Mining and Local Economic Development

Polluting Industries and Agricultural Productivity: Evidence from Ghana

Juan Pablo Rud
Royal Holloway, University of London
(joint with Fernando M. Aragón, SFU)

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The enclave challenge

'The grudge against what has become known as the enclave type of development is due to this ability of primary products from mines, wells, and plantations to slip out of a country without leaving much of a trace in the rest of the economy.'

A. Hirschman (*The Strategy of Economic Development*, 1958)

Mining as an enclave in developing countries

Characteristics

- Location: poor, rural areas
- Technology: capital-intensive (low levels of local employment)
- Ownership: foreign or domestic firms (dividends go elsewhere)
- Royalties: low in general, do not reach mining regions.
- Linkages: no forward or backward linkages to regional firms.

Mining in rural areas

What potential spillover effects on traditional agricultural activities?

- Most explored mechanism: input competition (labour, land, water)
- We investigate a channel that has been disregarded so far: pollution

Pollution: our study of gold mining in Ghana

- 12 capital-intensive modern mines with different levels of production
- Most fertile region (e.g., cocoa) where traditional agriculture is the main economic activity
- Poor environmental record

These features of the mining sector are common in the developing world

Mining, Pollution and Agriculture

- Mining has potential to pollute: air, water and soil
  - Industry-specific pollutants: cyanide, acid drainages, heavy metals
  - Similar to small city or power plant: emissions from heavy machinery (air pollutants)
- Biological evidence
  - Exposure to air pollutants from burning fossil fuels: reduction in yields 30-60%, more susceptible to diseases.
  - Heavy metals in water and soil: vegetation stunted or dwarfed

Our approach

- Main idea: non-input channels (e.g. pollution) affect a farmer's total factor productivity (TFP)
- Empirical strategy
  - Estimate an agricultural production function, augmented to allow for pollution effects
    - We account for the fact that input use might itself depend on TFP (*endogeneity*)
    - We look at TFP evolution for farmers exposed to mining (*diff-in-diff*)
  - Look for systematic differences in input use or prices
  - Test for alternative explanations

Method

Agricultural Production Function

$$Q_{ivt} = A_{ivt} M_{it}^{\alpha} L_{it}^{\beta} \tag{1}$$

- Assume $A_{ivt} = \exp(\eta_i + \rho_v + \gamma S_{vt})$
- Actual output $Y_{ivt} = Q_{ivt} e^{\epsilon_{it}}$
- We estimate the following model:

$$y_{ivdt} = \alpha m_{it} + \beta l_{it} + \phi Z_i + \delta_d + \gamma S_{vt} + \psi_t + \theta nearmine_v + \xi_{ivt} \tag{2}$$

  - Inputs and output in logs
  - S_{vt} cumulative gold production in locality v at time t
  - Z_i farmer controls, δ_d district fixed effects, and ξ_{ivt} is an error term that includes ϵ_{it} and the unaccounted heterogeneity

