

How Does Population Density Affect Agricultural Productivity? Evidence from Ethiopia

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Presentation at International Food Policy Research Institute, April 12, 2013

Ethiopia at a glance

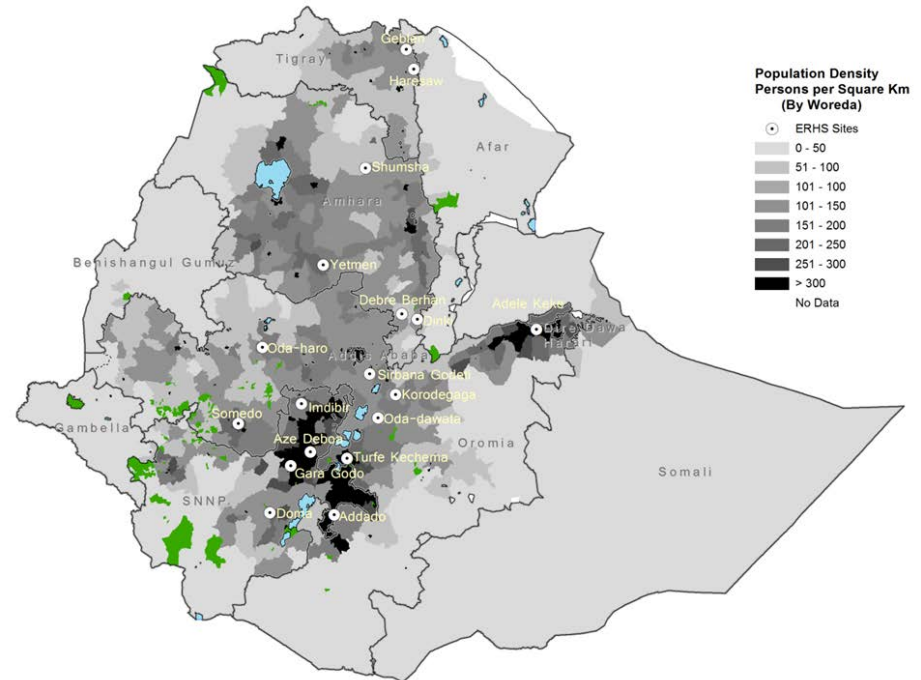
- Highly agrarian, very poor, history of famine & land degradation
- But Boserupian forces as well: long history of plough, some examples of cereal intensification, traditional cash crops (coffee) and emerging (sesame, qat)
- Unique agroecology: 80% of pop in highlands, large variation in ag. potential within highlands, teff a major crop, also maize, sorghum, wheat, pulses
- Unique land institutions: govt. ownership, substantial land redistribution, “use-it-or-lose-it” policies, major resettlement efforts, and “landgrabs” in recent times
- Small farms (avg. = 1 ha), rapidly growing population

Data & Methods

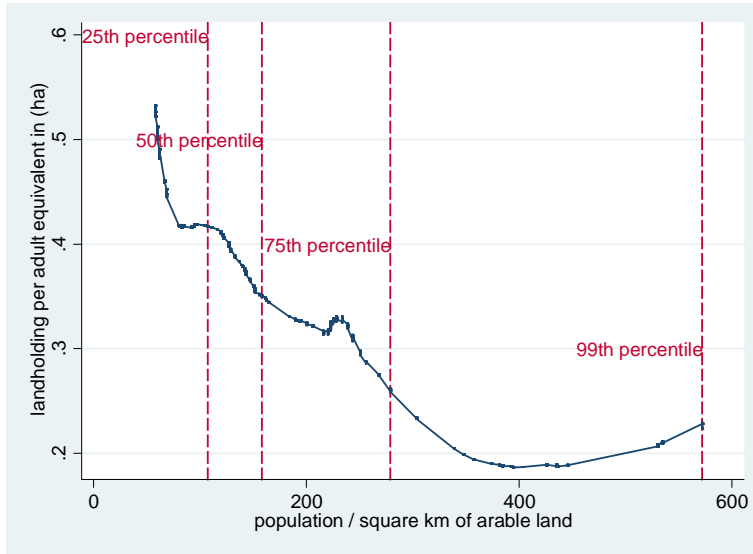
- Some challenges with data sets
- Started with ERHS, long-running panel, widely used:
- Downside is only has 15 villages
- Started using AGP, recent survey of 304 villages: but not a panel, and focused on higher potential areas
- Still working on how best to exploit both datasets; today we will present a bit of both

