3074	1				
Landless % of HHs	-0.0277	-0.0235	-0.0394	-0.0402	1			
% land in farms < 2 ha	-0.5332	-0.3807	-0.3714	-0.3914	-0.0549	1		
% land in farms 2-5 ha	-0.2152	-0.1358	-0.2897	0.0295	0.0988	-0.3839	1	
% land in farms > 5 ha	0.6912	0.4835	0.5593	0.403	0.0038	-0.8576	-0.1457	1
% land under largest 10% of farms	0.9767	0.7587	0.9359	0.4746	-0.0339	-0.4948	-0.2743	0.6829

Table 2. Farm structure in Tanzania, NPS 2009 vs. ASC 2008

	percentile								
	5th	10th	25th	50th	75th	90th	95th	99th	mean
cultivated land (NPS)	0.0	0.1	0.4	1.1	2.2	4.4	6.7	15.7	2.1
controlled land (NPS)	0.0	0.0	0.1	0.9	2.2	4.5	6.9	17.0	2.0
controlled land (ASC)	1.0	1.0	2.0	4.0	7.0	12.0	20.0	50.0	6.5

Table 3. Comparison of farmland owned and land under cultivation in Tanzania, 2008 Agricultural Sample Census Survey vs. 2008 LSMS/National Panel Survey

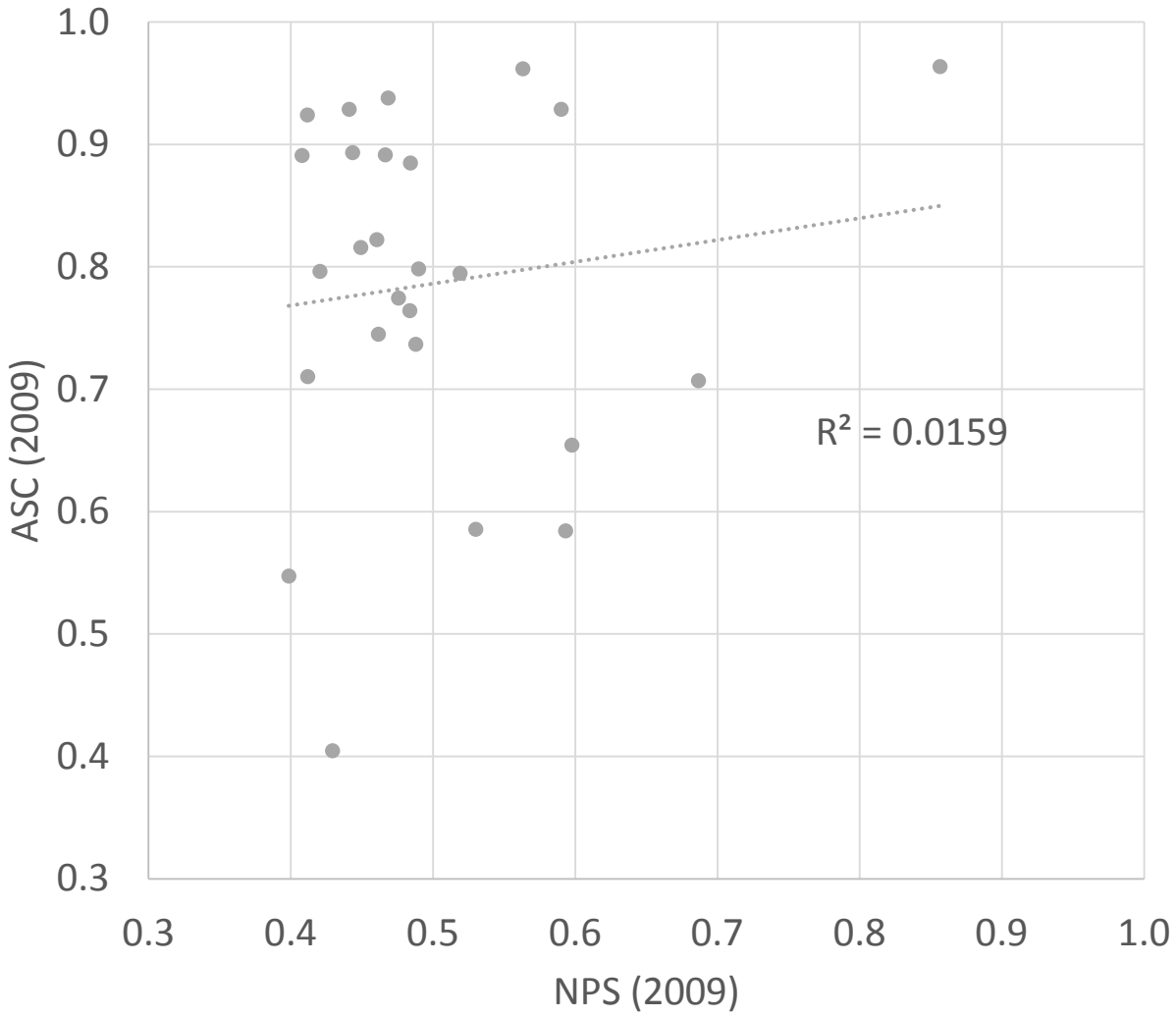
	Farm land controlled			Land under operation		
	LSMS	Ag Sample Census Survey	% difference	LSMS	Ag Sample Census Survey	% difference
By holdings of:	Million hectares			Million hectares		
0-5 ha	8.246	8.595	+4.2	8.117	8.130	+0.002
5-100 ha	3.872	5.861	+51.4	3.816	5.181	+35.8
Over 100 ha	0.809	1.294	+60.0	0.809	0.942	+16.5

