The Farm Size-Productivity Relationship Revisited

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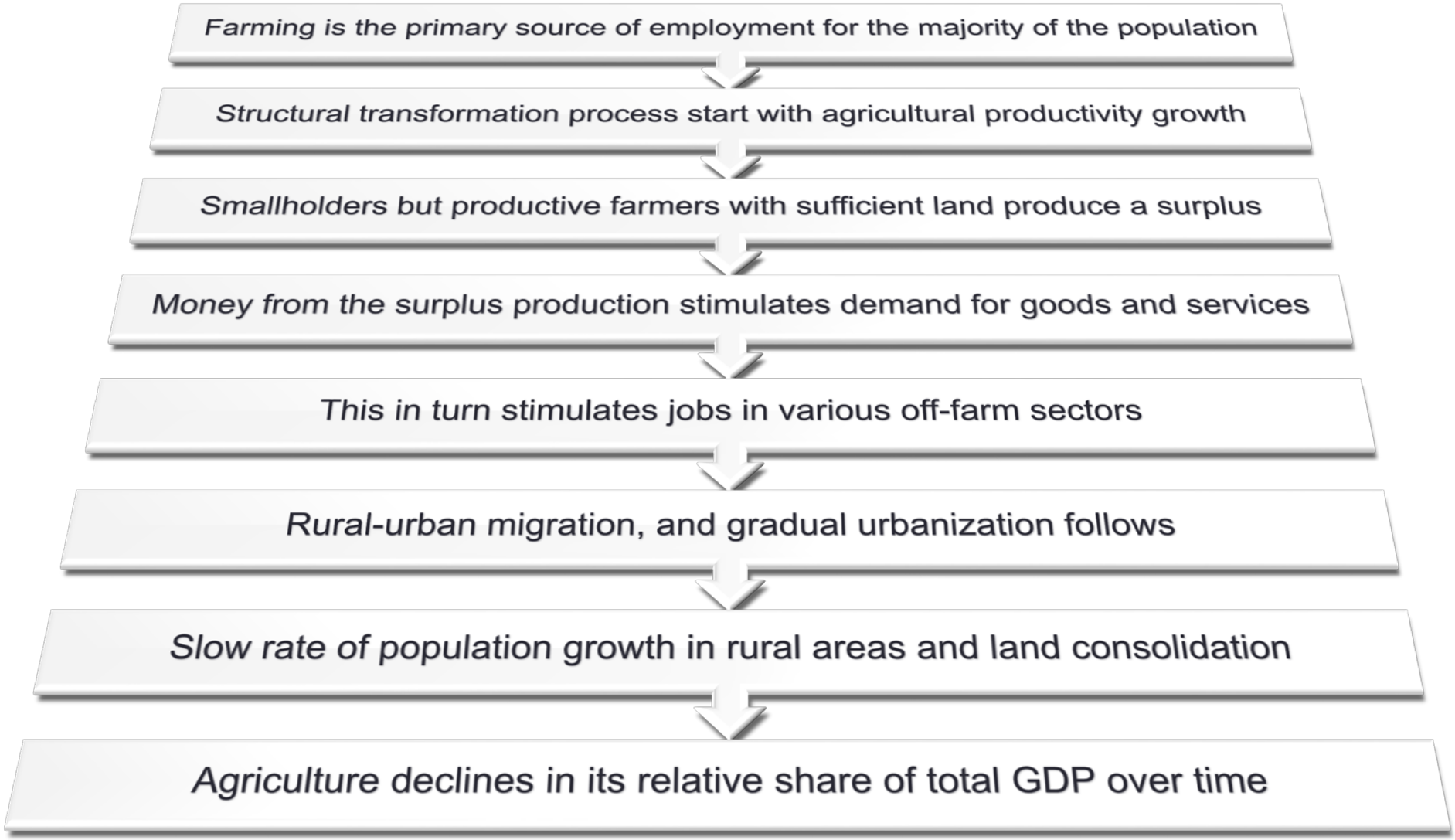
Introduction

- Based on experiences from Asia, a smallholder-led growth strategy has been widely accepted as the pathway for achieving economic transformation and mass poverty reduction in Africa
- Since smallholders also constitute the majority of farms in Africa, it is generally accepted that a smallholder-led strategy also holds the best prospects for economic development in Africa

Standard version of the structural transformation model (Mellor, 1976; Johnston and Kilby, 1975)



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Household land sizes in rural Tanzania

Landholding category	Landholding (ha)	Number of farmers	As % of total
1 ha and less	0.58	1,801,085	33.19
1-5 ha	2.18	3,111,927	57.35
5-10 ha	6.88	340,736	6.28
10-20 ha	13.01	118,547	2.18
20-50 ha	26.29	49,315	0.91
50-100 ha	65.98	3,131	0.06
over 100 ha	146.29	1,172	0.02
Total	2.47	5,425,913	100.00

91%

Source: Tanzania Agricultural Sample Census Survey 2007/08

Poverty levels in Tanzania

- According to the World Bank 2012 Household Budget Survey
  - Basic needs poverty declined from 34.4% in 2006, to 28.2% by 2012
  - Approximately 70% of Tanzanians live with less than $2 per day
- To reduce poverty, report recommends:
  - Development of the rural economy, agriculture, and diversification of livelihoods into non-farm businesses

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Motivation

CONCERNS on a smallholder-led growth strategy in Africa [I]

- Earlier results on IR seem incongruous, at least on the face of it, with research findings that small farms are relatively more productive than larger farms
  - Thus, renewed interest in the Inverse Farm Size-Efficiency Relationship (IR) among development economists
- Guiding land allocation policies for inclusive growth:
  - Are prevailing land policies promoting national goals of agricultural productivity, industrialization, food security and poverty reduction?

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Motivation

CONCERNS on a smallholder-led growth strategy in Africa [II]

- Small-scale farming in Africa has historically provided very LOW RETURNS to labor
  - Most rural Africans now appear to be seeking ways to improve their livelihoods away from farming
  - Diversifying into higher-return non-farm employment or getting out of farming entirely

Tests of the IR hypothesis take on even greater policy importance in light of recent studies questioning the viability and even the objectives of promoting small-scale agriculture in Africa

"Favouring small farmers, he argues, is romantic but unhelpful"

[Collier and Dercon, 2014]