ERHS

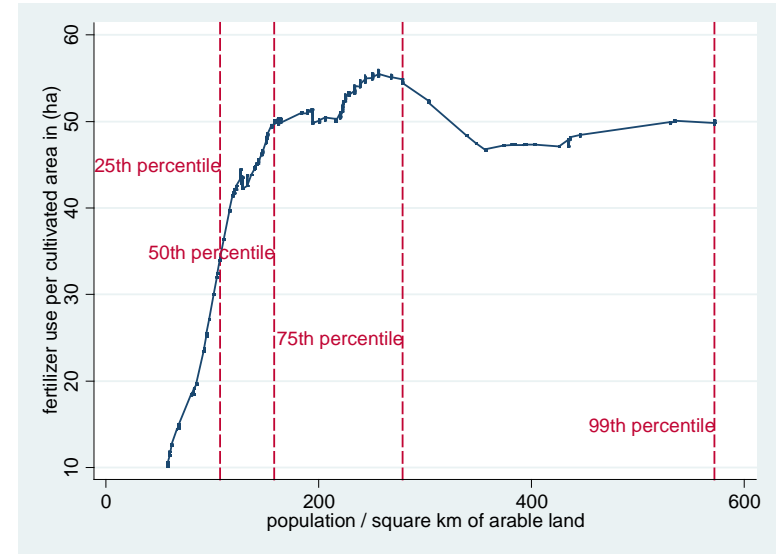
- Ethiopian Rural Household Survey
- Collected from 1989 – 2009, use center six rounds
- Focus groups conducted in 12 villages in May 2012
- In total 1,293 farmers surveyed in all six waves
- Non-pastoral households
- Population density measured as persons/km² of land using GRUMP and GAEZ.



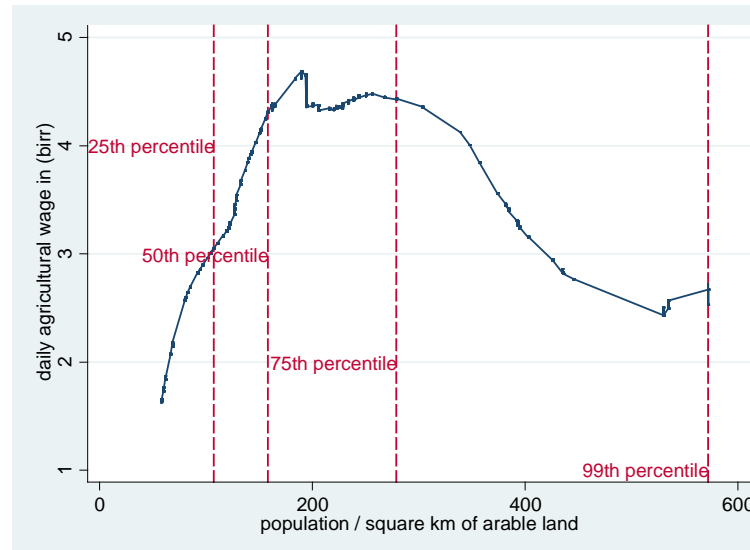
Household Landholding in Hectares per Adult Equivalent by Population Density



