Population Density and Smallholder Land Access, Crop Intensification, and Incomes in Rural Mozambique

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Smallholder land access in Africa

- Sub-Saharan Africa generally regarded as being land-abundant
- Yet increasing evidence to the contrary in some countries:
  - Rapidly declining land/labor ratios in some countries (on aggregate)
  - Small and shrinking farm sizes (seen in survey data)
- What about land abundant countries?
  - Paradox of land scarcity amid abundance (Zambia)
  - Case study: Mozambique

Rural Mozambique

- Abundant arable land
  - 36 million hectares of arable land
  - 10% is under cultivation (97% by smallholders)
  - 0.47 ha (10%) / 1.46 ha (median) / 4.03 ha (90%)
- Constraints to smallholder land access/use
  - Labor
  - Virtually no animal traction in north
  - limited area with relatively high potential
  - Limited complementary physical infrastructure
  - Poor input/output market access
  - Virtually no land rental or titling

Decreasing Land-labor Ratios

Population Density for Selected African Countries
1960 - 2010

1960 - 2010
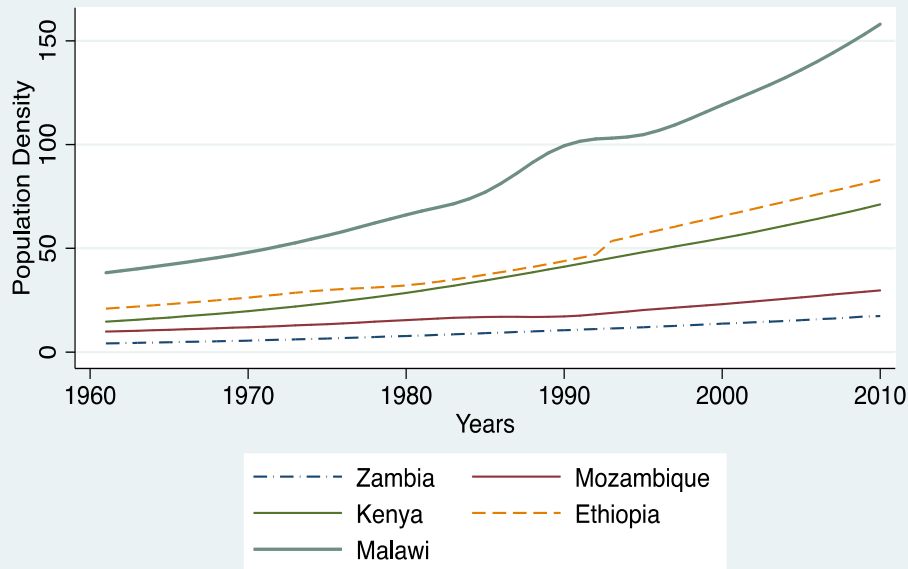
Arable Land Area Per Capita
Mozambique, 1960 - 2010
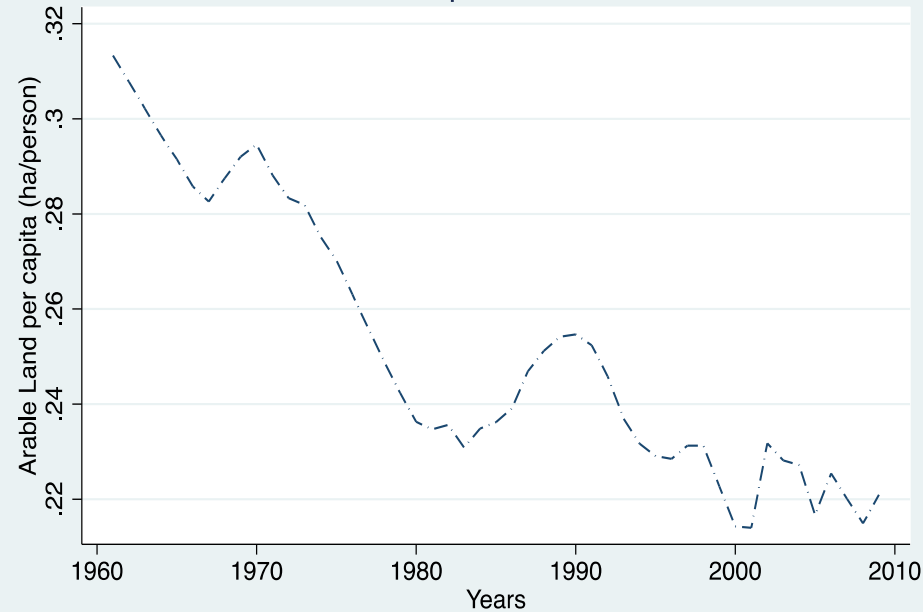
- Mozambique has relatively lower PD and increasing less rapidly than other SSA countries
- Arable land per capita falling in past 50 years

