Is Small Still Beautiful?
The Farm Size-Productivity Relationship Revisited

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Introduction

- Smallholder farms constitute the majority of farms in Africa, are poor, and food insecure
- Based on evidence from Asia, it is generally accepted that a smallholder-led strategy also holds the best prospects for achieving economic transformation and mass poverty reduction in Africa
- Smallholder farms are more efficient than large-scale farms [IR]

CONCERNS about the viability of a smallholder-led growth strategy in Africa

1. Small-scale farming in Africa has historically provided very LOW RETURNS to labor
2. Mounting POPULATION pressure and shrinking FARM SIZES
3. UNSUSTAINABLE forms of agricultural intensification
4. Changing FARM STRUCTURE-- rising proportion of land among medium-scale farms

Motivation

- These CONCERNS 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

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

"Favoring small farmers is romantic but unhelpful" [Collier and Dercon, 2014]

Contribution

1. Explore the IR hypothesis over a much wider range of family managed farm ranging between 0 and 100 ha
2. Study is based on a wider set of productivity and profitability measures
3. Account for both variable and fixed costs when computing the cost of production that earlier studies may have overlooked

Methods

&

data

Methods [I]

- Use neo-classical production function approach
- Farm output or productivity depends on land and labor
  - $Q_i = \alpha + \beta A_i + \gamma L_i + \boldsymbol{X}\delta + \boldsymbol{W}\tau + \boldsymbol{Z}\pi + \varepsilon_i$
  - Dependent variable (Q_i): measure of agricultural productivity, profitability, return on family labor
    - Gross/net value of output per operated farm size
    - Total factor productivity, computed following Li et al. (2013)
    - Productivity index: gross value of crop output/production costs
    - Gross/net value of output per unit of family labor

Methods [II]

- Variable of interest:
  - Operated farm size (A_i)
- Other controls:
  - Exogenous variables: Household's demographic characteristics (W); community level variables (Z)- length of growing period, elevation and slope of the farm, rainfall in the growing season, and market access conditions
  - Inputs and management practices: Family labor (L_i); input variables (X)- fertilizer and non-family labor use [if inputs not netted out from the dependent variables]

Data sources

- A survey of about 300 households, mostly smallholder collected in 2010 in 5 counties in Western Kenya
- A survey of 200 medium-scale (5-100ha) farms was carried out in 2012 in the same villages as in 2010
- All these were family managed farms

Data issues [I]

- Pooling of two data sets from different years may present some analytical problems.
  - Results may be influenced by differences between the two survey periods
  - Some groups may end up either being overrepresented
- Similarities between the two surveys
  - Same survey instrument and survey timing
  - Production in 2012 valued using 2010 prices
  - Pooled sample weighted using inverse proportional weights generated from a list of all farm in the study region conducted in 2016
  - Included time varying and time constant controls

Data issues [II]

Dummy and Overlap Tests

- Simple test is to include a survey dummy in the regression analysis
  - Tests if the difference in the two datasets affect only the y intercept but not the slopes
- But there was a considerable overlap/common support in terms of area operated between the two datasets
  - Used matching techniques (PSM) to match observation in 2012 survey with observations in 2010 survey.
  - Matching scores based on area operated, demographic characteristics, distances to infrastructure, and spatial characteristics of the household location

Descriptive & Econometrics Results

Descriptive results [I]