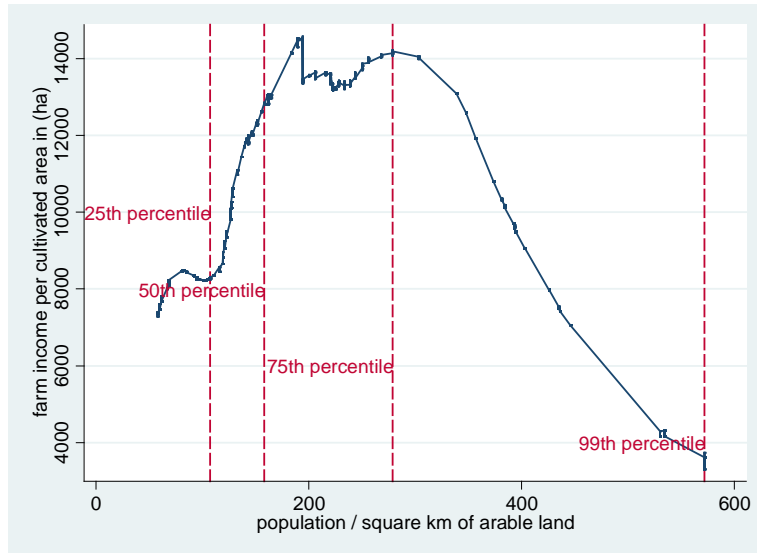
Use of Purchased Input per Hectare by Population Density



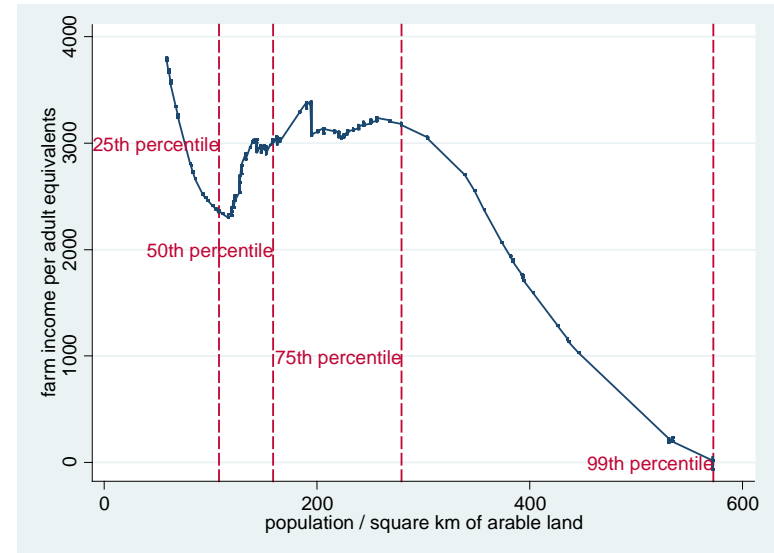
Real Agricultural Wage Rate (in birr per day)



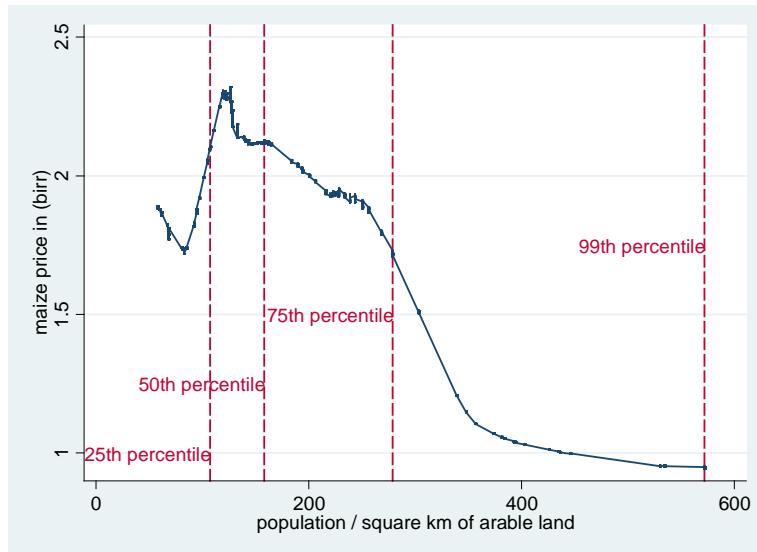
Net Farm Income per Hectare Owned, by Population Density