Tanzania: Data Sources

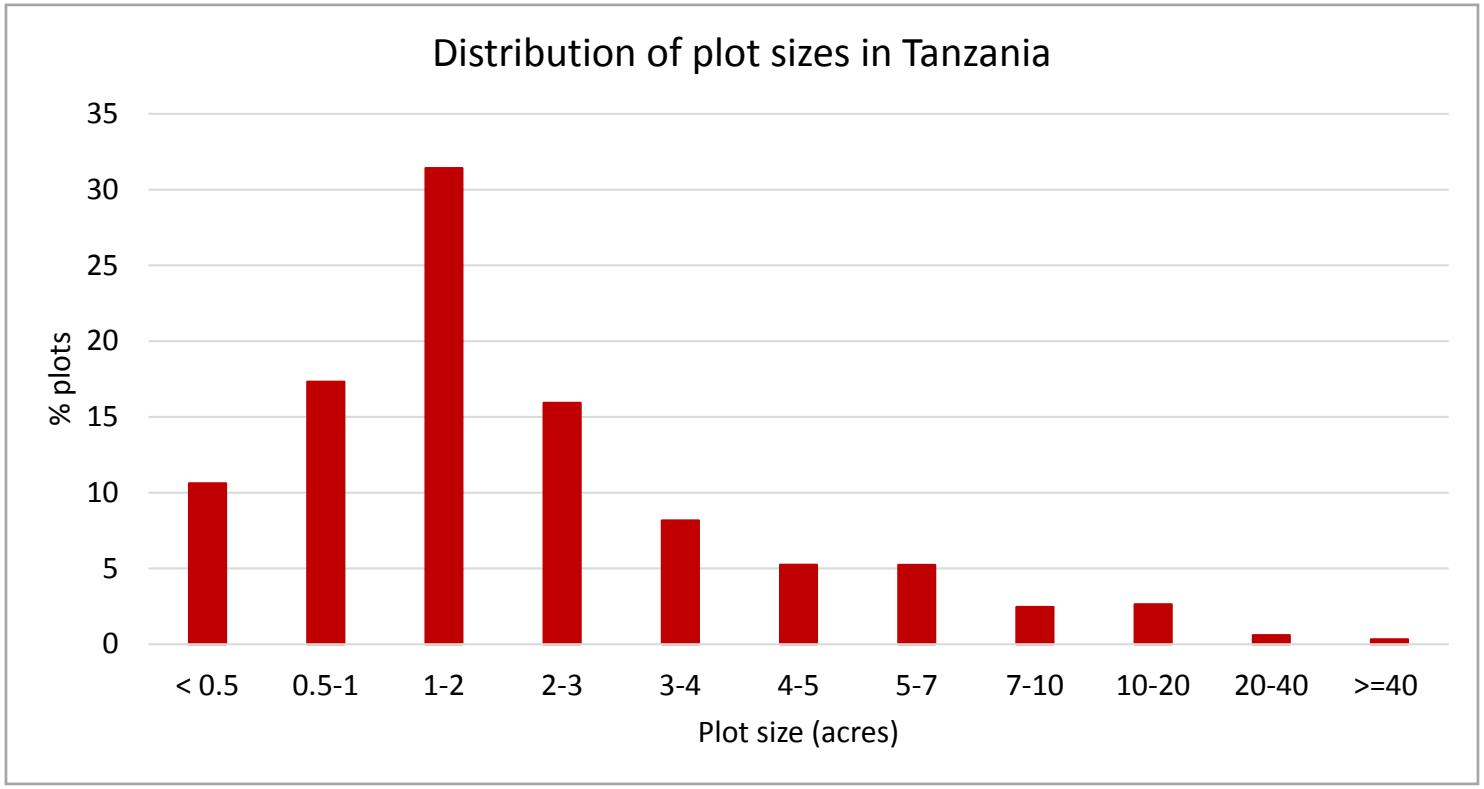
Number of plot-level observations

	Info on area and net value of crop production	Complete info for all RHS variables	Plots tracked from year 2009, present in all 3 survey waves with complete info in all waves
2008/09	4,734	4,401	2,370
2010/11	5,412	4,905	2,370
2012/13	6,635	6,187	2,370
Total	16,781	15,493	7,110
Sample restrictions		≤ 50 acres = 15,455	≤ 50 acres = 7,083

LSMS (NPS) Tanzania 2008/09, 2010/11, 2012/13

Source: Wiseman & Jayne, 2016

LSMS (NPS) Tanzania 2008/09, 2010/11, 2012/13

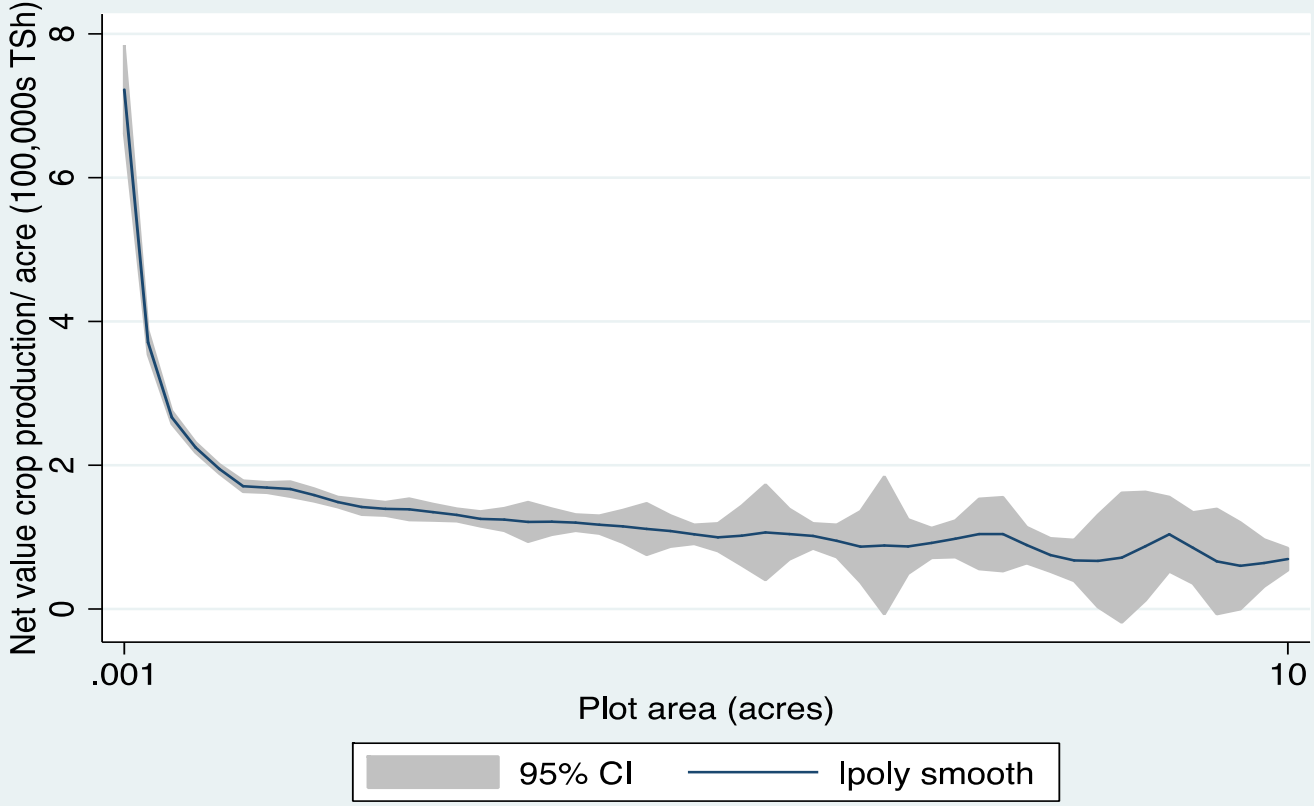


95th percentile: 7.20 acres (2.91 ha)

Source: Wiseman & Jayne, 2016

Relationship between plot area and crop revenue

Non-parametric polynomial regression



Relationship between plot area and crop revenue – Regression analysis (pooled OLS) –

	(1)	(2)	(3)	(4)	(5)
	Dependent variable: Net value crop production/ acre (100,000s TSh)				
Area (acres, estimated)	-0.14***	-0.29***	-0.12***	-0.05***	-0.04***
Area^2		0.01***			
1=Plot is right at residence			0.45***	0.33***	0.54***
Distance from plot to home (km)			-0.001***	-0.001***	-0.001
Distance from plot to road (km)			-0.03***	-0.03***	0.01
Distance from plot to market (km)			-0.01**	-0.002	-0.01
1= Problems with erosion on plot			-0.11*	-0.12**	0.09
1= Soil quality is 1 out of 3 (best)			0.37***	0.32***	0.34***
1= Soil quality is 3 out of 3 (worst)			-0.46***	-0.41***	-0.19
1= Slope is 'flat'			0.05	0.03	0.07
1= Slope is 'steep'			0.08	0.20*	0.19
Population density (persons/km^2)			0.000**	0.000***	
1= Plot cultivated in both seasons				0.46***	0.52***
1= Plot was irrigated (≥ 1 season)				1.67***	2.05***
Kgs manure/ acre				0.002***	0.001***
Kgs fertilizer/ acre				0.02***	0.01
Labor days/ acre (both seasons)				0.01***	0.01***
Region and Year Fixed Effects			Y	Y	
Household-Year Fixed Effects					Y
Constant	1.90***	2.13***	0.85***	0.32***	0.55***
Slope on area=0 at this value:		22.35 acres			
% Plots larger than this value:		0.61%			
Observations	15,455	15,455	15,455	15,455	12,801
R-squared	0.030	0.044	0.095	0.215	0.369

