How Does Population Density Affect Agricultural Intensification and Household Well-being in Africa?

Insights from 5 countries

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Why does Population Density Matter?

- Population in SSA expected to grow by 500 million in next 20 years.
- Many rural households live in areas of relatively high population density.
- large tracts of un-used land in many countries.
- What does this mean for agriculture and food security?

Kenya

Zambia

[Map showing population density in Kenya and Zambia]
Descriptive evidence reveals that larger farms have higher incomes.
Boserupian theory predicts that population density drives intensification

Research questions:

1) Through what channels does population density drive intensification?

2) What are the constraints to smallholder intensification in areas of high population density?

3) Is there a population density threshold beyond which farmers are no longer able to intensify production?
Pathways Through which Population Density Affects Household Outcomes

**INDIRECT EFFECTS**
- Land prices
- Non-market institutions
- Landholding
- Output prices
- Wage rates

**DIRECT EFFECTS**
- Information flow, Institution development, Transaction costs

**Observed**
- Input demand
- Output supply
- Income

**Unobserved**
Household Intensification Under Population Density

\[ Y_{it} = \alpha_1 D_t + \alpha_2 D^2_t + P_t \beta + \rho L_{it} + X_{it} \vartheta + c_i + v_{it} \]

Y: Outcome measure of interest
D: population density and its square.
P: factor and output prices
L: landholding
X: other household, and community factors
c: unobserved time-constant effects
v: unobserved time-varying effects

\[ H_0: \hat{\alpha}_1, \hat{\alpha}_2 = 0 \]
tests the direct effect of pop den on Y
Indirect Partial Effect + Total Partial Effect

Landholding (farm size)

\[ L_{it} = \eta_1 D_t + \eta_2 D^2_t + M_{it} \delta + \mu_{it} \]

Prices

\[ P_{it} = \zeta_1 D_t + \zeta_2 D^2_t + Z_{it} \delta + \epsilon_{it} \]

Calculating Total Effect (combine \( D \) and \( D^2 \))

\[ Y_{it} = \alpha D_t + (D_t)P_{it}\beta + \rho L_{it}(D_t) + X_{it} \delta + c_i + v_{it} \]

Total Partial Effect

\[
\frac{\partial Y_{it}}{\partial D_t} = \left\{ \frac{\partial Y_{it}}{\partial D_t} \right\} + \left\{ \frac{\partial Y_{it}}{\partial P_{it}} \times \frac{dP_{it}}{dD_t} + \frac{\partial Y_{it}}{\partial L_{it}} \times \frac{dL_{it}}{dD_t} \right\}
\]

or

\[
\frac{\partial Y_{it}}{\partial D_t} = \left\{ \hat{\alpha} \right\} + \left\{ \hat{\beta} \left( \zeta_1 + 2\zeta_2 D_t \right) + \hat{\rho} \left( \eta_1 + 2\eta_2 D_t \right) \right\} = \text{TOTAL EFFECT}
\]
Is population density endogenous?

• Maybe
  – Due to omitted variables
  – Or due to reverse causality

• correlation between covariates and unobserved heterogeneity $c_i$ controlled for using the correlated random effects (CRE) estimator.

$$c_i = \Psi + \bar{X}_i \delta + a_i; \text{ where } a_i = (\alpha, \sigma^2)$$

• Some countries used IV methods with control function approach.
Estimation Procedure

• All models estimated linearly.

• Pooled CRE

• Estimate via Seemingly Unrelated Regression (SUR).
  – Models are linked through their error terms, so allows us to directly compute total partial effects.
  – Efficiency gain over equation-by-equation.
Case Studies

Ethiopia
Kenya
Zambia
Malawi
Mozambique

“Land abundance” (high land/labor ratios)
“Land constrained” (low land/labor ratios)
Gridded Population Data

• High-resolution gridded estimates of rural population distributions
  – GRUMP (Global Rural-Urban Mapping Project, Balk and Yetman 2004)
  – AfriPop project (Linard et al. 2012)

• Significant improvements over earlier databases
  – input statistical data are at fairly high levels of disaggregation
  – reporting units further disaggregated spatially
INDIVIDUAL COUNTRY CASE STUDIES