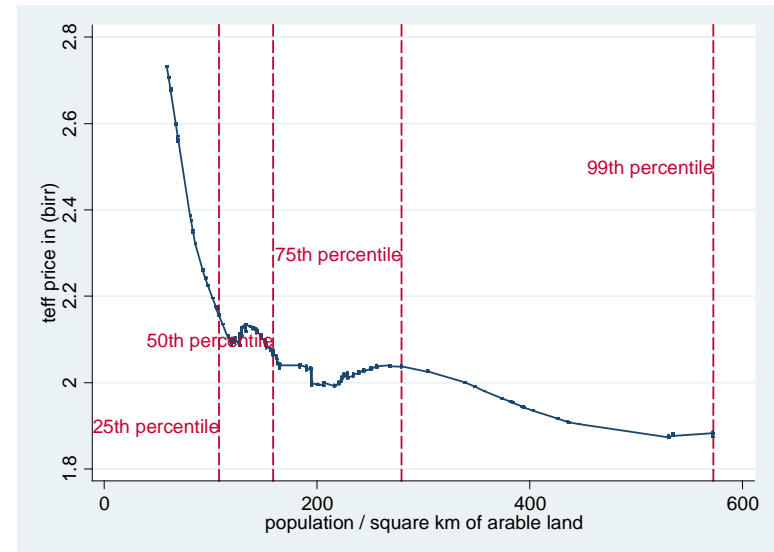
Net Farm Income per Adult Equivalent (in birr) by Population Density



Real Retail Harvest Season Maize Prices in birr/kg, by Population Density



Real Retail Harvest Season Teff Prices in birr/kg, by Population Density



Household Variables

- Value of assets
- Land lost – security proxy
- Highest grade
- Female headed
- Recent death
- Adult equivalents
- Number of oxen
- Landholding
- Maize price (log)
- Teff price (log)
- Daily agricultural wages(log)
- Fertilizer price (log)

Community Variables

- Population density
- Distance to cooperative
- Distance to road
- Number of cooperatives
- Distance to capital
- Net primary productivity
- Annual rainfall
- Ten year rain average
- Elevation, elevation square

Econometric Results

Covariates	(1) Landholding	(2) Log Wage Rate	(3) Log Maize Price	(4) Log Teff Price
Pop. Density *100	-0.399***	0.024	-0.043***	-0.079***
Land Lost	-0.122**	-	-	-
Highest Grade	0.013	0.009*		
Distance to Paved Road			0.045***	0.016***
Distance to Cooperative	-	-	0.017*	0.095**
	Obs = 7758	Obs = 7758	Obs = 7758	Obs = 7758
	R-sq. = 0.27	R-sq. = 0.12	R-sq. = 0.74	R-sq. = 0.53

*, **, *** denotes that corresponding coefficients are statistically significant at the 10%, 5%, 1% levels respectively; other covariates not shown

Covariates	(1) Fertilizer Demand	(2) Maize Production	(3) Teff Production	(4) Farm Revenue
Land Lost	8.95***	19.17*	405***	992*
Landholding	13.22***	532***	642***	2,315***
Distance to Cooperative	-0.764***	-	-	-
I. Direct effect: APE of pop density and av. pop. Density*100	19.73***	-39.86	-38.68	-2,733***
II. Indirect Effect: APE of population density through landholding, wages, and prices *100	-5.91***	-150**	-205***	1,251**
III. Total Effect: ATPE, direct + indirect *100	13.82***	-190**	-244***	-1,482***
	Obs = 7758	Obs = 7758	Obs = 7758	Obs = 7758
	R-sq. = 0.32	R-sq. = 0.20	R-sq. = 0.40	R-sq. = 0.15

*, **, *** denotes that corresponding coefficients are statistically significant at the, 10%, 5%, 1% levels respectively; other covariates not shown

Ag Growth Program (AGP) results

- 304 villages surveyed in 2010-11, 28 HH per EA
- Focused on relatively high potential areas
- Survey very focused on intensification, and we are able to measure wide range of indicators of ag potential, market access and basic policy/institutional variables
- Rather than pop density, we used average farm size at EA level as indicator of “land pressures” (discuss?)
- We are concerned about farm size measurement error, so we use LAD regressor to reduce influence of outliers
- Regressions in log-log for key vars
- Still work in progress, but here are results so far . . .