Decreasing Land-labor Ratios

Countries	Arable land to labor ratios					
	1960-69	1970-79	1980-89	1990-99	2000-09	2000-09 as % of 1960-69
Ethiopia	0.501	0.444	0.333	0.224	0.218	43.5%
Zambia	0.643	0.607	0.398	0.342	0.297	46.2%
Kenya	0.462	0.364	0.305	0.264	0.219	47.4%
Uganda	0.655	0.569	0.509	0.416	0.349	53.3%
Malawi	0.480	0.466	0.357	0.304	0.307	64.0%
Zimbabwe	0.613	0.550	0.452	0.420	0.469	76.5%
Rwanda	0.212	0.213	0.195	0.186	0.174	82.1%
Mozambique	0.356	0.337	0.320	0.314	0.294	82.6%
Ghana	0.646	0.559	0.508	0.492	0.565	87.5%
Nigeria	0.982	0.860	0.756	0.769	0.898	91.4%

- Mozambique trend is not as strong as in Zambia, but declining nevertheless
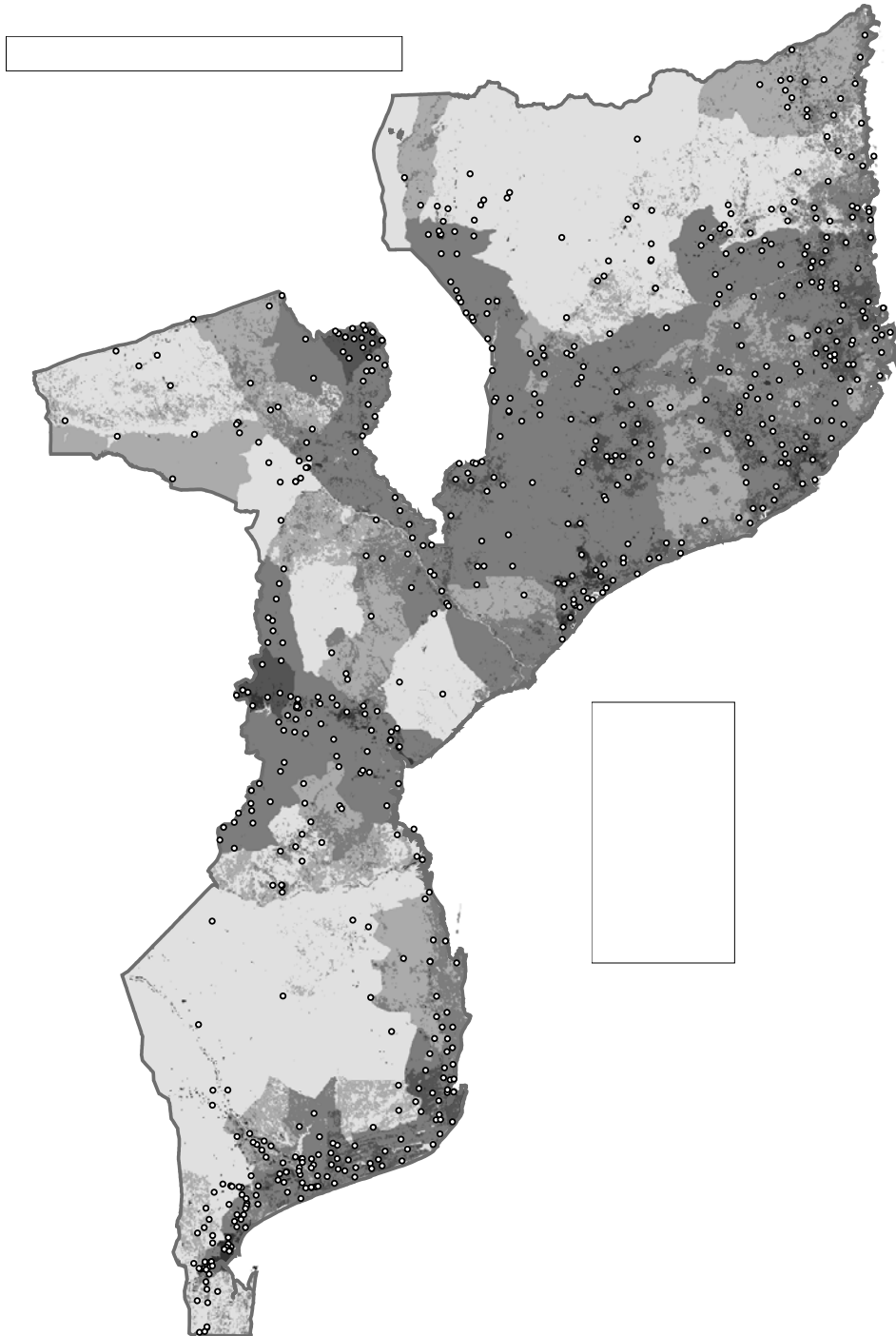
Population Density (2008) & TIA household survey villages (2008)