Figure 1: NPR results in the full sample

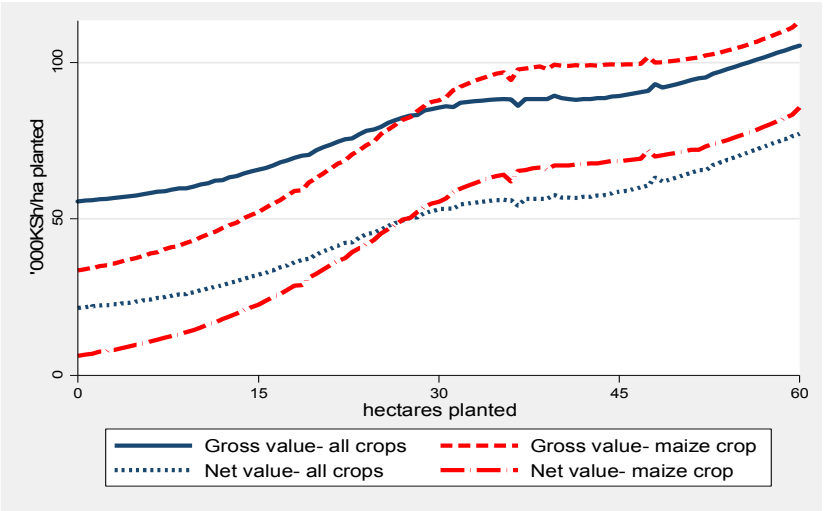


Figure 2(a): Value of crop production/ha planted

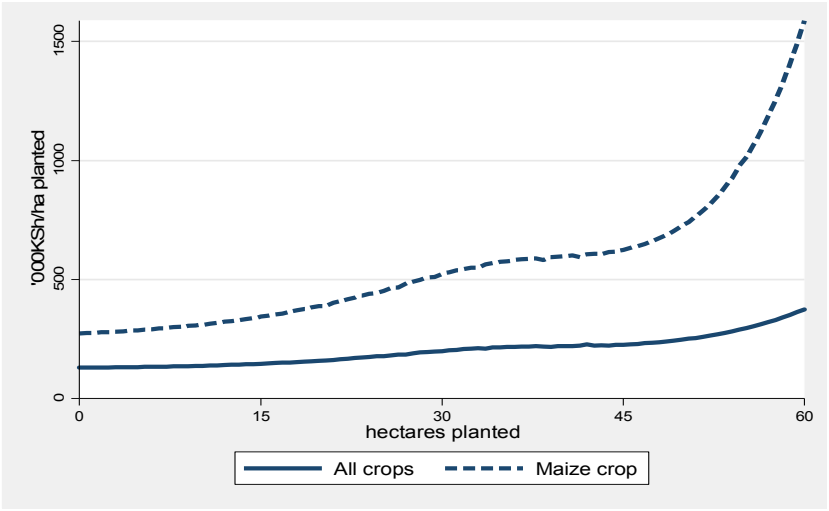


Figure 2(b): Total factor productivity

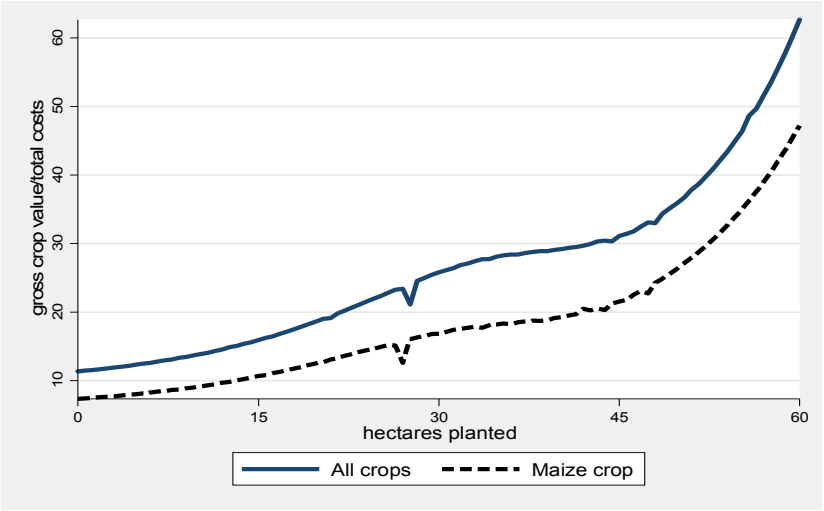


Figure 2(c): Gross value of crop /total production costs

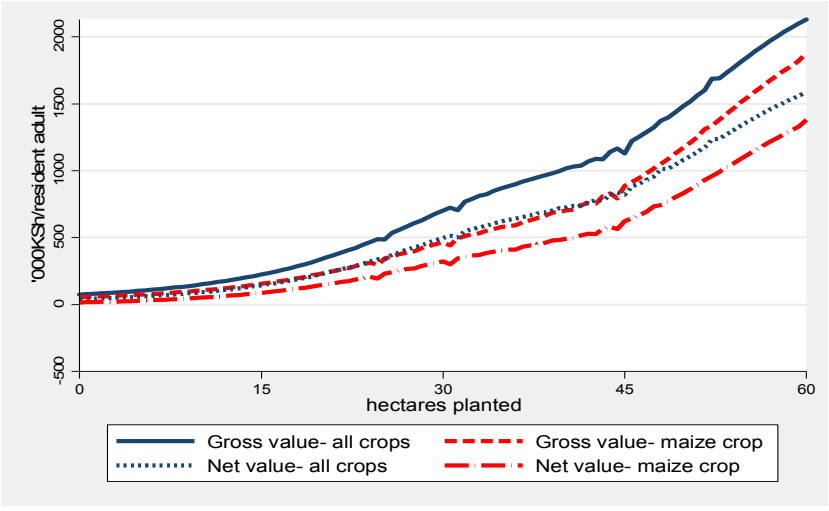


Figure 2(d): Gross value of crop production per resident adult

Notes: Non-parametric regression using Nadaya-Watson Approach, bandwidth=8

Descriptive results [II]