*** p<0.01, ** p<0.05, * p<0.1

Includes plots ≤ 50 acres

Preliminary Conclusions

- IR is **persistent** in plot-level analysis.
- IR evident along spectrum of plot sizes.
- Crop mix, unobserved plot effects do not seem to (fully) explain the IR

Ongoing studies on IR

Household land sizes [Agric. Sample Census Survey 2007/08]

Landholding category	Landholding (ha)	Number of farmers	As % of total	Land controlled (ha)	As % of total area
1 ha and less	0.58	1,801,085	33.19	1,040,010	7.77
1-5 ha	2.18	3,111,927	57.35	6,779,527	50.66
5-10 ha	6.88	340,736	6.28	2,345,525	17.53
10-20 ha	13.01	118,547	2.18	1,542,855	11.53
20-50 ha	26.29	49,315	0.91	1,296,627	9.69
50-100 ha	65.98	3,131	0.06	206,559	1.54
over 100 ha	146.29	1,172	0.02	171,455	1.28
Total	2.47	5,425,913	100.00	13,382,558	100.00

9%

42%

New analysis contribution [I]

- Explore the IR hypothesis over a much wider range of farm sizes - a statistically representative sample of farms between 1 and 50 hectares
  - Inform current policy discussions about how governments should allocate unutilized/underutilized land in order to achieve national equity and productivity goals
  - Unutilized/underutilized land is being claimed and transferred at a very rapid pace in some countries

New analysis contribution [II]

- Number of studies have conventionally measured productivity as yield per unit area of land
- Ongoing studies are based on a wider set of productivity measures:
  - Gross/net value of total crop production per unit of area planted (land productivity)
  - Total factor productivity
  - Productivity index (gross production/total production costs)
  - Gross/net value of crop production per adult labor unit (labor productivity)

New analysis contribution [II]

- Number of studies have conventionally measured productivity as yield and or net value of crop production per unit area of land
  - In understanding the impact of farm production on household POVERTY, labor productivity may be more insightful

	Net farm production /ha	Farm size (ha)	Total net farm output	Household size	Revenue/adult equivalent	Revenue /ae/ day
Smallholder farm	$1,000	0.25	$250	6	$41.67	$0.11
Medium-scale farm	$500	10	$5,000	6	$833.33	$2.28

New analysis contribution [III]

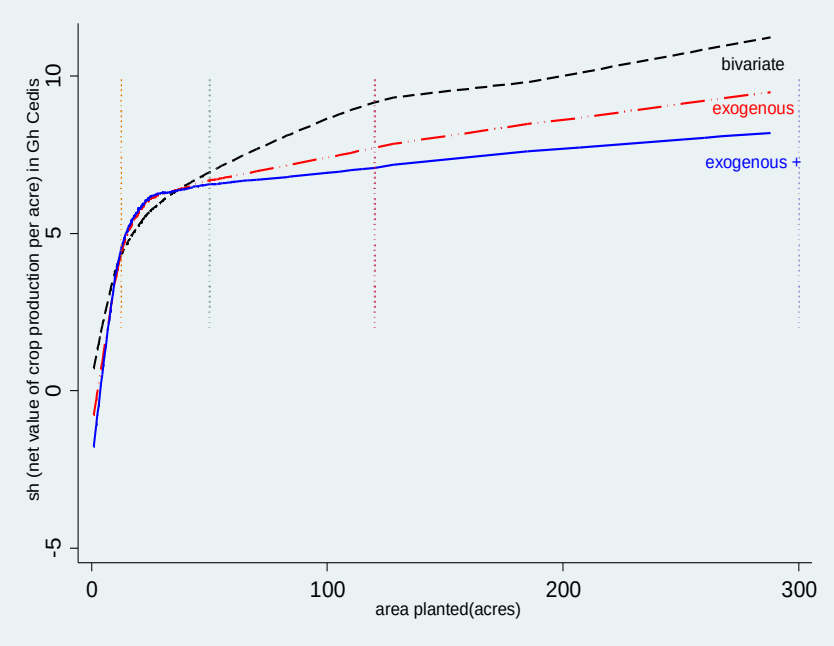
- Account for both variable and fixed costs when computing the cost of production
  - Most of the prior studies typically ignored fixed and labor costs
  - Led to overstated productivity of farms with high fixed and labor costs