Village quintiles of PD	Pop / km2 (2008)
Q1 - low	14
Q2	26
Q3 - mid	45
Q4	76
Q5 - high	193
Total	80

Data

Household survey data

- Nationally representative rural household surveys (TIA) 2001/02, 2004/05 & 2007/08
- n=4,736 households (2002) n=5,875 households (2005) n=5,559 household (2008)
- Smallholders : 0-10 ha cultivated area
- Medium-holders 10-50 ha or >10 cattle or >50 medium livestock, etc

Geospatial data

- Spatial population distributions (1km)
  - GRUMP
  - AfriPop
- Length of growing period
- Rainfall time-series
- Elevation & slope
- Travel time to nearest market
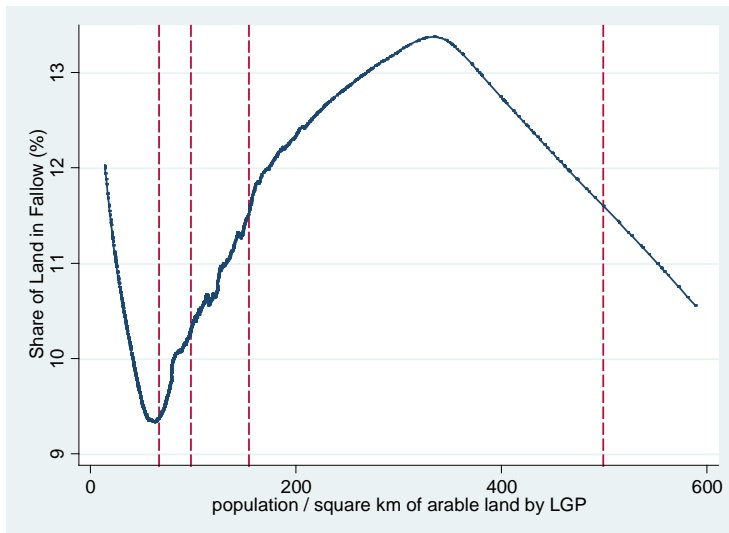
Population Density, Land & Labour Availability/Use

Total Landholding (ha)

Area Cultivated (ha)