Figure 2: NPR results in smallholder farms

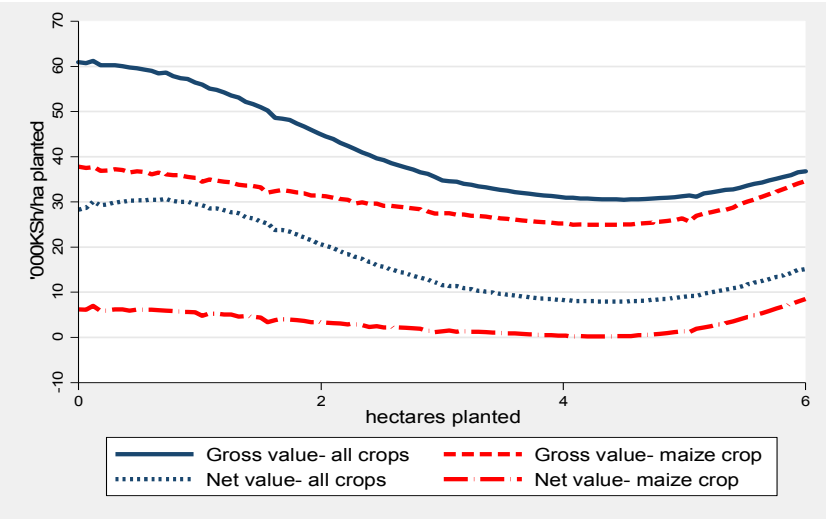


Figure 2(a): Value of crop production/ha planted

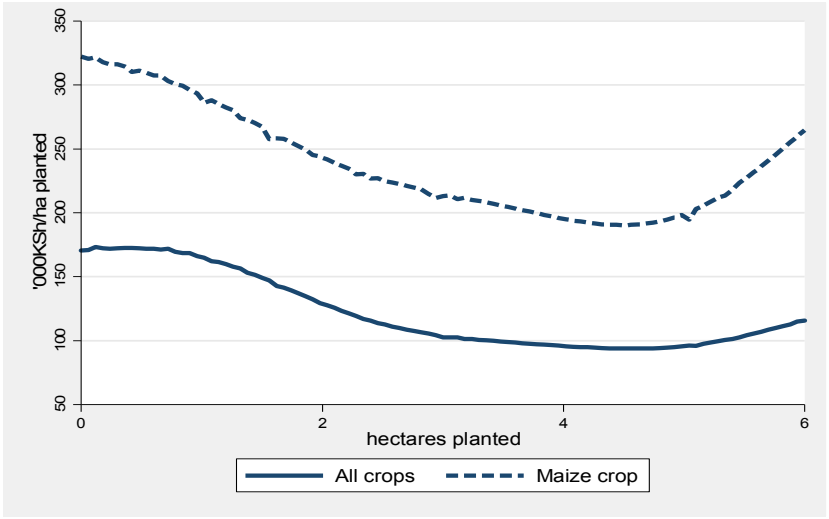


Figure 2(b): Total factor productivity

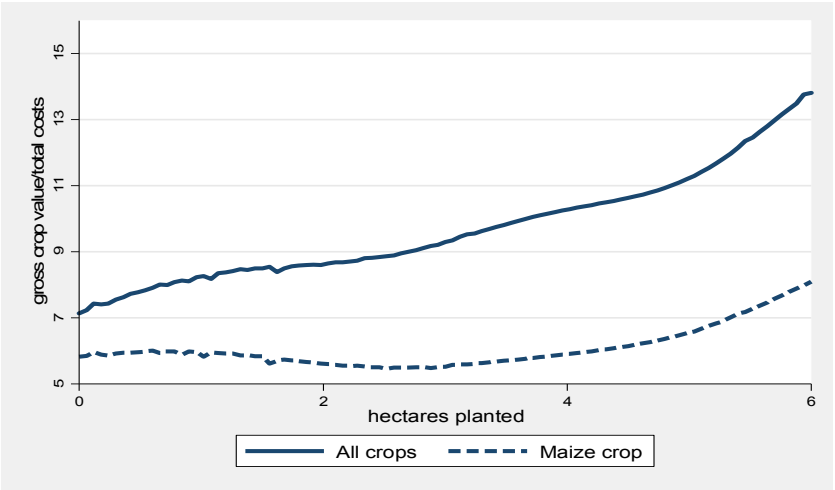


Figure 2(c): Gross value of crop /total production costs

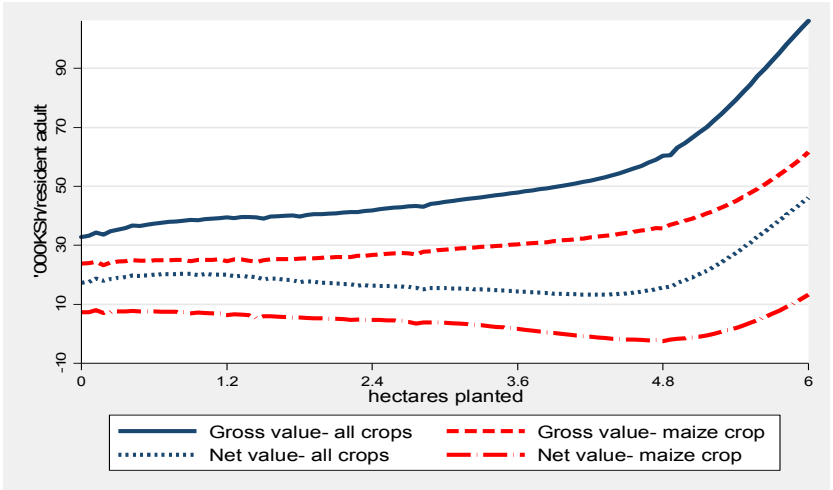
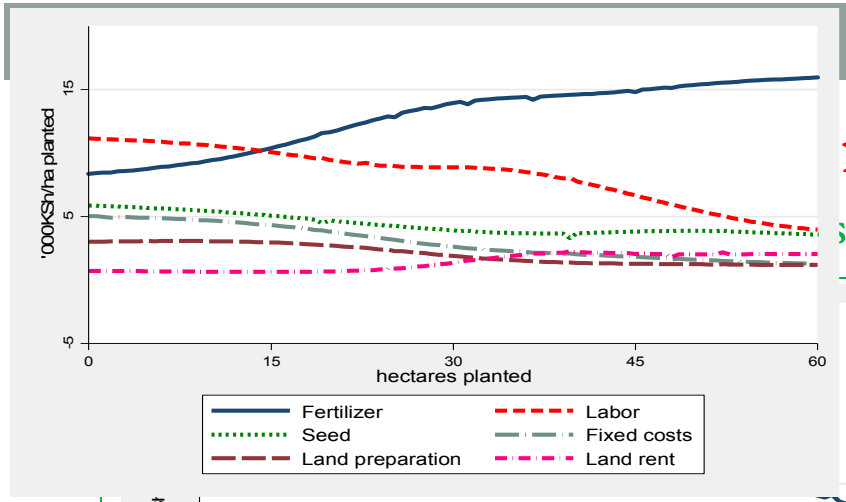


Figure 1(d): Value of crop production per resident adult

Notes: Non-parametric regression using Nadaya-Watson Approach, bandwidth=0.8

ive results [IV]