Study countries

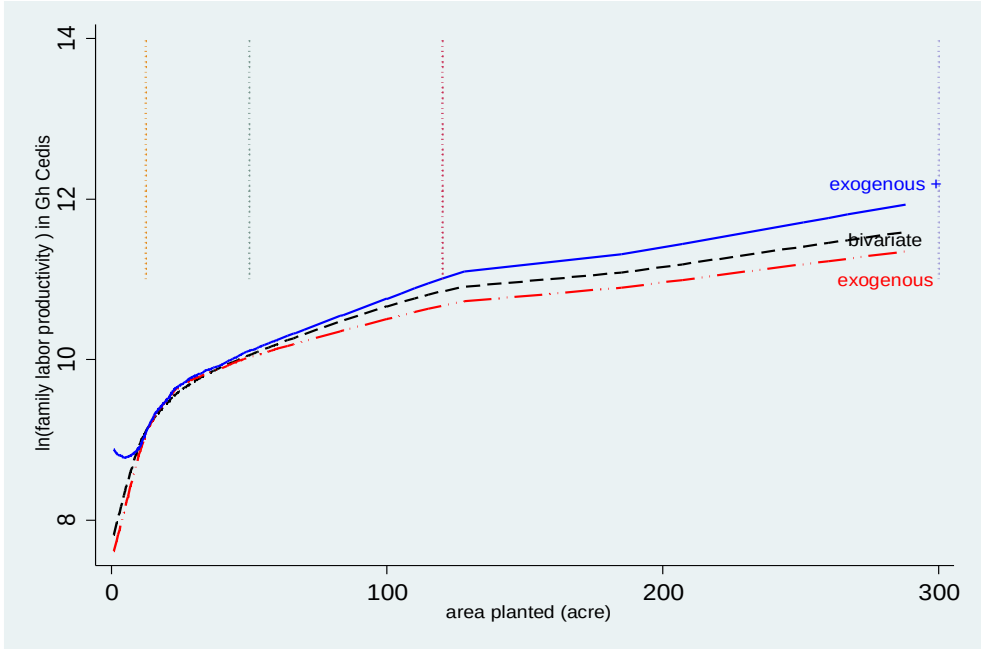
- Ghana
- Kenya
- Zambia
- Tanzania

GHANA

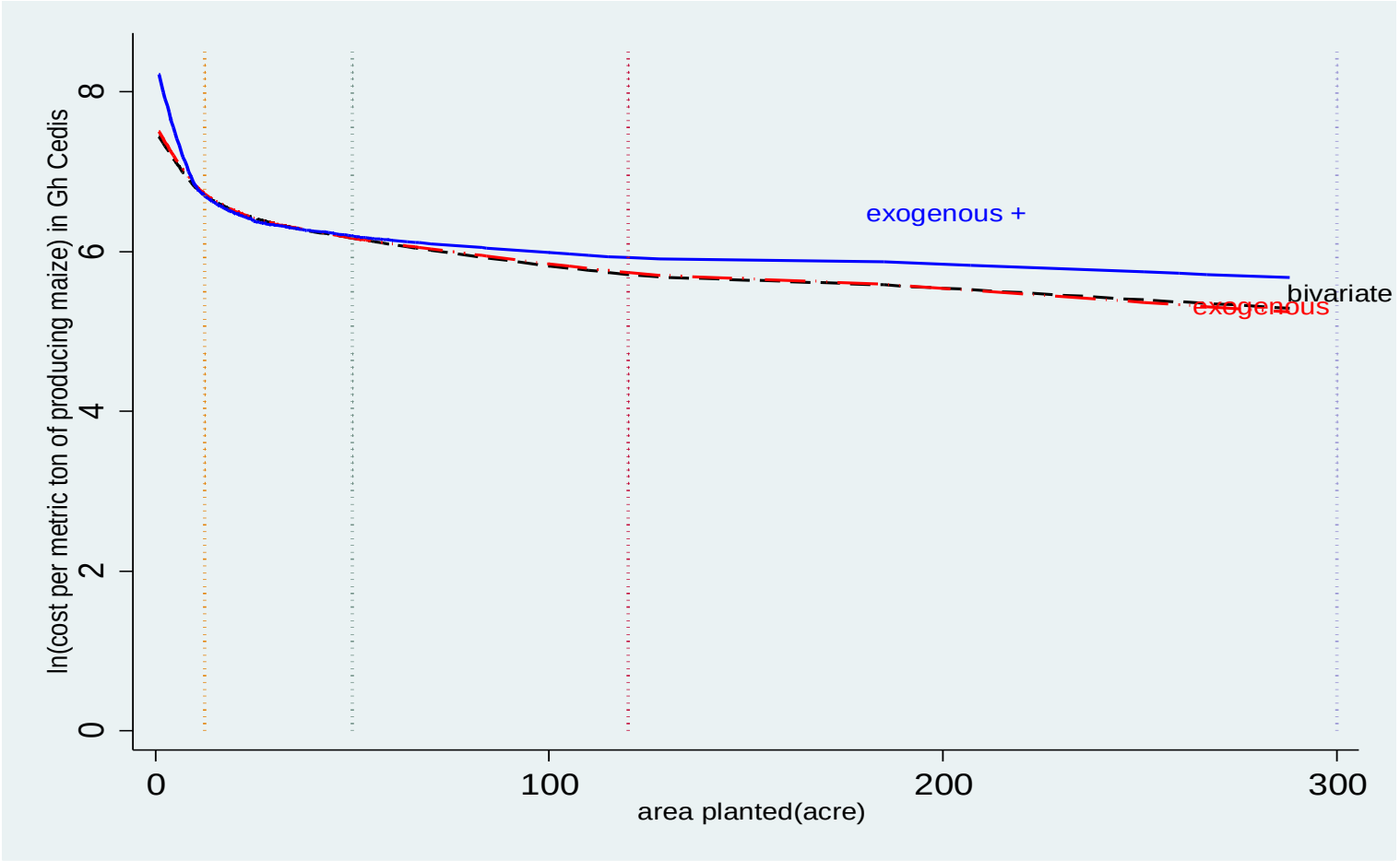
Net value of production on area planted in Acres



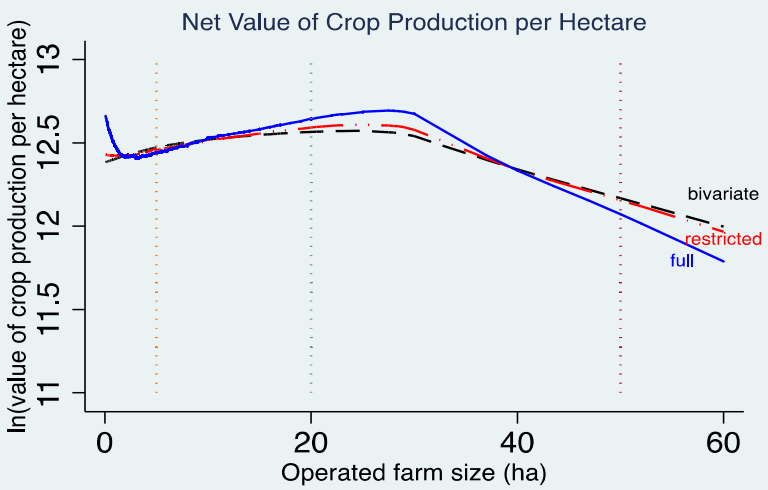
Family labor productivity on area planted in Acres

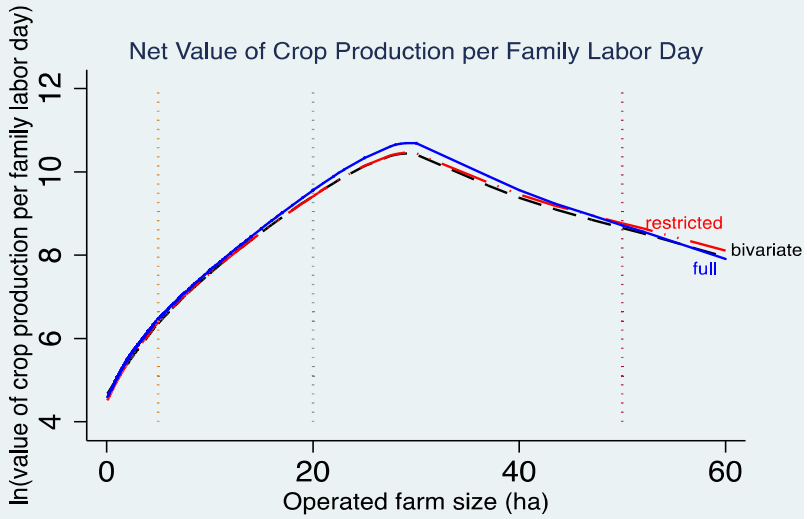


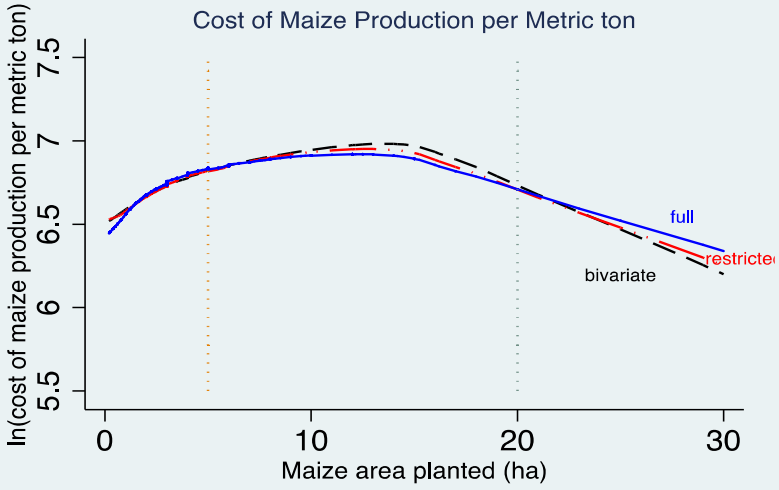
GHANA: Cost of maize production on area planted in Acres