Share of Landholdings in Fallow (%)
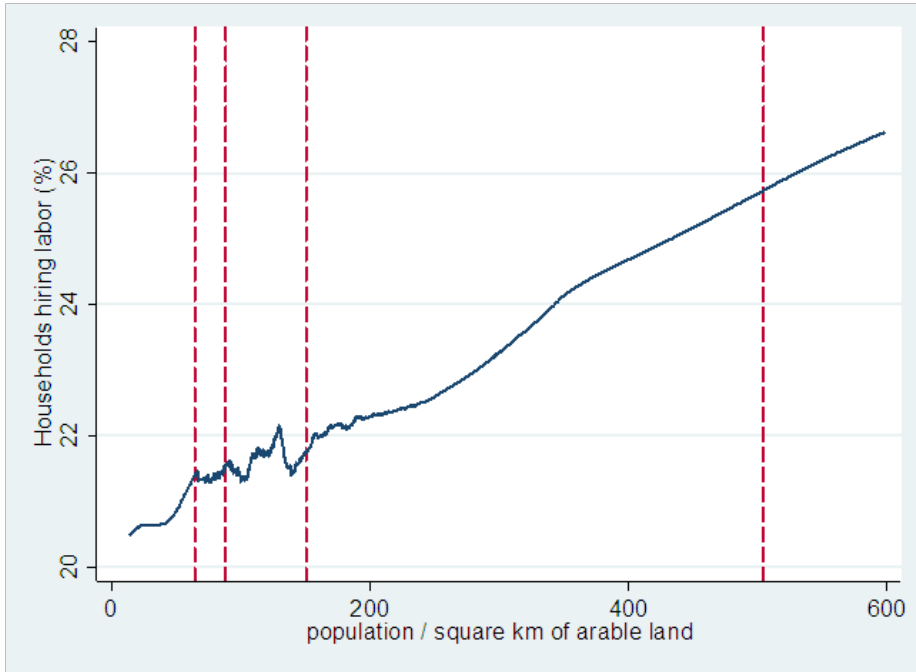

Household Adults in Ag per ha cultivated

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Population Density & Intensification in Agriculture

% of HHs Hiring Labour

% of HHs using Chemical Inputs
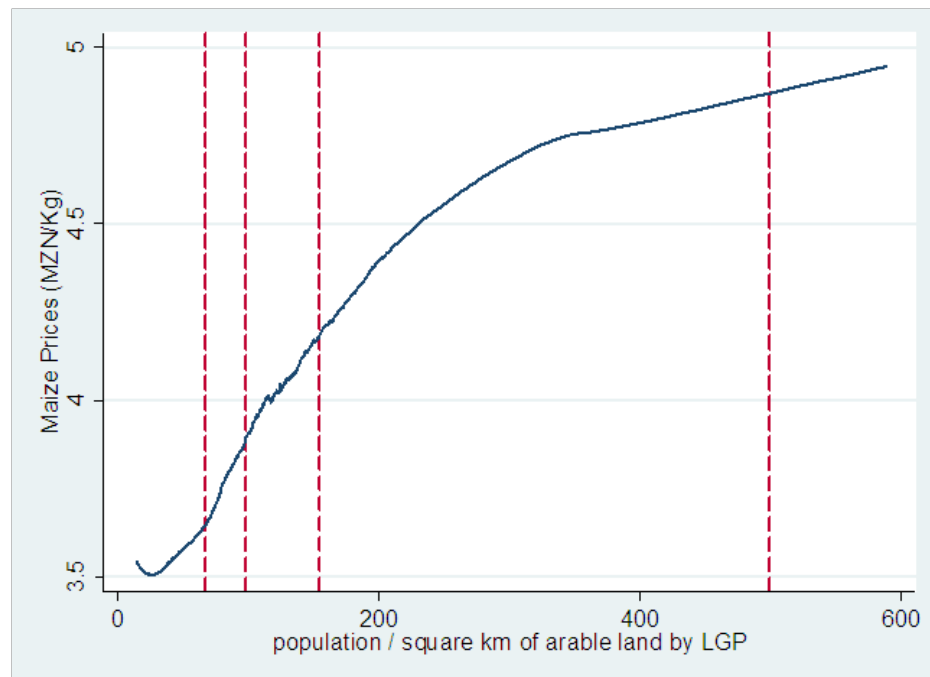
Population Density, Household Maize Output and Maize Prices
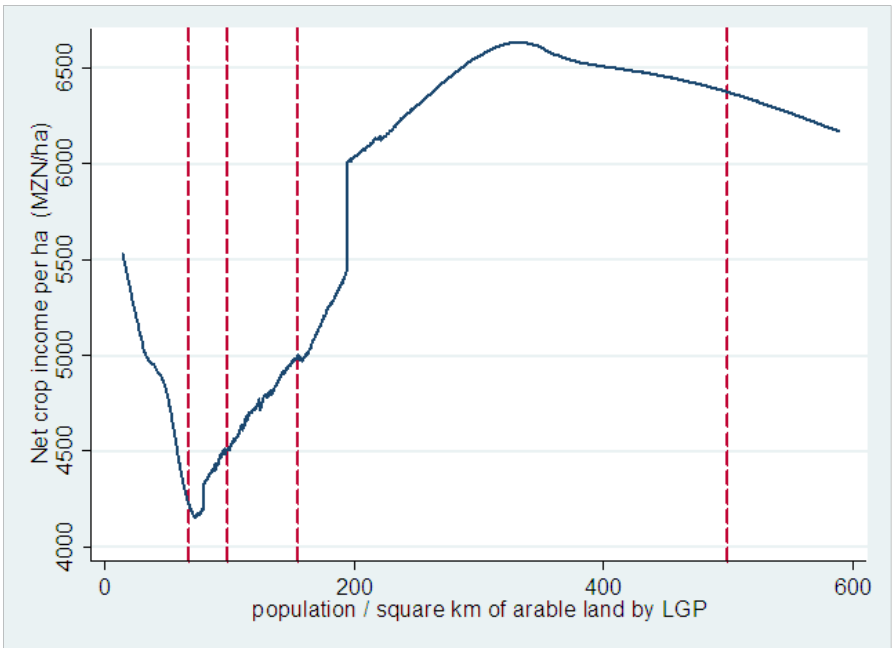
Maize Production per HH (kg)