sults of crop production costs



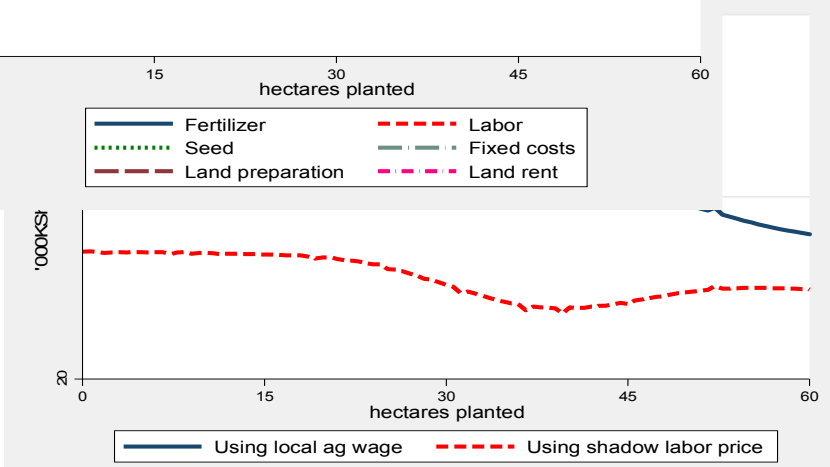


Figure 4(a): Aggregate production costs/ha planted

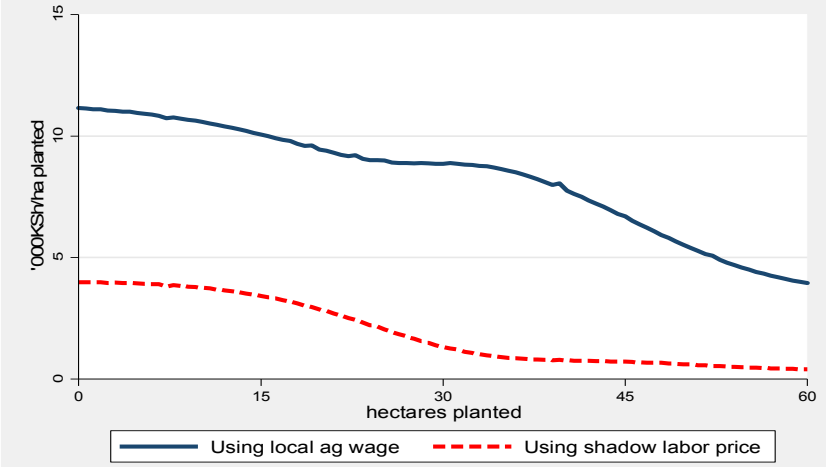


Figure 4(b): Disaggregated production costs/ha planted

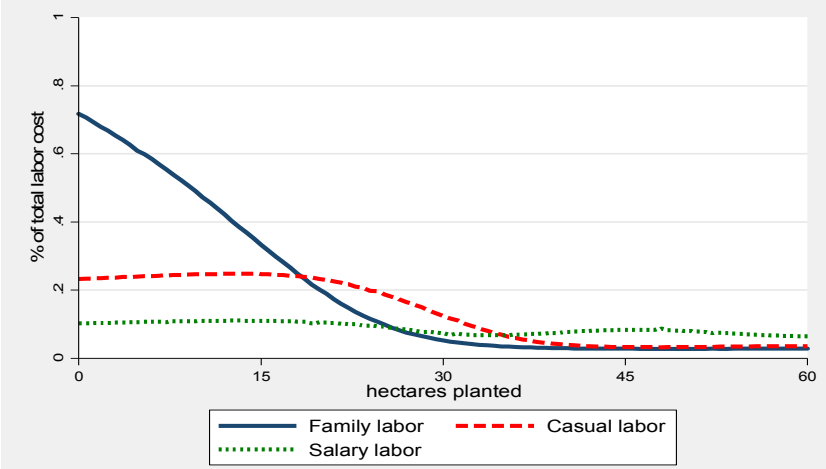


Figure d(c): Labor costs/ha planted

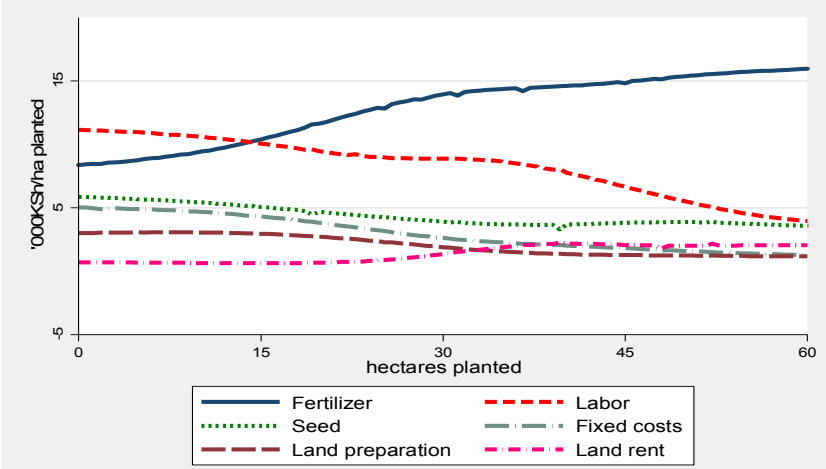
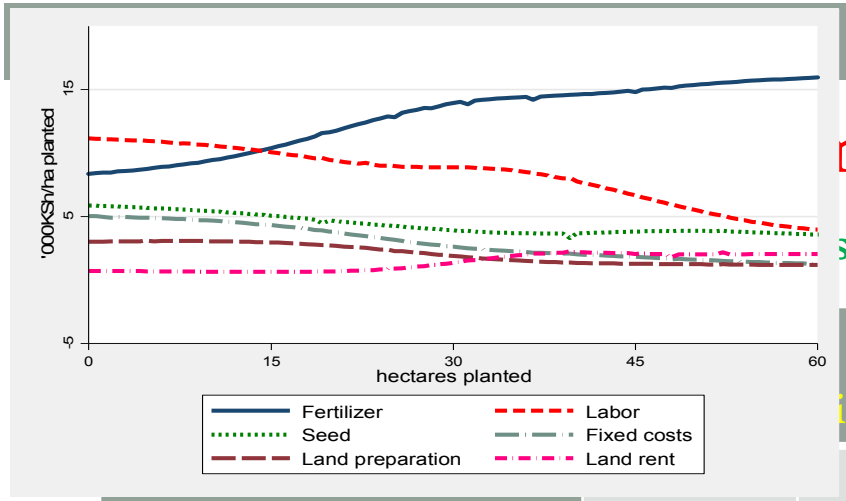