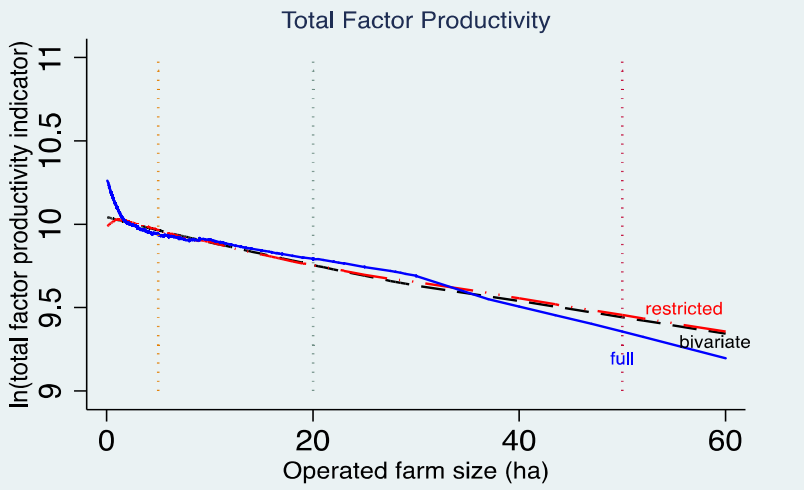


ZAMBIA


Net Value of Crop Production per Hectare
ln(value of crop production per hectare)
11
11.5
12
12.5
13
0
20
40
60
Operated farm size (ha)
bivariate
restricted
full


Net Value of Crop Production per Family Labor Day
ln(value of crop production per family labor day)
4
6
8
10
12
0
20
40
60
Operated farm size (ha)
restricted
bivariate
full


Cost of Maize Production per Metric ton
ln(cost of maize production per metric ton)
5.5
6
6.5
7
7.5
0
10
20
30
Maize area planted (ha)
full
bivariate


Total Factor Productivity
ln(total factor productivity indicator)
9
9.5
10
10.5
11
0
20
40
60
Operated farm size (ha)
restricted
bivariate
full

KENYA: full sample

Figure 1(a): Value of crop production/ha planted

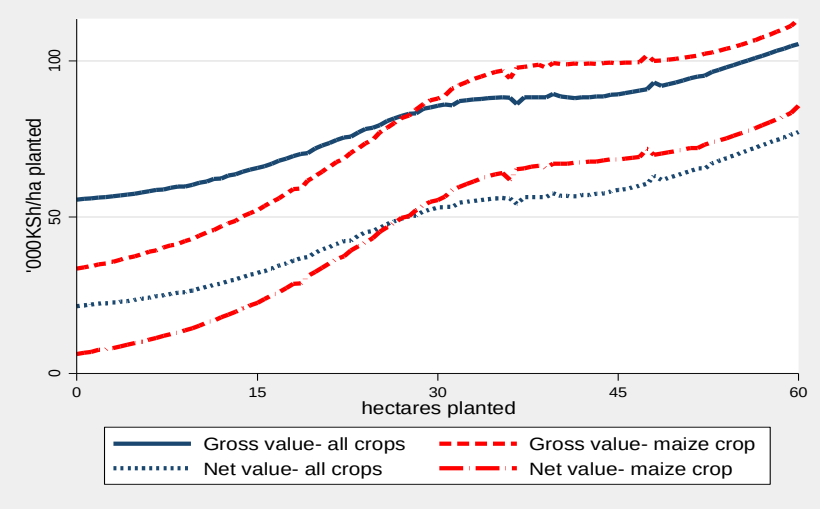


Figure 1(b): Total factor productivity

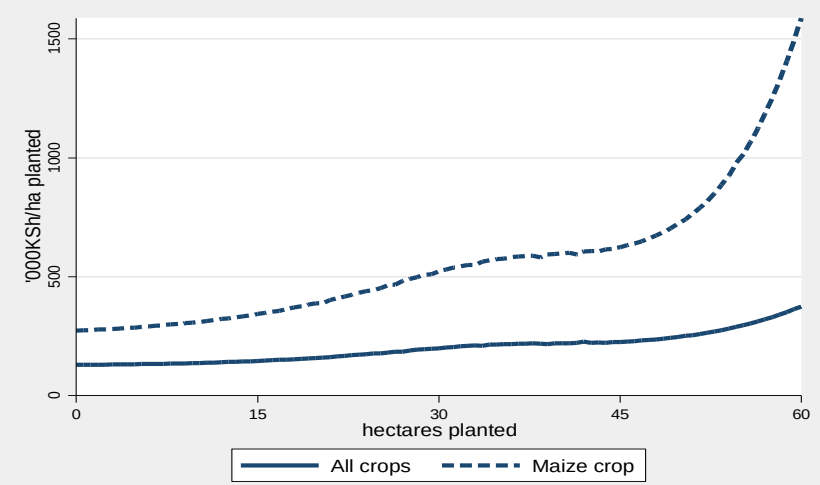


Figure 1(c): Gross value of output/total costs

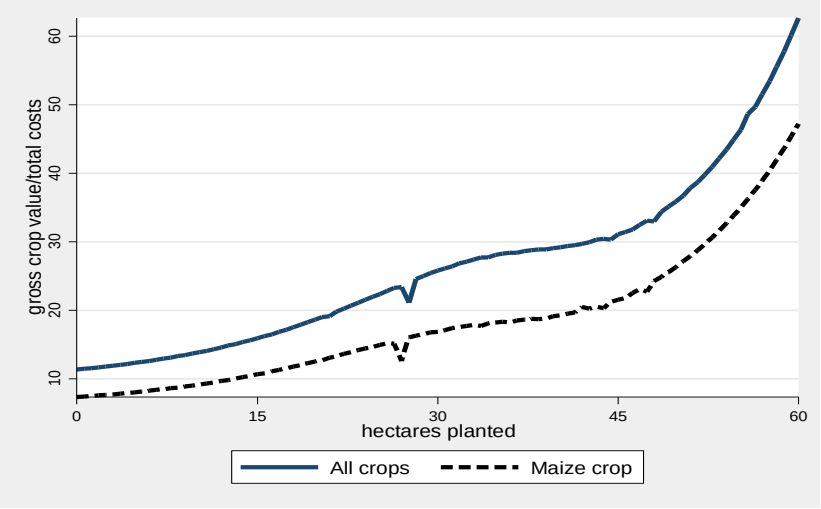
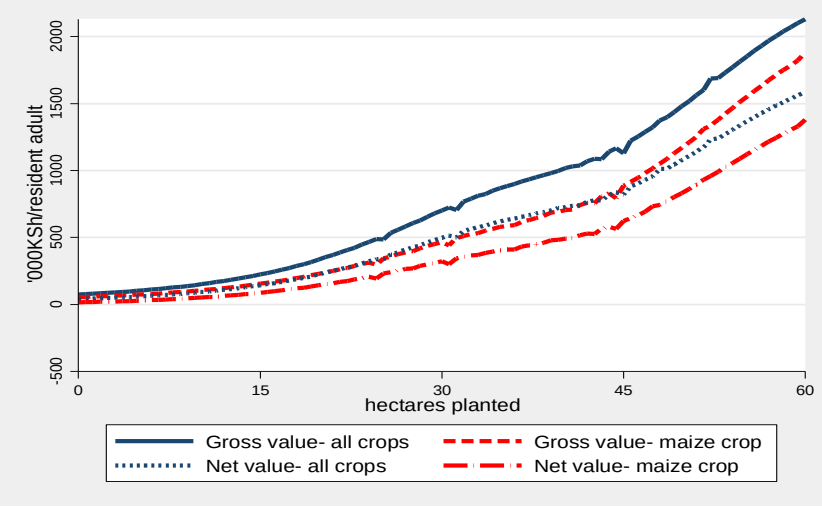