Farm-gate Maize Price (MZN/kg)

Population Density and Household Crop Income
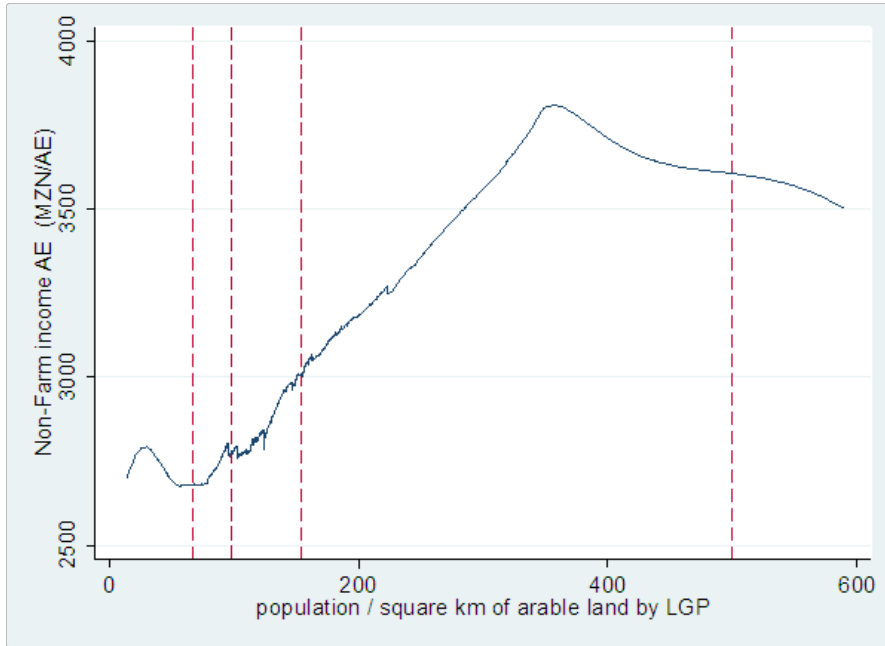
Net Crop Income per Hectare

Net Crop Income per Adult in Ag

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Population Density & Non-Farm and Total Income

Non-Farm Income per Adult Equivalent

Total Household Income per AE

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Summary of Descriptive Results

Determinants of Total Household Landholding (ha)

Selected explanatory variables	Coeff.	p-value	Coeff.	p-value
population density (arable)	-0.0021**	(0.0000)	-0.0012**	(0.0000)
population density (arable), sq	0.0000	(0.1348)	0.0000	(0.1090)
residual from PD control function	0.0010**	(0.0094)		
travel time to city of 30k+ (hours)	0.0260**	(0.0000)	0.0272**	(0.0000)
travel time, squared	-0.0003*	(0.0239)	-0.0003*	(0.0154)
1=village has cell service	-0.3252**	(0.0000)	-0.3372**	(0.0000)
1=village has mill	0.0906+	(0.0538)	0.0976*	(0.0363)
HH size in adult equivalents	0.1832**	(0.0000)	0.1833**	(0.0000)
1=HH owns animal traction	1.2347**	(0.0000)	1.2304**	(0.0000)

Determinants of Farm-gate Maize Prices (MZN/kg)

