Polluting Industries and Agricultural Productivity: Evidence from Mining in Ghana

Online Appendix

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A Additional Results

Figure A.1: *Evolution of the Unconditional Mean of ln(Real Agricultural Output)*

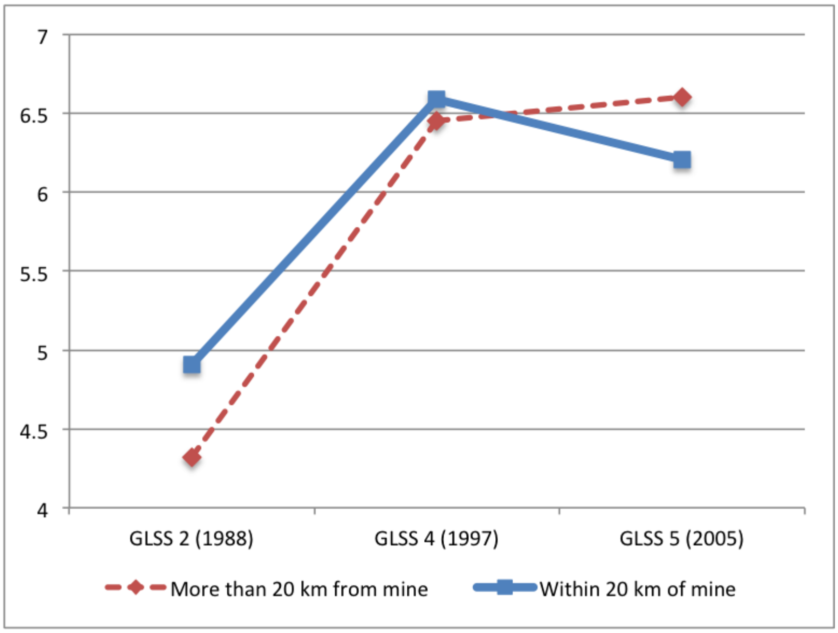

Table A.1: *Evolution of Agricultural Output in Mining vs Non-Mining Areas*

	ln(real agricultural ouput)	
	(1)	(2)
Within 20 km of mine × GLSS 4	-0.261	
	(0.370)	
Within 20 km of mine × GLSS 5		-0.515*
		(0.256)
Sample	GLSS 2 and 4	GLSS 4 and 5
Estimation	OLS	OLS
Farmer controls	Yes	Yes
Input Controls	No	No
Observations	1,473	1,627
R-squared	0.251	0.223

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include district and survey fixed effects, as well as a set of farmer characteristics as in Table 3. *GLSS 4* and *GLSS 5* are indicators equal to 1 if survey is GLSS 4 or 5, respectively. *Within 20 km of mine* is a dummy equal to 1 if household is in a mining area.

Table A.2: *First Stage Regressions of Column 3 in Table 3*

	ln(land)	ln(labour)
	(1)	(2)
ln(land owned)	0.917***	0.172***
	(0.027)	(0.038)
ln(nr adult equivalents)	0.024	0.475***
	(0.019)	(0.056)
F-test excl. instruments	781.6	76.8
Observations	1,627	1,627
R-squared	0.798	0.243

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All columns include district and survey fixed effects, an indicator of being within 20 km of a mine, and farmer controls. See Table 3 for details on the second stage.

Table A.3: *Main Results Using a Time Trend as Treatment Variable*

	ln(real agricultural ouput)			ln(yield cocoa)	ln(yield maize)
	(1)	(2)	(3)	(4)	(5)
Within 20 km of mine × GLSS 5	-0.515*	-0.566**	-0.565**	-0.913**	-1.173**
	(0.256)	(0.236)	(0.247)	(0.430)	(0.519)
ln(land)		0.631***	0.678***		
		(0.037)	(0.047)		
ln(labour)		0.210***	0.346***		
		(0.032)	(0.112)		
Estimation	OLS	OLS	2SLS	OLS	OLS
Farmer's controls	Yes	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1,627	1,627	1,627	948	605
R-squared	0.223	0.447	0.438	0.344	0.410

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. See notes of Table 3 for further details on control variables and instruments.