Figure 1(d): Value of crop production/resident adult



KENYA: smallholder sample

Figure 2(a): Value of crop production/ha planted

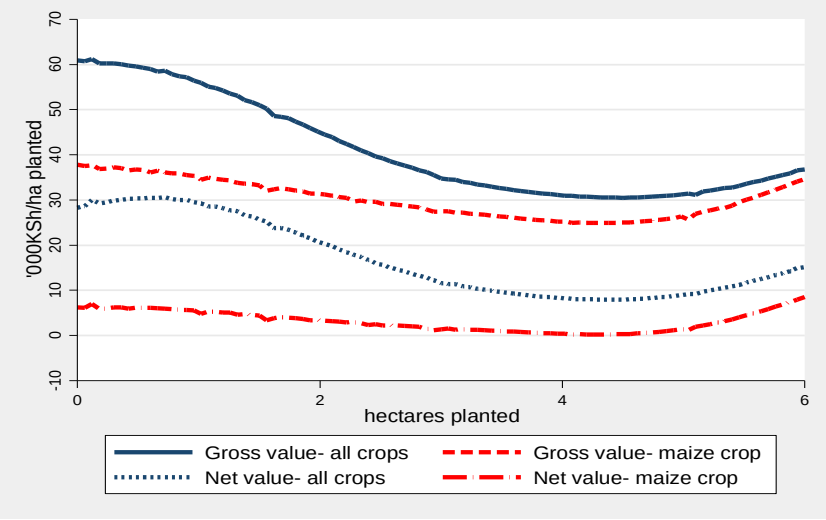
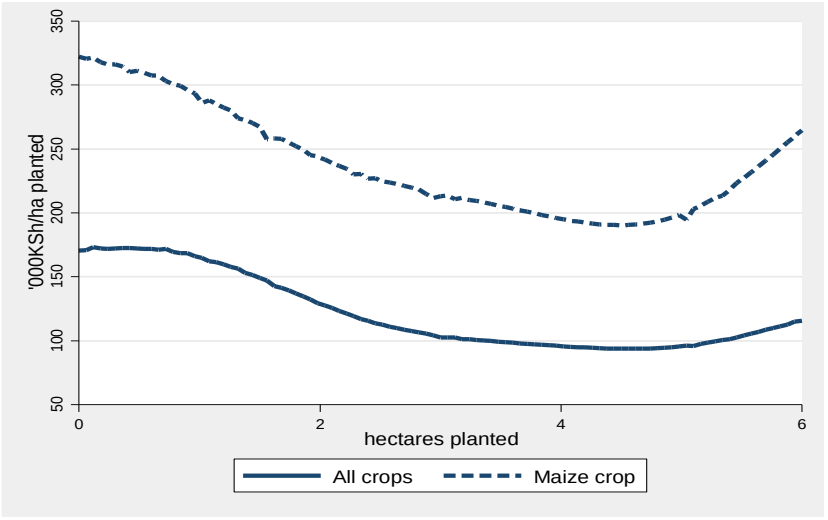


Figure 2(b): Total factor productivity



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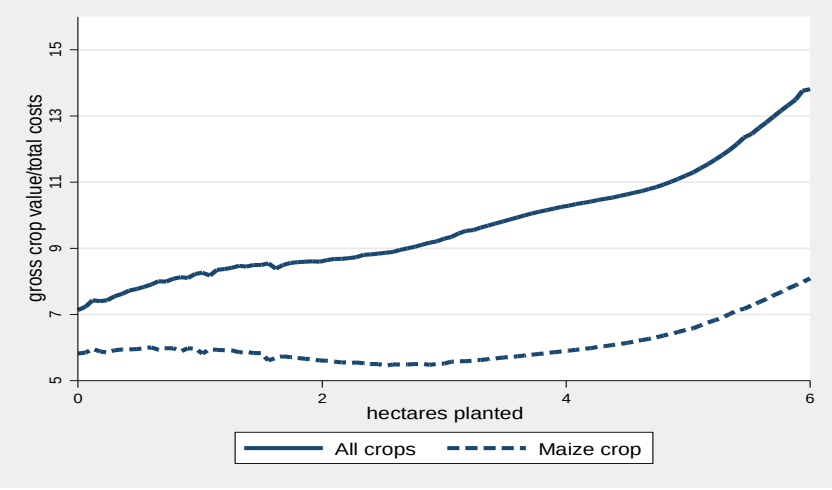

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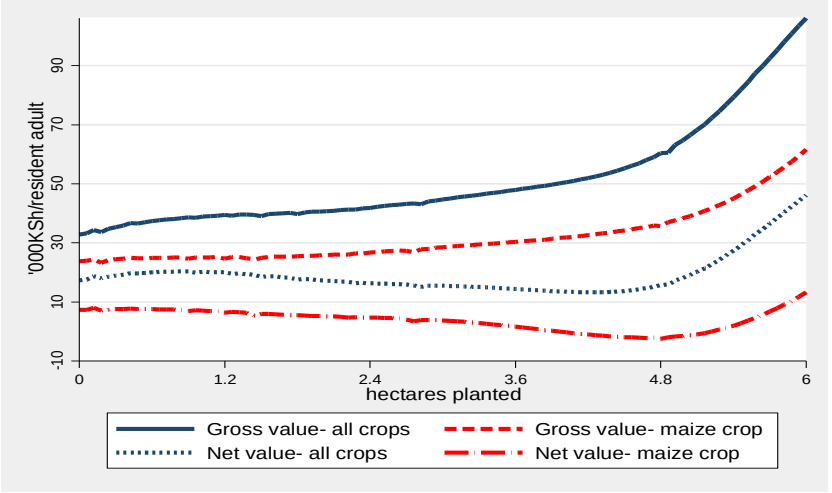