Selected explanatory variables	Coeff.	p-value
population density (arable)	0.0024*	(0.0422)
population density (arable), sq	-0.0000	(0.8904)
residual from PD control function	-0.0016+	(0.0947)
travel time to city of 30k+ (hours)	-0.0293+	(0.0622)
travel time, squared	0.0009**	(0.0072)
1=village has cell phone service	0.4954*	(0.0113)
main season rainfall (mm)	-0.1914**	(0.0077)
Years of education of HH head	-0.0001*	(0.0133)
1=HH owns bicycle	0.0128	(0.8549)

HH maize production and HH maize yield

Selected explanatory variables	maize output (kg)			maize yield (kg/ha)	
	APE	p-value		APE	p-value
population density (arable)	-0.374**	(0.000)		0.000	(0.456)
residual from PD control function	0.281**	(0.000)		-0.001+	(0.071)
travel time to city of 30k+ (hours)	5.955**	(0.000)		0.002	(0.668)
Elevation (m)	0.408**	(0.000)		0.000**	(0.003)
exp. farmgate maize price	30.662**	(0.000)		-0.081**	(0.003)
HH total landholding (ha)	80.495**	(0.000)		-0.064**	(0.000)
HH # of adults in ag	20.128**	(0.000)		0.063**	(0.004)
Years of education of HH head	9.310**	(0.000)		0.056**	(0.000)
1=HH owns animal traction	203.766**	(0.000)		0.153	(0.155)
Components of ATPE	APE			APE	
indirect: land(PD)*100	-0.169			0.013	
indirect: price(PD)*100	0.073			-0.019	
direct: PD*100	-0.374			0.100	
Average Total PE of PD*100	-0.469			0.094	

HH welfare outcomes

Selected explanatory vars	log(crop income per hectare)		log(nonfarm income/AE)		log(total HH income/AE)	
	APE	p-value	APE	p-value	APE	p-value
population density (arable)	0.0010**	(0.0005)	-0.0002	(0.4239)	-0.0004*	(0.0252)
residual from PD C.F.	-0.0007**	(0.0035)				
travel time to city of 30k+ (hrs)	0.0079**	(0.0022)	-0.0028	(0.3826)	0.0076**	(0.0044)
Elevation (m)	0.0003**	(0.0010)	-0.0001	(0.5182)	0.0005**	(0.0000)
median farmgate maize price	0.1028**	(0.0000)	0.0639*	(0.0485)	0.0726**	(0.0000)
HH total landholding (ha)	-0.0794**	(0.0000)	0.0032	(0.6037)	0.0653**	(0.0000)
HH # of adults in ag	0.0351*	(0.0164)			-0.2043**	(0.0000)
HH # of adults in non-farm			0.3516**	(0.0000)	0.4712**	(0.0000)
HH head years of education	0.0269**	(0.0002)	0.1462**	(0.0000)	0.0763**	(0.0000)
1=HH owns animal traction	0.0447	(0.4965)			-0.3048**	(0.0002)
1=village has cell service			0.2235**	(0.0002)	0.0260	(0.4843)
Components of ATPE	APE		APE		APE	
indirect: land(PD)*100	0.0167		-0.0007		-0.0137	
indirect: price(PD)*100	0.0247		0.0153		0.0174	
direct: PD*100	0.1000		-0.0200		-0.0400	
Average Total PE of PD*100	0.1413		-0.0053		-0.0363	

Conclusions

- Descriptive and non-parametric evidence
  - Direction of effects of PD on landholding, input use, crop/nonfarm/total income as expected, yet of minimal magnitude

- Econometric results
  - Direction of effects of PD on landholding, maize prices, and crop income as expected, yet of minimal magnitude
  - Negative (yet very small) effect of PD on maize production, negligible effect on maize yields
  - Negative (yet very small) effect of PD on nonfarm & total income

Conclusions

- Some evidence that PD is generating expected intensification effects at present, though of small magnitude
- Although pop densities are rising in rural Mozambique, no evidence yet of land scarcity amid abundance
- Bigger concerns:
  - Transparency / outcomes of large-scale land acquisitions
  - Relatively poor market access
  - Very low input use (3% use inorganic fertilizer on maize)
  - Complete lack of animal traction in relatively high-potential north (trypanosomiasis)
  - Rural education levels improving slowly, but still quite low