- Two issues: endogeneity of input choice and evolution of productivity

Endogeneity of inputs

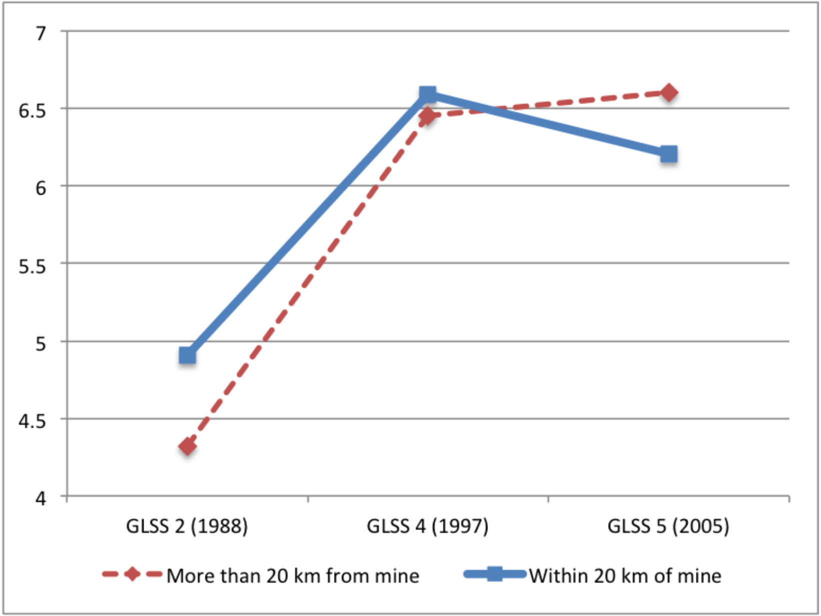
- OLS would work if farmer heterogeneity is fully captured by controls and district/mining area fixed effects
- Two IV approaches that rely on imperfect input markets: many farmers rely on their endowments

1. If input endowments are strong predictor of input use (testable) and uncorrelated to error term: standard IV works (*Benjamin, 1992; Besley 1995*)
2. If we allow for correlation, we can use an Imperfect IV strategy (*Nevo and Rosen, 2012*)

Difference-in-difference assumption

- Treated and control group defined by proximity to mine
- mining area = within 20 km of an active mine
- Treatment (continuous) : cumulative gold production
- S_{vt} = cumulative gold production within 20 km

Evolution of the unconditional mean of agricultural output



Data

Household data

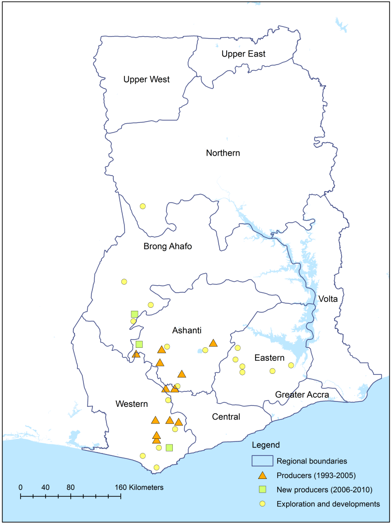
- Living Standards Surveys (GLSS): 2 rounds (1998-9 and 2005-6), repeated cross sections
- Inputs and Outputs for farming households
- Poverty measure and expenditures for all households

Distance to mining areas

- Distance to mine sites using GIS

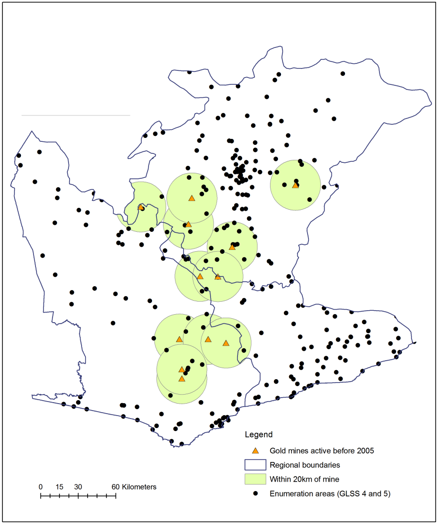
Location

Country



Location

Close up of area of study



Mining and agricultural productivity

	ln(real agricultural output)			ln(yield maize)
	(1)	(2)	(3)	(4)
Cumul Gold Prod	-0.733**	-0.727**	[-0.301 -0.675]	-0.689**
Within 20 km of mine	(0.268)	(0.273)	(-0.131 -0.750)	(0.280)
ln(land)	0.630***	0.675***	[0.195 0.676]	
	(0.037)	(0.048)	(-0.031 0.770)	
ln(labor)	0.218***	0.356***	[0.664 0.356]	
	(0.034)	(0.115)	(0.806 0.294)	
Estimation	OLS	2SLS	IIV	OLS
Farmer's controls	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes
Imperfect IV for			Land	
Observations	1,627	1,627	1,627	933
R-squared	0.462	0.453		0.272