Figure 3(d): Disaggregated labor costs /ha planted

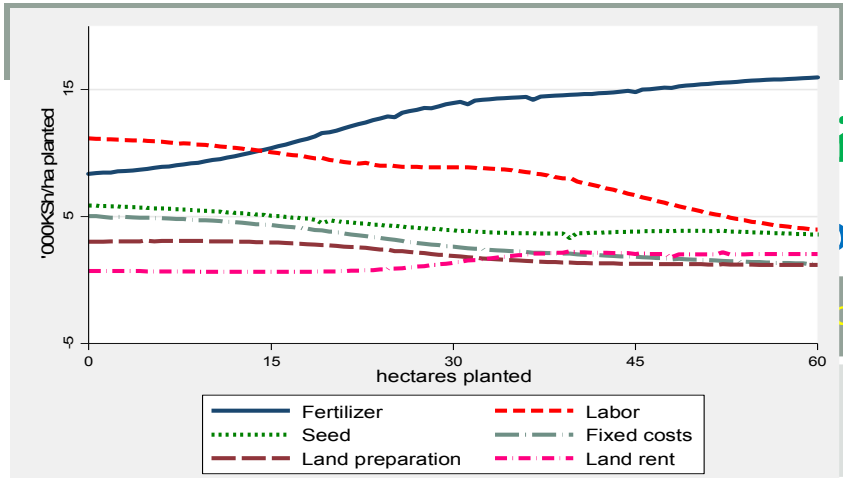
Notes: Non-parametric regression using Nadaya-Watson Approach, bandwidth=8



netrics Results

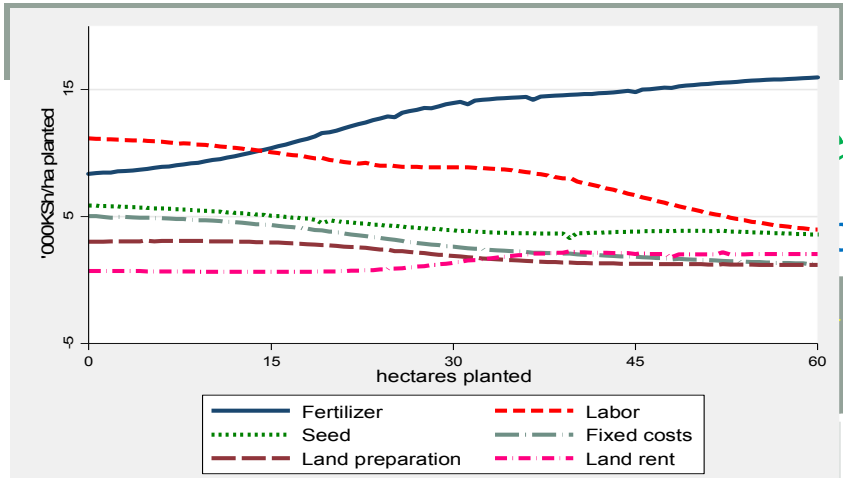
stimation Results of Land Productivity

	value of crop ion/ha 'oooKSh			Net value of crop production/ha 'oooKSh	
	Model I(a)	Model I(b)	Model I(d)	Model II(a)	Model II(b)
Ha planted	1.61***	0.83***	1.87***	2.41***	2.01***
Sq. ha planted 'oo	-1.02***	-0.22***	-1.51***	-1.87***	-1.51***
Exogenous variables		YES	YES		YES
Inputs & management practices			YES		
Household location dummies	YES	YES	YES	YES	YES
Sample (1=2012; 0=2010)	-1.02	-10.28	1.24	-4.86	-8.58
_cons	77.62***	-293.34	-107.87*	42.51***	-81.92
Observations	479	479	479	479	479
R Square	0.10	0.17	0.57	0.24	0.28
Turning point (ha)	78.79	187.54	62.12	64.45	66.61



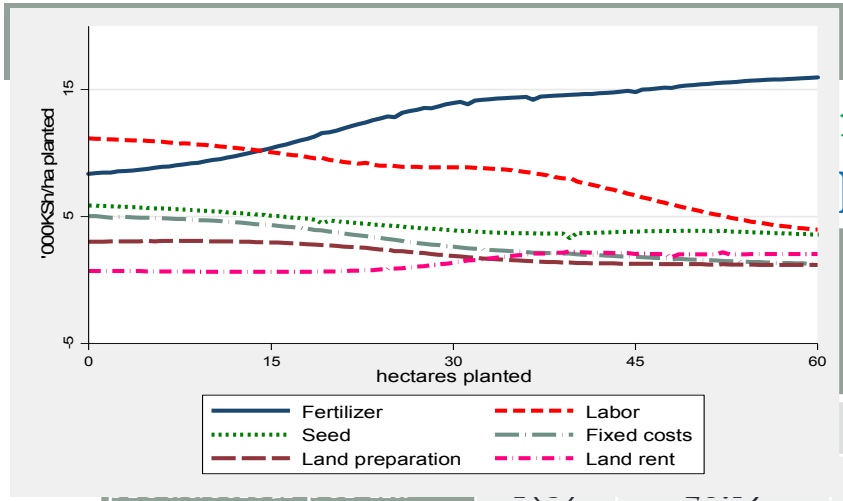
ion Estimation Results of TFP
oductivity Index

	or productivity 'oooKSh			Productivity index	
	Model I(b)	Model I(d)	Model II(a)	Model II(b)
Ha planted (ha)	0.10^^^	0.07***	0.11***	0.03***	0.03***
Sq. ha planted 'ooo	-0.61***	-0.36***	-0.81***	0.03***	0.03***
Exogenous variables		YES	YES		YES
Inputs & management practices			YES		
Household location dummies	YES	YES	YES	YES	YES
Sample (1=2012; 0=2010)	-0.23	-0.54	-0.05	-0.54	-0.58
_cons	4.32***	-7.25	-1.06	3.29***	0.06
Observations	479	479	479	479	479
R Square	0.18	0.23	0.38	0.20	0.26
Turning point (ha)	81.81	103.13	69.71	-441.77	-515.77