Table 3. Counts of farm holdings over 10 hectares in five districts of Tanzania, according to three data sources.

District	Region	2012 Tanzania National Panel Survey	2008 Agricultural Sample Census Survey	Mdoe et al. (2016)
Kilombero	Morogoro	0	1,445	1,348
Moshi (Rural)	Kilamanjaro	2,316	423	489
Njombe	Iringa	0	1,015	1,828
Mvomero	Morogoro	742	1,814	1,910
Kiteto	Manyara	0	2,982	3,668

Sources: 2012 Tanzania National Panel Survey, 2008 Agricultural Sample Census Survey, and the population lists developed by Mdoe et al. (2016).

Figure 2: Scatterplot of regional Gini coefficients on landholdings from ASC and NPS



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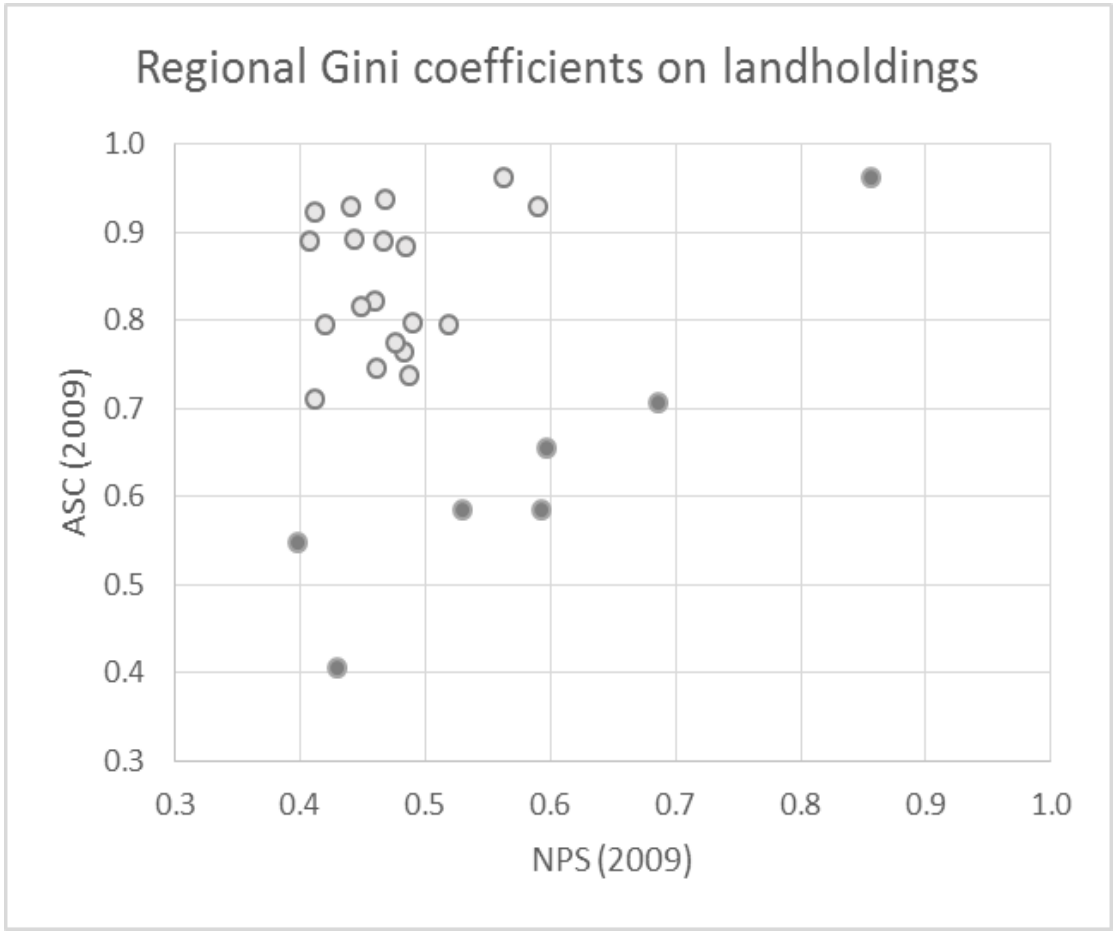