Table A.4: *Main Results Using Official CPI as Price Deflator*

	ln(value agricultural ouput / CPI)		
	(1)	(2)	(3)
Within 20 km of mine × GLSS 5	-0.155*	-0.183**	-0.176*
	(0.085)	(0.085)	(0.088)
ln(land)		0.631***	0.673***
		(0.038)	(0.048)
ln(labour)		0.202***	0.358***
		(0.033)	(0.114)
Estimation	OLS	OLS	2SLS
Farmer controls	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes
Observations	1,627	1,627	1,627
R-squared	0.243	0.459	0.447

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. See notes of Table 3 for further details on control variables and instruments. CPI is the consumer price index reported by GSS. This index has a lower geographical resolution than the price index used in the main results reported in the paper.

Table A.5: *Replication of Table 3 Using Distance Brackets*

	ln(real agricultural ouput)			ln(yield cocoa)	ln(yield maize)
	(1)	(2)	(3)	(4)	(5)
Between 0-5 km of mine × GLSS 5	-0.852**	-1.006**	-1.022***	-0.607	-2.736***
	(0.335)	(0.404)	(0.387)	(0.596)	(0.572)
Between 5-10 km of mine × GLSS 5	-1.260***	-1.137***	-1.144***	-1.446***	-5.037***
	(0.344)	(0.260)	(0.272)	(0.289)	(0.503)
Between 10-20 km of mine × GLSS 5	-0.497	-0.610**	-0.629**	-0.968***	-1.016**
	(0.333)	(0.276)	(0.281)	(0.343)	(0.420)
Between 20-30 km of mine × GLSS 5	-0.489	-0.403	-0.405	-0.701	0.083
	(0.541)	(0.476)	(0.466)	(0.557)	(0.769)
Between 30-40 km of mine × GLSS 5	-0.575	-0.562	-0.585	-0.591	-1.657***
	(0.373)	(0.382)	(0.387)	(0.571)	(0.502)
Between 40-50 km of mine × GLSS 5	-0.070	-0.009	-0.068	0.334	0.467
	(0.434)	(0.401)	(0.406)	(0.428)	(0.753)
ln(land)		0.628***	0.684***		
		(0.036)	(0.044)		
ln(labour)		0.207***	0.330***		
		(0.031)	(0.105)		
Estimation	OLS	OLS	2SLS	OLS	OLS
Farmer's controls	Yes	Yes	Yes	Yes	Yes
District fixed effects	Yes	Yes	Yes	Yes	Yes
Observations	1,627	1,627	1,627	948	605
R-squared	0.233	0.453	0.445	0.371	0.469

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include district and survey fixed effects, and farmer's controls. The set of farmer's controls includes: household head's age, literacy, and an indicator of being born in the village; as well as an indicator of the household owning a farm plot. Column 3 is estimated using 2SLS. The excluded instruments are: ln(area of land owned) and ln(number of adults equivalents in the household). Cumulative gold production is measured in hundreds of tonnes. '*Between X-Y km of mine*' is a dummy equal to 1 if household is located in distance bracket [X,Y]. Omitted category is households located farther than 50 km of a mine.