ssion Estimation Results of on Family Labor

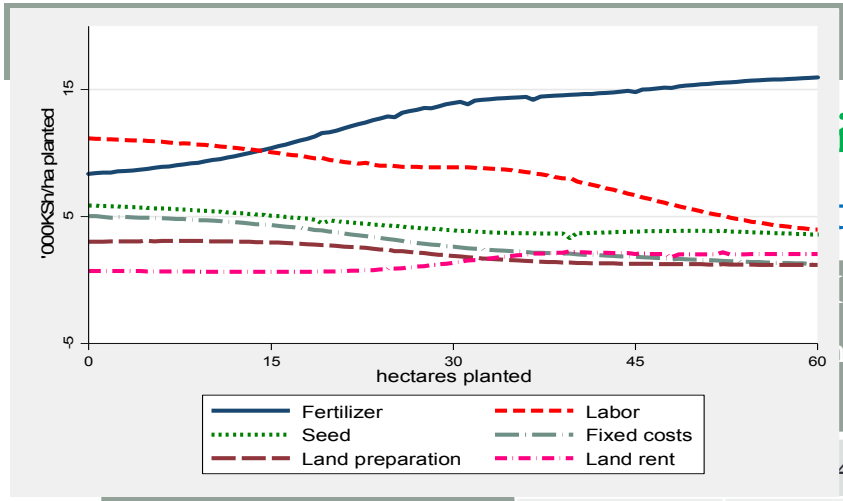
	e of crop production/ha 'oooKSh		Net value of crop production/ha 'oooKSh	
	Model I(b)	Model I(d)	Model II(a)	Model II(b)
Ha planted (ha)	30.52***	30.67***	19.91***	19.74***
Sq. ha planted	0.14***	0.13***	0.15***	0.15***
Exogenous variables	YES	YES		YES
Inputs & management practices		YES		
Household location dummies	YES	YES	YES	YES
Sample (1=2012; 0=2010)	7.18	4.37	3.10	-1.16
_cons	-224.50*	-178.77	-7.57	-133.61
Observations	479	479	479	479
R Square	0.67	0.67	0.63	0.64
Turning point (ha)	-112.29	-114.91	-67.11	-65.33



ion Estimation Results of Land
LLHOLDER SUB-SAMPLE

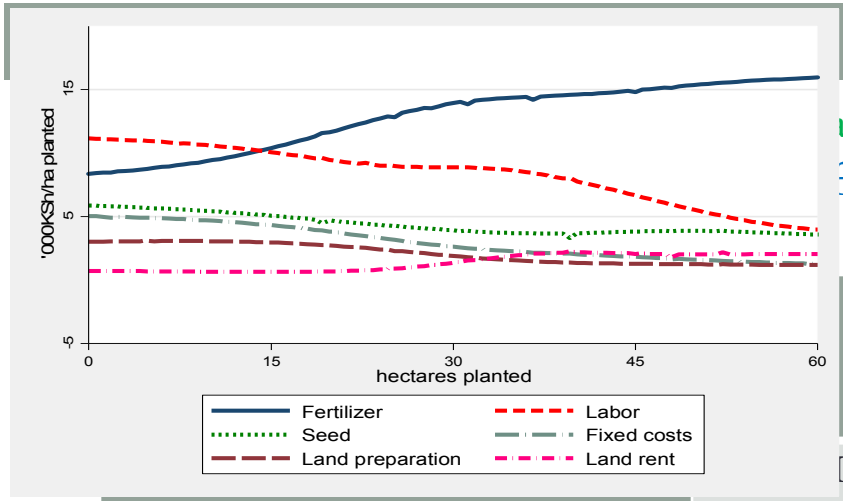
			Sq. ha planted	Exogenous variables	Inputs & management practices	Turning point (ha)
			3.72*			
			4.36*	yes		3.00
planted 'oooKSh	I(c)	-13.83*	2.48*	yes	yes	2.78
Net value of crop production per ha planted 'oooKSh	II(a)	-19.95***	3.56***			2.8
	II(b)	-22.35***	3.92***	yes		2.85
Total factor productivity 'oooKSh	III(a)	-1.41***	0.24***			2.96
	III(b)	-1.58***	0.26***	yes		3.01
	III(c)	-1.13***	0.19***	yes	yes	2.91
Crop productivity index [crop value/total costs]	IV(a)	-1.52***	0.25***			3.08
	IV(b)	-1.55***	0.25***	yes		3.10
	IV(c)	-1.25***	0.20***	yes	yes	3.06
Gross value of crop production/adult person 'oooKSh	V(a)	11.79***	0.96***			-6.16
	V(b)	10.72***	1.00***	yes		-5.36
	V(c)	11.01**	0.95**	yes	yes	-5.80
Net value of crop production/adult person 'oooKSh	VI(a)	-2.40**	1.73**			0.69
	VI(b)	-4.28**	2.00**	yes		1.07

Robustness checks



ion Estimation Results for Maize
turn on Family Labor [N=471]

		ha nted	Sq. ha planted	Exogenous variables	Inputs & management practices
		4**			
production/ha planted '000KSh	I(b)	0.51**		yes	
	I(d)	0.46		yes	yes
Net value of maize production/ha planted '000KSh	II(a)	2.07***	-0.02***		
	II(b)	2.16***	-0.02***	yes	
Maize total factor productivity	III(a)	14.77***	-0.05***		
	III(b)	14.98***	-0.05***	yes	
	III(d)	12.02***	-0.04***	yes	yes
Value of maize/total production costs	IV(a)	1.28***	-0.01***		
	IV(b)	1.32***	-0.01***	yes	
Gross value of maize production/resident adult '000KSh	V(a)	14.10***	0.36***		
	V(b)	15.46	0.34	yes	
	V(d)	14.77	0.35	yes	yes
Net value of maize production/resident adult '000KSh	VI(a)	5.30	0.33		
	VI(b)	6.03	0.32	yes	