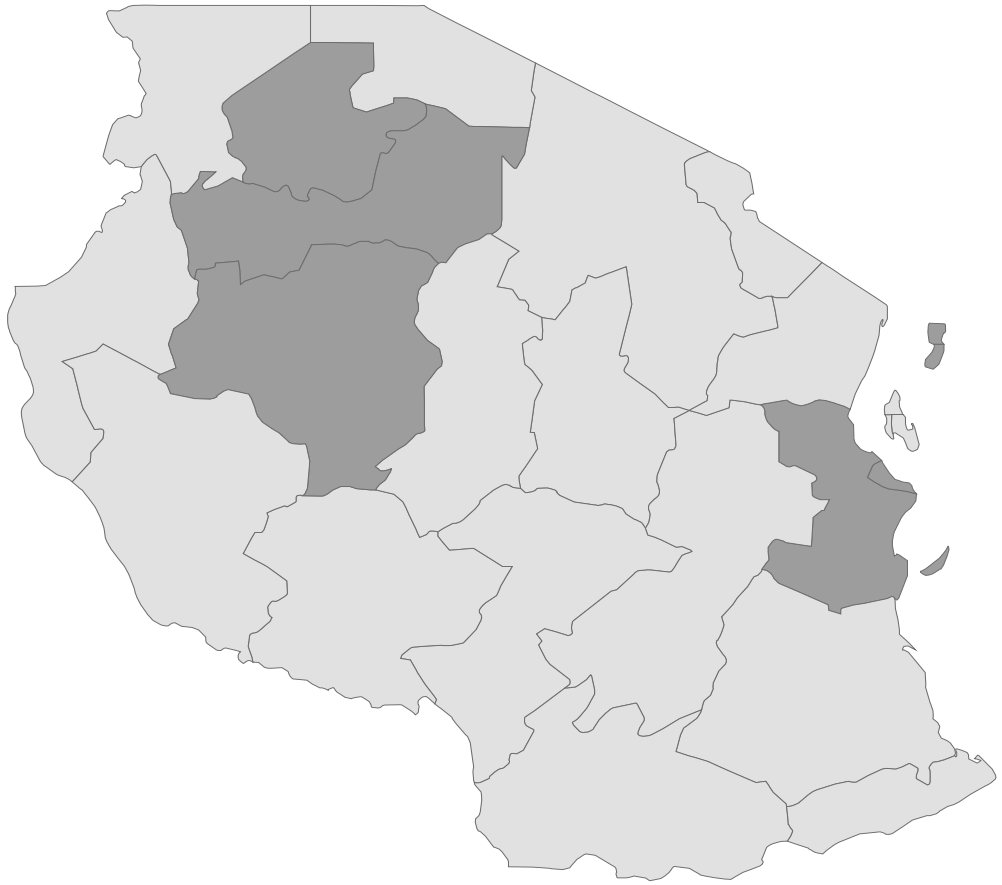

Descriptive statistics of variables used in econometric analysis

variable	unit	5th	10th	25th	50th	75th	90th	95th	99th	mean
farm labor prod.	1000s real 2009 TSh	0	0	0	41.3	167.5	403.1	610.0	1627.0	183.4
non-farm non-ag. labor prod.	1000s real 2009 TSh	0	0	0	160.0	1375.0	4656.0	10100.0	37000.0	2748.8
non-farm ag. labor prod.	1000s real 2009 TSh	0	0	0	0	0	90.0	220.0	835.2	45.7
total labor prod.	1000s real 2009 TSh	1.0	31.5	142.3	478.5	1590.5	4890.9	10600.0	37600.0	2977.9
farm size	hectares	0	0.1	0.4	1.1	2.4	4.7	7.2	18.3	2.2
age of head	years	24	27	33	43	56	70	76	86	45.9
size of household	#	1	2	3	5	7	9	10	15	5.1
max. edu. attainment	years	4	5	7	7	10	12	15	22	8.3
female head	binary	0	0	0	0	1	1	1	1	0.3
# of plots		1	1	1	2	3	4	5	7	2.3
Value of productive assets	1000s real 2009 TSh	<1	<1	<1	18	40	159	3,768	10,400	530.3
has ox plough	binary	0	0	0	0	0	1	1	1	0.2
has tractor	binary	0	0	0	0	0	0	1	1	0.1
fertilizer application	kg	0	0	0	0	0	200	800	3000	156.0
distance to road	km	0.1	0.3	1.1	8.3	23.1	43.7	56.0	88.1	16.1
distance to market	km	3.3	5.4	21.3	64.3	97.3	137.9	162.6	209.6	67.0
elevation	meters above sea level	21	40	489	1147	1277	1522	1682	2028	945.3
slope	degrees	1.2	1.4	2.1	3.4	6.2	12.0	16.7	27.2	5.3
pop. density	persons/km2	10	20	60	190	960	6,850	14,100	30,760	2210.0
bimodal rainfall area	binary	0	0	0	1	1	1	1	1	0.5
rainfall (avg. annual)	mm	420	495	677	827	967	1044	1154	1666	821.8

Estimation results:

Impact of land concentration on labor productivity

Table 6: Baseline regression specifications

	(1)	(2)	(3)	(4)	(5)	(6)
	Log farm labor productivity			Log non-farm labor prod.		
farm size (ha)	0.0285**	0.0282**	0.0284**	-0.0381*	-0.0481**	-0.0372*
	(0.0431)	(0.0447)	(0.0403)	(0.0615)	(0.0181)	(0.0683)
age of head	-0.0179**	-0.0181**	-0.0180**	-0.0887	-0.0917	-0.0895
	(0.0441)	(0.0396)	(0.0451)	(0.116)	(0.118)	(0.112)
size of household	-0.0825***	-0.0796***	-0.0820***	0.114	0.0975	0.107
	(0.0002)	(0.0003)	(0.0002)	(0.298)	(0.378)	(0.328)
edu.attainment of head	-0.00382	-0.00419	-0.00359	0.117*	0.114*	0.115*
	(0.767)	(0.745)	(0.780)	(0.0779)	(0.0905)	(0.0841)
female head (=1)	-0.150	-0.152	-0.148	0.776	0.843	0.756
	(0.438)	(0.436)	(0.443)	(0.554)	(0.509)	(0.564)
# of farm plots	0.230***	0.228***	0.231***	0.132	0.176	0.130
	(3.03e-08)	(4.79e-08)	(2.67e-08)	(0.581)	(0.462)	(0.586)
log(prod.assets)	0.0439***	0.0413***	0.0448***	-0.0554	-0.0199	-0.0521
	(0.00523)	(0.00793)	(0.00436)	(0.429)	(0.781)	(0.458)
has ox plough (=1)	-0.0453	-0.0451	-0.0451	1.309**	1.294**	1.317**
	(0.647)	(0.649)	(0.648)	(0.0163)	(0.0181)	(0.0158)
has tractor (=1)	-0.0236	-0.0528	-0.0254	1.316*	1.339*	1.407*
	(0.865)	(0.703)	(0.854)	(0.0800)	(0.0724)	(0.0594)
log(fert.kg)	-0.00665	-0.00677	-0.00651	0.0560	0.0431	0.0559
	(0.658)	(0.649)	(0.665)	(0.480)	(0.591)	(0.481)
km to road	-0.0145	-0.0142	-0.0147	0.00702	-0.00499	0.00593
	(0.125)	(0.131)	(0.119)	(0.894)	(0.930)	(0.911)
km to market	-0.00115	-0.00126	-0.00126	-0.0344	-0.0381	-0.0337
	(0.781)	(0.760)	(0.758)	(0.173)	(0.154)	(0.180)
elevation	0.000941	0.000969	0.000909	0.00346	0.00318	0.00373
	(0.144)	(0.142)	(0.151)	(0.213)	(0.256)	(0.182)
slope	0.00559	0.00565	0.00527	0.126	0.124	0.126
	(0.767)	(0.764)	(0.781)	(0.179)	(0.183)	(0.180)
pop.density	-1.82e-05	-1.88e-05	-1.62e-05	9.42e-05	0.000189	9.54e-05

	(0.632)	(0.620)	(0.671)	(0.428)	(0.121)	(0.422)
bimodal (=1)	0.757	0.806	0.715	-1.563	-2.034	-1.464
	(0.164)	(0.149)	(0.182)	(0.537)	(0.465)	(0.563)
rainfall (mm)	0.000922	0.00126	0.000948	0.000118	-0.00148	-0.000392
	(0.396)	(0.248)	(0.384)	(0.982)	(0.779)	(0.939)
1=rural	-0.0564	-0.0590	-0.0562	-3.066***		-3.065***
	(0.404)	(0.380)	(0.406)	(0)		(0)
year=2013	0.0550	0.0510	0.0539	-0.605**	-0.581**	-0.599**
	(0.213)	(0.247)	(0.222)	(0.0158)	(0.0226)	(0.0169)
regional land: Gini	0.250			-3.392***		
	(0.158)			(0.000570)		
regional land: skewness		-0.00628***			-0.00548	
		(0.000603)			(0.584)	
regional land: share under farms >10 ha			0.600***			-3.229***
			(0.000595)			(0.000543)
Constant	11.05***	11.53***	10.73***	16.68***	11.53***	16.29***
	(0)	(0)	(0)	(0)	(0)	(0)
Observations	4,595	4,595	4,595	5,069	5,069	5,069
R-squared	0.216	0.219	0.218	0.144	0.125	0.143