Table 3. The impacts of average farm sizes and other factors on indicators of technological intensification

Regression No.	1	2	3	4
No. Obs.	7162	7186	7119	7194
Dependent variable	Fertilizers	Plow equip. index	Handheld equip. index	High value share
Average EA farm size	-3.904***	-0.074	-0.047	0.837***
Coef. Var. of EA farm size	0.557***	-0.023	-0.022*	0.537***
Nearest market town	-0.540***	-0.037***	0.009*	-0.018
Nearest 50K city	-1.026***	0.164***	-0.009	0.523***
Policy vars	Yes	Yes	Yes	Yes
HH vars	Yes	Yes	Yes	Yes
Agroecol. controls	Yes	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes	Yes

Table 4. The impacts of average farm sizes and other factors on indicators on maize and teff yields

Regression No.	1	2
No. Obs.	3089	3972
Dependent variable	Maize yield	Teff yield
Average EA farm size	-1.483***	-1.443***
Coef. Var. of EA farm size	0.139**	0.183***
Nearest market town	-0.047**	0.059***
Nearest 50K city	-0.527***	-0.262***
Policy vars	Yes	Yes
HH vars	Yes	Yes
Agroecol. controls	Yes	Yes
Regional dummies	Yes	Yes
Pseudo-R sq	16%	13%

Table 4. The impacts of average farm sizes and other factors on indicators of variable costs, gross farm income and net farm income

Regression No.	1	2	3
No. Obs.	7194	7193	7193
Dependent variable	Non-labor variable inputs per hectare	Gross farm income per hectare	Net farm income per hectare
Average EA farm size	-5.497***	-2.964***	-0.249***
Coef. Var. of EA farm size	0.300***	0.568***	0.060***
Nearest market town	-0.521***	-0.059***	-0.004*
Nearest 50K city	-1.494***	-0.148***	-0.021***
Policy vars.	Yes	Yes	Yes
HH vars.	Yes	Yes	Yes
Agroeco. controls	Yes	Yes	Yes
Regional dummies	Yes	Yes	Yes

Table 5. Average farm sizes and EA daily wage rates for men

Dependent variable	Daily wage rate
No. Obs.	298
Significant variables only	
Average EA farm size	0.322**
Inequality EA farm size	0.152***
EA extension dummy	-0.087*
EA S & L assoc. dummy	0.183***
Percent of men with tertiary educ.	6.412**
Percent of fertile soil	0.121***
Percent of mid-quality soil	0.071***
Percent total land cultivated	0.035***
Altitude 1000-1500m dummy	-0.441*
Altitude 1500-2000m dummy	-0.608**
Altitude 2000-2500m dummy	-0.584**
Altitude 2500-3000m dummy	-0.595**
Altitude>3000m dummy	-0.918***

Conclusions so far

Summary of results so far

1. Land pressures and better market access increase fertilizer use & other variable inputs in both surveys
2. Land pressures lower yields of maize and teff in ERHS
3. Land pressures increase yields of maize and teff in AGP
4. Land pressures lower net revenue per ha in ERHS
3. Land pressures increase net revenue per ha in AGP
4. Land pressures have no effect on wages in ERHS
5. Land pressures have +ve effect on wages in AGP
6. Land pressures have –ve effect on HV outputs in AGP
7. Some effects of policy vars. in both datasets

Further steps

- Still working on both datasets
- For AGP, trying to incorporate data on farm and hired labor inputs
- ERHS, we are still debating how to use data
- with 15 villages, should we look at HH farm size effects instead of village effects?
- Should we tease out dynamics more?
- Welcome your inputs