ıtion Results for Value of Crop Production per for Proportion of Land under Different Crop Categories

	value of crop production/ ha planted 'oooKSh			Net value of crop production/ ha planted 'oooKSh	
	I(a)	Model I(b)	Model I(d)	Model II(a)	Model II(b)
Ha planted	1.67***	1.20***	1.73***	2.29***	2.12***
Sq. ha planted 'oo	-1.10***	-0.54***	-1.26***	-1.71***	-1.56***
Exogenous variables		YES	YES		YES
Inputs & management practices			YES		
Proportion of area under crop categories	YES	YES	YES	YES	YES
Household location dummies	YES	YES	YES	YES	YES
Sample (1=2012; 0=2010)	7.55	-2.11	2.51	-2.96	-7.02
_cons	59.70***	-216.43	-53.25	36.78***	-47.61
Obs	479	479	479	479	479
R Square	0.18	0.23	0.60	0.27	0.30
Turning point (ha)	76.21	111.05	68.91	66.74	67.88

Descriptive results [III]

Figure 3: NPR results using shadow price of family labor

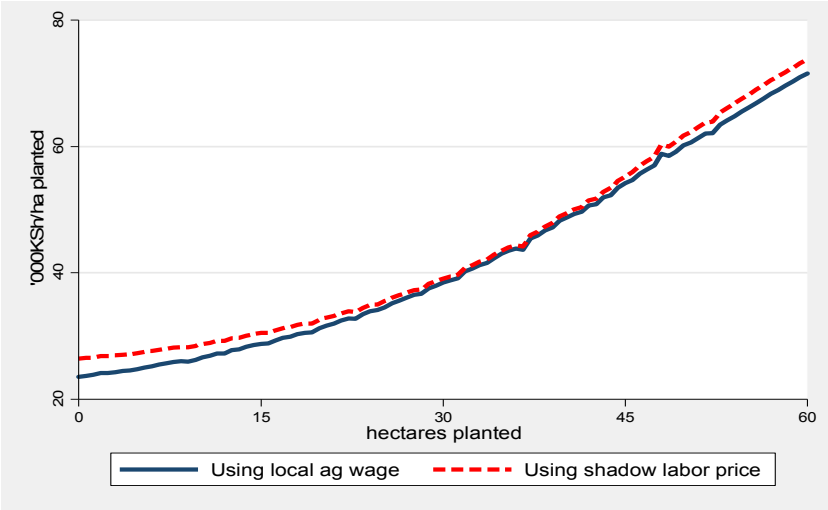


Figure 3(a): Net value of crop production/ha planted--Full sample

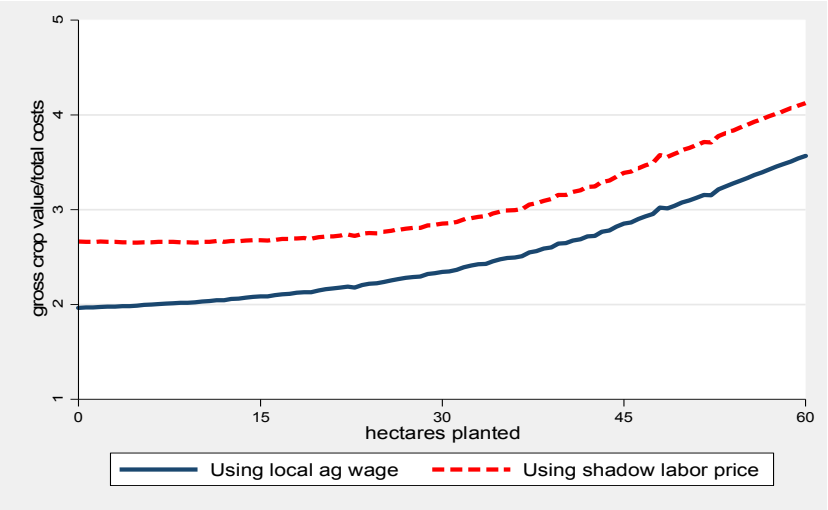


Figure 3(b): Gross value of crop /total production costs--Full sample

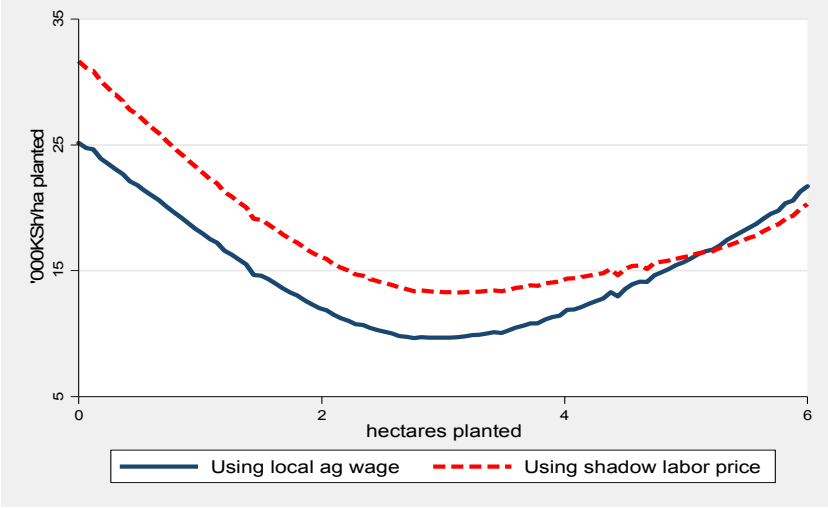


Figure 3(c): Net value of crop production/ha planted-- Smallholders

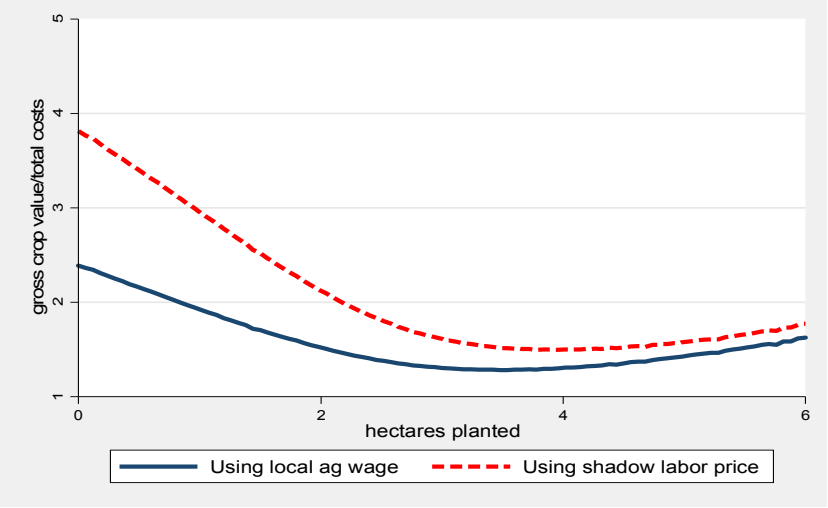
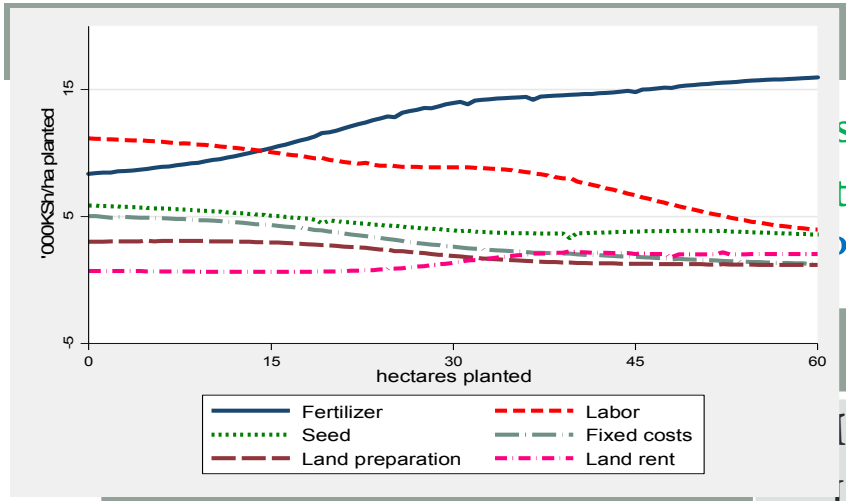


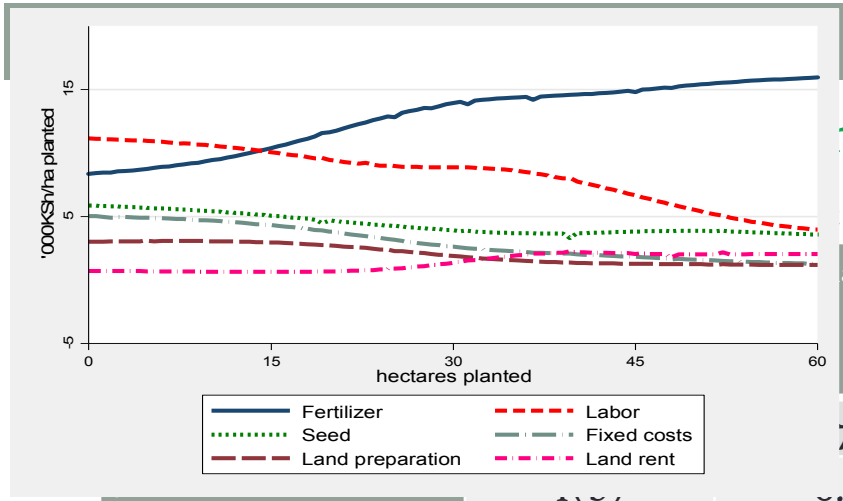
Figure 3(d): Gross value of crop /total production costs-- Smallholders

Notes: Non-parametric regression using Nadaya-Watson Approach, bandwidth=0.8



stimation Results for Net Value of Crop
ted 'oooKSh-- Family Labor Valued using
Price of Family Labor

	Full sample		Smallholder sub-sample	
	lodel I(a)	Model I(b)	Model II(a)	Model II(b)
Ha planted	1.43***	0.80***	-36.62**	-41.82**
Sq. ha planted ('o)	-0.07***+	-0.03***	59.90**	68.00**
Exogenous variables		YES		YES