Table A.6: *Replication of Table 4 Using Distance Brackets*

	ln(real agricultural output)			
	(1)	(2)	(3)	(4)
Between 0-5 km of mine × GLSS 5	-0.981*	-1.042***	-1.188***	
	(0.489)	(0.347)	(0.434)	
Between 5-10 km of mine × GLSS 5	-1.115***	-1.024***	-1.164***	-1.107***
	(0.231)	(0.252)	(0.352)	(0.268)
Between 10-20 km of mine × GLSS 5	-0.724***	-0.584**	-0.730**	-0.606**
	(0.261)	(0.254)	(0.342)	(0.275)
Between 20-30 km of mine × GLSS 5	-0.447	-0.395	-0.534	-0.419
	(0.484)	(0.429)	(0.485)	(0.482)
Between 30-40 km of mine × GLSS 5	-0.540	-0.485	-0.602	-0.564
	(0.397)	(0.365)	(0.422)	(0.382)
Between 40-50 km of mine × GLSS 5	0.012	0.018	0.053	-0.010
	(0.447)	(0.393)	(0.413)	(0.401)
ln(land)	0.667***	0.598***	0.601***	0.634***
	(0.037)	(0.036)	(0.036)	(0.036)
ln(labour)	0.218***	0.205***	0.201***	0.207***
	(0.031)	(0.030)	(0.032)	(0.031)
Farmer control	No	Yes	Yes	Yes
Other inputs	No	Yes	Yes	No
Heterogenous trends	No	No	Yes	No
Sample	All	All	All	Excl. within 5 km of mine
Observations	1,627	1,627	1,627	1,598
R-squared	0.431	0.472	0.475	0.455

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions are estimated using OLS, and include district and survey fixed effects, and an indicator of being within 20 km of a mine. Column 1 does not include any additional control. Column 2 replicates the baseline regression in Table 3 but includes indicators of use of other inputs, such as fertilizers, manure and improved seeds. Column 3 adds to the previous column the interaction of time trends with indicators of ecological zone, proximity to coast, and proximity to region capitals. Column 4 replicates the baseline regression but excludes farmers within 5 km of a mine. "*Between X-Y km of mine*" is a dummy equal to 1 if household is located in distance bracket [X,Y]. Omitted category is households located farther than 50 km of a mine.

Table A.7: *Replication of Table 4 Using 2SLS*

	ln(real agricultural output)				
	(1)	(2)	(3)	(4)	(5)
Cumulative gold prod. within 20 km	-0.160*	-0.160*	-0.162*	-0.162*	
	(0.096)	(0.083)	(0.086)	(0.087)	
Within 20 km of active mine × GLSS 5					-0.809***
					(0.278)
Within 20 km of future mine × GLSS 5					0.480
					(0.423)
ln(land)	0.729***	0.649***	0.655***	0.681***	0.677***
	(0.047)	(0.047)	(0.047)	(0.047)	(0.047)
ln(labour)	0.369***	0.331***	0.326***	0.352***	0.340***
	(0.113)	(0.112)	(0.112)	(0.110)	(0.106)
Use fertilizer		0.411***	0.411***		
		(0.094)	(0.094)		
Use manure		0.519***	0.518***		
		(0.150)	(0.152)		
Use improved seeds		-0.120	-0.121		
		(0.085)	(0.084)		
Estimation	2SLS	2SLS	2SLS	2SLS	2SLS
Farmer control	No	Yes	Yes	Yes	Yes
Heterogenous trends	No	No	Yes	No	No
Sample	All	All	All	Excl. within 5 km of mine	All
Observations	1,633	1,627	1,627	1,598	1,627
R-squared	0.411	0.456	0.457	0.437	0.445

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions are estimated using 2SLS with input endowments as instruments for actual input use as in columns 3 and 4 of Table 3. Regressions include district and survey fixed effects, and an indicator of being within 20 km of a mine. Column 1 does not include any additional control. Column 2 replicates the baseline regression in Table 3 but includes indicators of use of other inputs, such as fertilizers, manure and improved seeds. Column 3 adds to the previous column the interaction of time trends with indicators of ecological zone, proximity to coast, and proximity to region capitals. Column 4 replicates the baseline regression but excludes farmers within 5 km of a mine. Column 5 performs a falsification test. *active mines* are mines that had some production in period 1988-2005, while *future mines* are mines that started operations after 2005 or have not started production yet, but are in the stage of advanced exploration or development.