KENYA: crop production costs

Figure 4(a): Aggregate production costs/ha planted

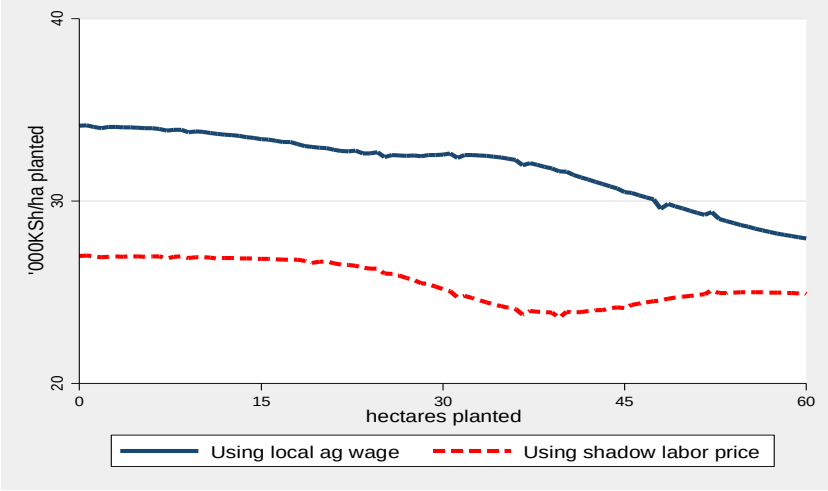


Figure 4(b): Disaggregated production costs/ha planted

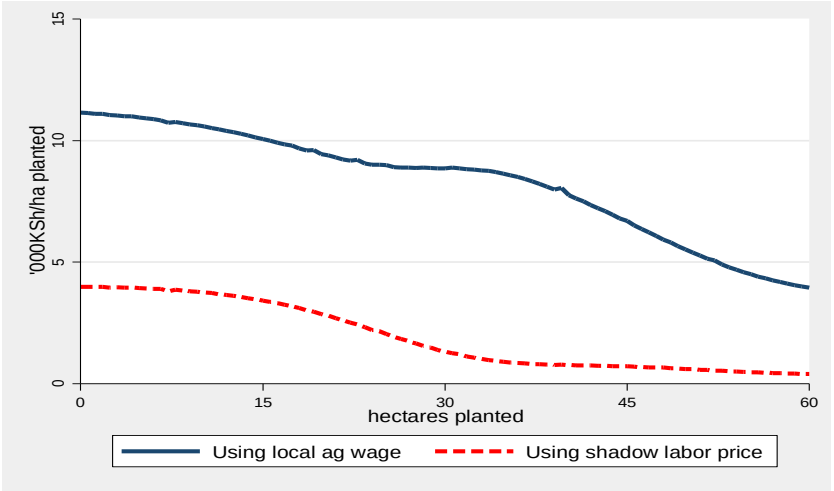
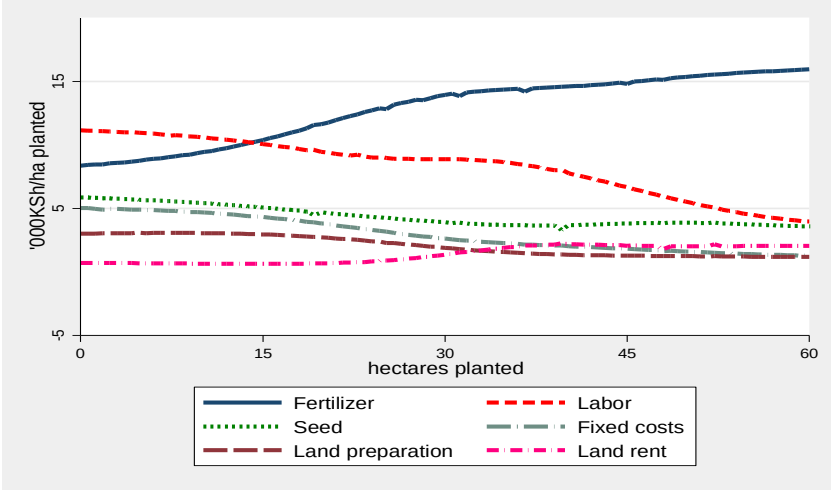


Figure d(c): Labor costs/ha planted

Figure 3(d): Disaggregated labor costs /ha planted



Are smallholders under siege?

1. Important policy issues therefore revolve around whether most smallholder farms are becoming, or have already become, "too small" to generate meaningful production surpluses and participate in broad-based inclusive agricultural growth processes given existing on-shelf production technologies?

Smallholders under siege

2. Mounting POPULATION pressure and shrinking FARM SIZES

- Area expansion is increasingly difficult in areas where the land frontier has been reached
- While farm sizes are small and close to those in much of Asia, most African farms have little control over water, are prone to frequent droughts, and have only one growing season per year
- Can rural labor productivity can rise very much above poverty wage levels without massive shifts in the labor force from farming?

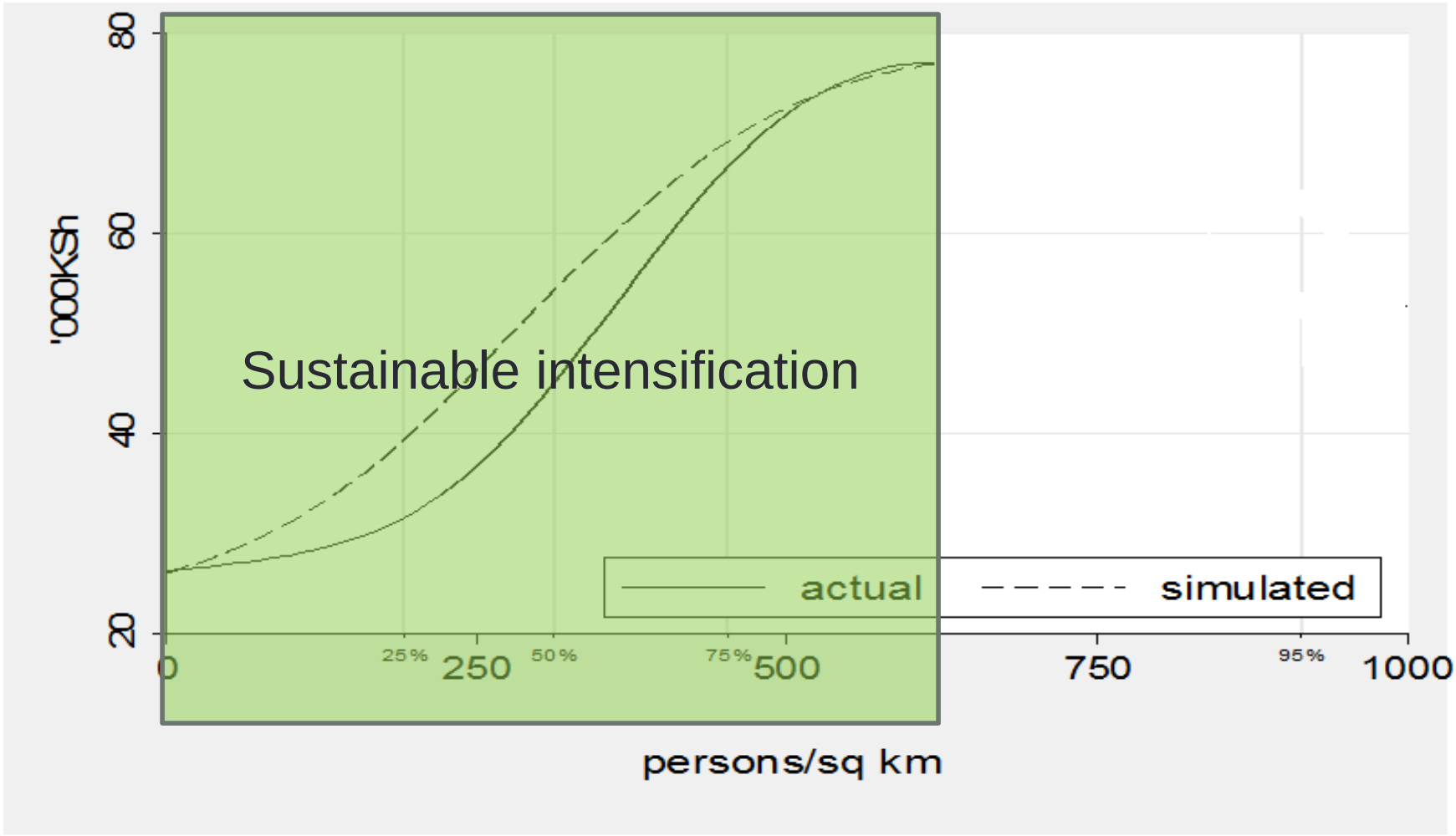
Smallholders under siege

3. UNSUSTAINABLE forms of agricultural intensification

- Shrinking farms are associated with increasing land intensification [Boserup, 1965; Tiffen et al, 1994]
- Soil fertility depletion
  - Low soil organic carbon/matter
- Soil acidification
  - Continued use of fertilizer without fallowing and soil testing