Household location dummies	YES	YES	YES	YES
Sample (1=2012; 0=2010)	-9.59	-17.13	-1.35	-8.91
_cons	49.02***	-254.15	79.20***	-259.09
Observations	479	479	343	343
R Square	0.11	0.17	0.19	0.26
Turning point (ha)	110.32	123.26	3.06	3.07



n of crop and maize output per bias
d hectare planted

		anted	Ha planted sq.	Exogenous variables	Inputs & management practices
		70	-0.01		
		.19	0.01	yes	
planted ‘oooKSh	I(c)	1.18	-0.01	yes	yes
Net value of crop production/ha planted ‘oooKSh	II(a)	2.00***	-0.02***		
	II(b)	1.55***	-0.01***	yes	
	II(c)	1.81***	-0.02***	yes	yes
Gross value of maize production/ha planted ‘oooKSh	III(a)	2.07***	-0.02***		
	III(b)	1.62***	-0.02***	yes	
	III(v)	1.45**	-0.02**	yes	yes
Net value of maize production/ha planted ‘oooKSh	IV(a)	2.76***	-0.03***		
	IV(b)	2.47***	-0.02***	yes	
	IV(c)	2.34***	-0.02***	yes	yes
Crop total factor productivity	V(a)	31.46***	-0.15***		
	V(b)	17.06***	-0.04***	yes	
	V(c)	46.04***	-0.35***	yes	yes
Maize total factor productivity	VI(a)	23.29***	-0.14***		
	VI(b)	22.17***	-0.13***	yes	
	VI(c)	21.63***	-0.12***	yes	yes

Conclusions

Conclusions

1. Small may NOT be necessarily beautiful in family managed farms
   - May be farm sizes have become too small and make-ups not helping
   - May be medium-scale farms are now able to overcome scale challenges
2. 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?
3. 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?

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Policy implications

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   - 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?
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Acknowledgements

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BILL & MELINDA GATES foundation