Mining on Agricultural Productivity

Flexible specification

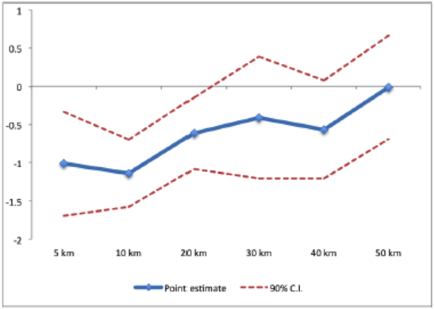


Figure 3: The effect of mining on agricultural productivity, by distance to a mine

Reduction in productivity: is it due to pollution?

- No ground measures of pollution: satellite imagery (cross section only, 2005)
- Detect NO2 at the start of the agricultural season:
  - Air pollutant linked to fuel combustion, toxic & precursor of tropospheric ozone.
  - These pollutants can be removed from the atmosphere by direct uptake by vegetation and soils or through acid rain, that impoverishes soils and damages vegetation
- Results on the cross section hold when using average NO2 concentration directly in the main specification
- No evidence of downstream/upstream effects (i.e. water pollution) or of heterogeneous locations of effects

Mining and pollution
NO2 concentration

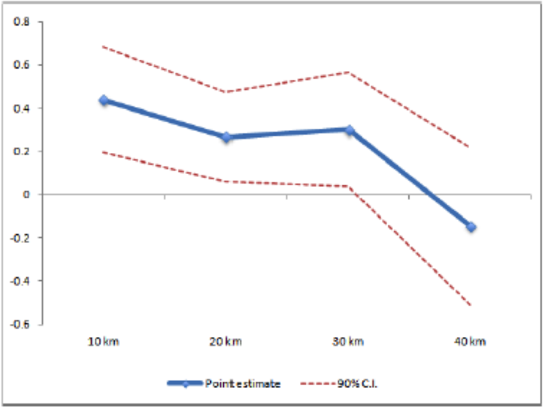


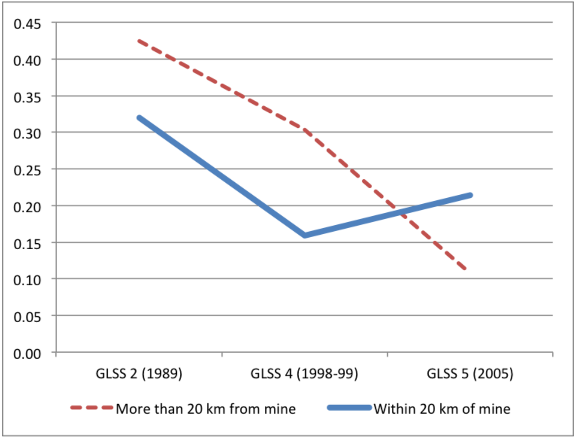
Figure 4: Increase in concentration of NO_2, by distance to a mine

Alternative Explanations: no evidence

- There is no increase in agricultural wages or land rents
- Mining areas are left with a selection of low productivity farmers (e.g. lower educational levels, move to non-agricultural activities, etc.)
- Property rights: fear of expropiation induce changes in agricultural practices (e.g. less cocoa plants)

Mining and poverty

Evolution of poverty headcount



Conclusion

Findings Expansion of mining associated to:

- A reduction in agricultural productivity
- Increase in poverty

Channel Negative spillovers through pollution, not inputs

Policy Huge redistributive effects: local farmers lose, capital city gains

- Disregard for these spillover effects over-estimates the net benefits of the sector

How can mining benefit local communities?

Linkages: our study of a Peruvian Gold Mine

Local purchases by the mine increased local income and reduced poverty