Table 5. Baseline results: impact of land concentration on labor productivity

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Farm labor productivity			non-farm labor prod.			total labor prod.		
Land concentration									
Gini	0.25			-3.39***			-0.54**		
	(0.158)			(0.00057)			(0.036)		
Skewness		-0.0063***			-0.00548			-0.0064**	
		(0.000603)			(0.584)			(0.012)	
share under			0.600***			-3.229***			-0.457*
farms >10 ha			(0.00059)			(0.00054)			(0.063)

Notes: Dependent variables are transformed using the inverse hyperbolic sine transform. Regional-level land concentration measures from 2009 Ag. Sample Census. Dependent variables and other independent control variables are from the 2011 and 2013 rounds of the NPS. All models include the Mundlak-Chamberlain device. Robust p-val in parentheses, with significance *** p<0.01, ** p<0.05, * p<0.1.

Table 6. Impact of land concentration on labor productivity, with interactions between district land concentration * hh farm size categorical variables

	(1)	(2)	(3)	(4)	(5)	(6)	(10)	(11)	(12)
	Farm labor prod.			Non-farm labor prod.			Total labor prod.		
*Land concentration * farm-size*									
Gini * farm size 0-2 ha	-0.0633			-3.232***			-0.719***		
	(0.720)			(0.00118)			(0.00552)		
Gini * farm size 2-10 ha	0.540***			-3.471***			-0.350		
	(0.00254)			(0.000555)			(0.179)		
Gini * farm size > 10 ha	0.761***			-3.875***			-0.278		
	(5.45e-05)			(0.000375)			(0.320)		
skewness * farm size 0.2 ha		-0.0118***			-0.00527			-0.00978***	
		(5.17e-10)			(0.613)			(0.000234)	
skewness * farm size 2-10 ha		0.00174			-0.0103			-0.000646	
		(0.411)			(0.389)			(0.821)	
skewness * farm size > 10 ha		0.00631**			-0.00990			0.00131	
		(0.0169)			(0.526)			(0.732)	
% land on farms >10 ha * farms 0-2 ha			0.239			-3.045***			-0.669***
			(0.170)			(0.00133)			(0.00748)
% land on farms >10 ha * farms 2-10 ha			0.833***			-3.274***			-0.298
			(1.88e-06)			(0.000568)			(0.232)
% land in farms >10 ha * farms > 10 ha			1.034***			-3.692***			-0.222
			(1.44e-08)			(0.000341)			(0.402)

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% change in household income per adult (with change in land gini from 25th to 75th percentile)

Magnitude of effect on labor productivity

LAND INEQUALITY	Evaluated at		
GINI	25th pct of gini	75th pct of gini	% difference
log: hh farm labor productivity	10.59	10.40	+ 6.4
log: hh non-farm income per adult	11.48	10.74	-21.7
Log: total hh labor productivity	12.67	12.91	- 8.3

Summary

1. Landholding distribution influences household income growth – in both farm and non-farm sectors
   - All other factors equal, households in districts at the 25th percentile of farmland gini inequality (relatively low level of inequality) have
     - 6.4% lower farm incomes
     - 21.9% higher non-farm incomes
     - 8.3% higher total incomes

     per household than in districts at the 75th percentile of farmland gini inequality (high inequality)
   - Robust to alt. measure of land concentration
2. Effects of land concentration are most adverse on the smallest farm households (> 90% of farms in Tanzania)
   - Generally insignificant effects on total labor productivity of larger farms

Policy Questions:

- Farm structure in many African countries is changing rapidly. Should governments want to influence this?

GINI coefficients in farm landholding

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Zambia (landholding)	2001 → 2012	0.42 → 0.49

Source: Jayne et al. 2014 (JIA)

Policy questions:

1. Farm structure in many African countries is becoming more concentrated – should governments want to influence this?

2. Is rising land inequality contributing to concentration of marketed farm output? Can agric development still be small-farm led?

3. Implications for poverty reduction strategies?

4. Implications for structural transformation processes?

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