Intensification tends to plateau at about 500–600 persons/km²

Figure 4: Net crop income per hectare cultivated



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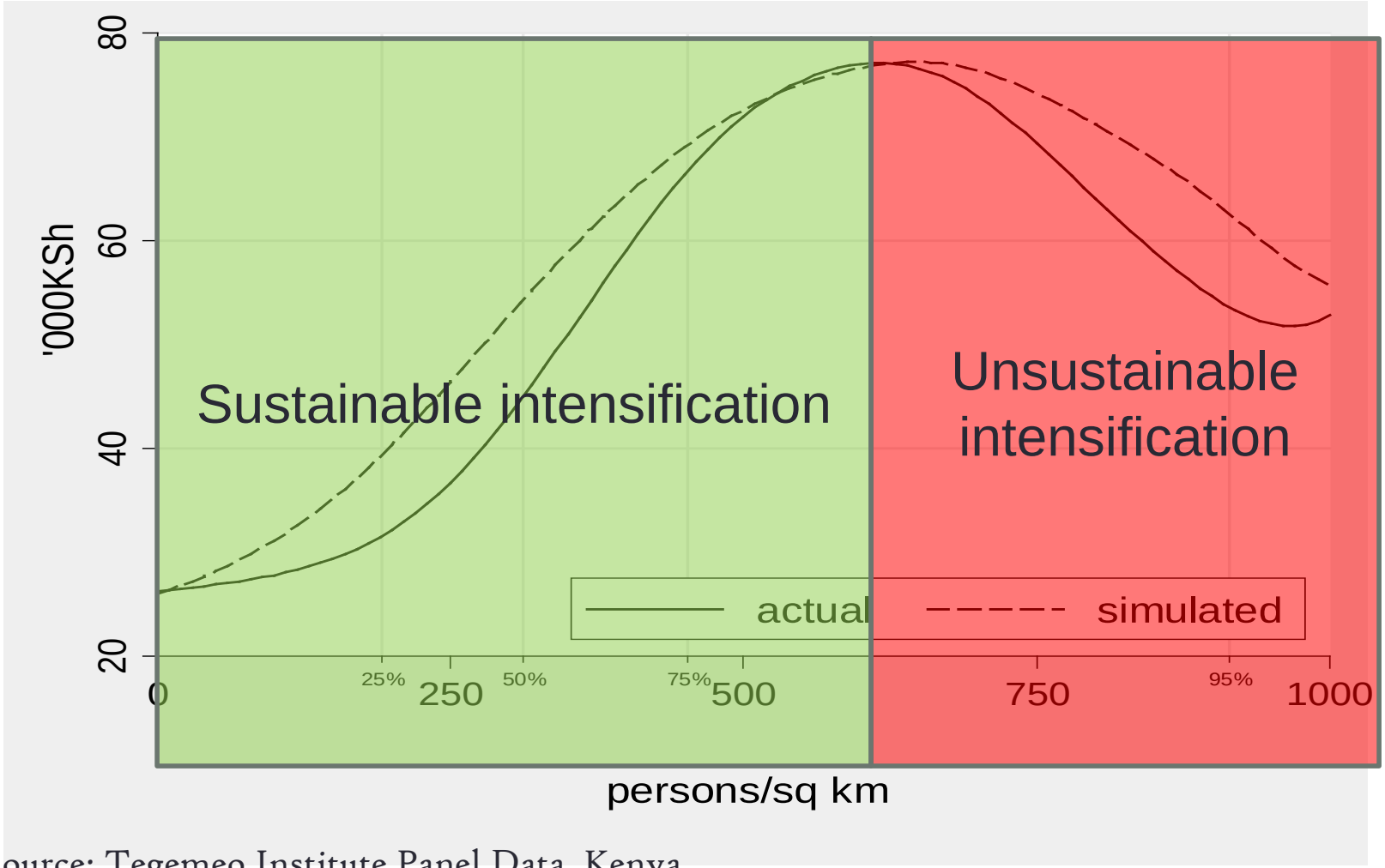

Source: Tegemeo Institute Panel Data, Kenya

Smallholders under siege

Signs of UNSUSTAINABLE forms of agricultural intensification

- While shrinking farms are associated with increasing land intensification, intensification tends to plateau at about 500–600 persons/km^2
- Soil fertility depletion
  - Low soil organic carbon/matter
- Soil acidification
  - Continued use of fertilizer without fallowing and soil testing

Policy implications

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1. Production efficiency, while relevant, should not be the ONLY factor in guiding agricultural and land policies
   - Which scale has the largest multiplier and employment effects?
2. All depends on the government's development objective:
   - Production for domestic food self sufficiency and export market?
   - Broad based growth for reduced food insecurity and poverty reduction?
3. In in all, the changing farm structure is going to continue in the next 5-10 years
   - Drivers: political economy factors and market forces

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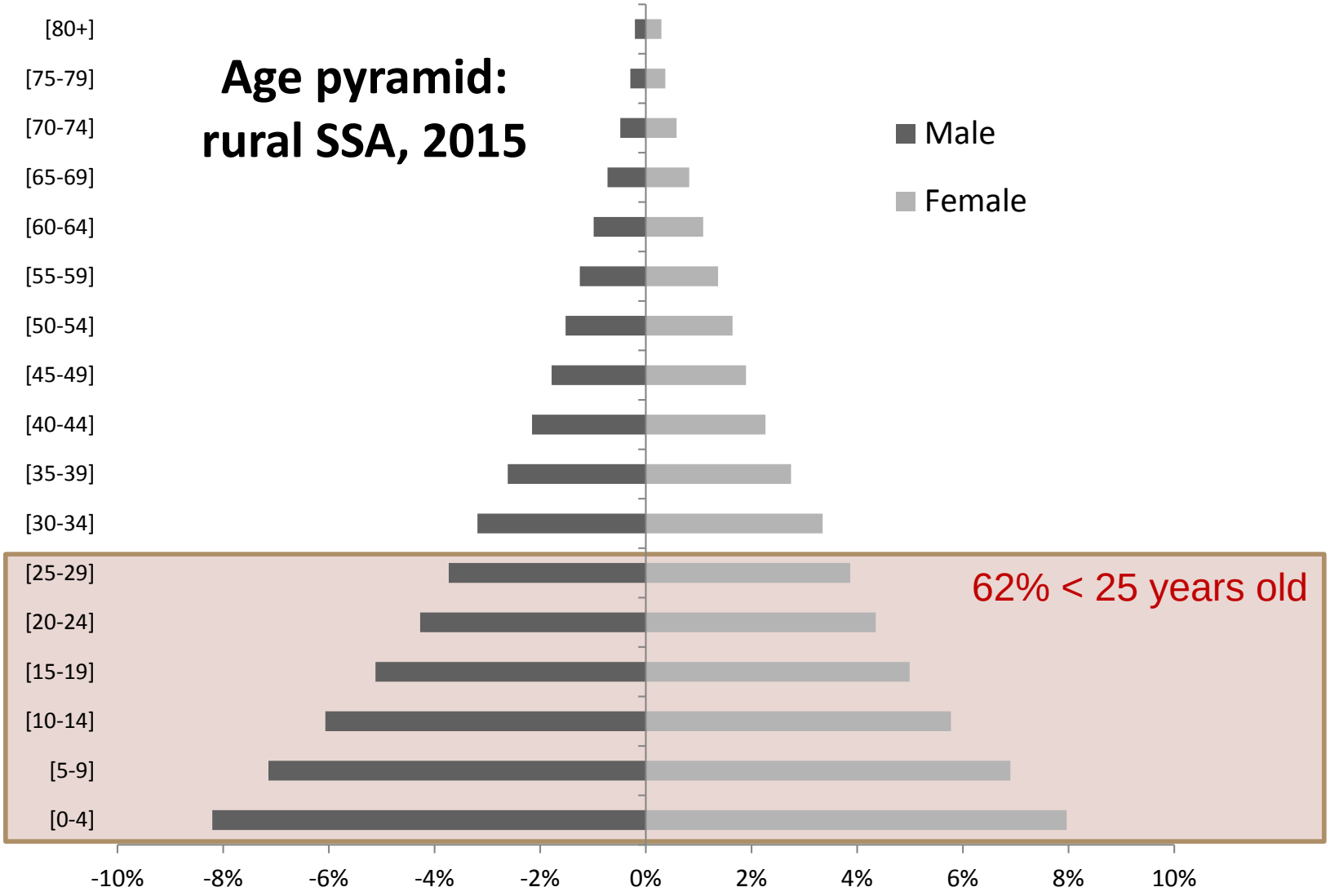
3. In in all, the changing farm structure is going to continue in the next 5-10 years
   - Drivers: political economy factors and market forces
   - Smallholder farmers will be squeezed in a tight corner

Looming employment challenge in SSA



Conclusion

- Land policies will determine whether millions of rural Africans will make a decent livelihood
  - How supportive the land allocation and agricultural policies are to smallholders
- Land policies will determine the speed at which African countries get industrialized
- African leaders will soon realize that political stability will depend on how the remaining land is distributed and the profitability of farming

Acknowledgements

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