Table A.8: *Including Mine Fixed Effects and Excluding Obuasi Mine*

	ln(real agricultural output)	
	(1)	(2)
Cumulative gold	-0.652***	-0.156
prod. within 20 km	(0.224)	(0.103)
ln(land)	0.635***	0.631***
	(0.038)	(0.039)
ln(labour)	0.210***	0.203***
	(0.034)	(0.034)
Mine fixed effects	Yes	No
Sample	All	Excl. Obuasi mine
Observations	1,627	1,580
R-squared	0.422	0.443

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions are estimated using OLS, and include district and survey fixed effects, an indicator of being within 20 km of a mine and farmer's controls as the baseline specification in Table 3. Column 1 also include a set of mine fixed effects. Column 2 excludes farmers located within 20 km of Obuasi mine.

B Robustness to Using a CES Production Function

The baseline results assume a Cobb-Douglas production function. Here, we relax this assumption and assume instead a constant-elasticity-of-substitution (CES) technology. We use non-linear least squares to estimate the following model:

$$y_{ivt} = A_{ivt}[\eta M_{it}^{-\rho} + (1-\eta)L_{it}^{-\rho}]^{-\frac{\lambda}{\rho}},$$

where $A_{ivt} = \exp(\gamma S_{vt} + \phi Z_i + \delta_d + \psi_t + \theta mining\_area_v)$, M and L represent land and labour use, while S_{vt} is the measure of mining activity, i.e., cumulative gold production within 20 km. The parameter of interest is γ, the effect of mining activity on total factor productivity.

Table B.1 displays the results. The implicit elasticity of substitution, $\sigma = \frac{1}{1-\rho}$, is less than one, and we cannot rule out constant returns to scale ($\lambda = 1$). Similar to the baseline results, the estimate of γ is negative, suggesting that the increase in cumulative gold production is associated to lower productivity.

Table B.1: *Using a CES Production Function*

Parameter	Estimate	S.E.
γ	-0.165**	0.083
λ	0.911***	0.052
ρ	-0.787***	0.228
η	0.997***	0.005
Implied σ	0.560	

Note: * denotes significant at 10%, ** significant at 5% and *** significant at 1%. Regression includes district and survey fixed effects, indicators of proximity to a mine, and farmer characteristics as in Table 3.

C Estimates Using Imperfect Intruments

Table C.1: *Imperfect Instruments with Multiple Endogenous Variables*

$(\lambda_{land}, \lambda_{labour})$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\beta}$
(0, 0)	-0.170	0.676	0.352
(0, 0.1)	-0.165	0.657	0.422
(0, 0.2)	-0.152	0.610	0.601
(0, 0.3)	-0.053	0.249	1.967
(0, 0.4)	-0.238	0.921	-0.577
(0, 0.5)	-0.205	0.802	-0.126
(0, 0.6)	-0.197	0.771	-0.009
(0, 0.7)	-0.193	0.757	0.045
(0, 0.8)	-0.190	0.749	0.075
(0, 0.9)	-0.189	0.743	0.095
(0, 1)	-0.188	0.740	0.109
(0.1, 0)	-0.171	0.687	0.344
(0.1, 0.1)	-0.166	0.668	0.413
(0.1, 0.2)	-0.154	0.620	0.590
(0.1, 0.3)	-0.051	0.235	1.998
(0.1, 0.4)	-0.236	0.928	-0.539
(0.1, 0.5)	-0.205	0.813	-0.115
(0.1, 0.6)	-0.197	0.782	-0.004
(0.1, 0.7)	-0.193	0.768	0.047
(0.1, 0.8)	-0.191	0.760	0.077
(0.1, 0.9)	-0.190	0.755	0.096
(0.1, 1)	-0.189	0.751	0.110
(0.2, 0)	-0.173	0.702	0.335
(0.2, 0.1)	-0.168	0.683	0.402
(0.2, 0.2)	-0.155	0.634	0.575
(0.2, 0.3)	-0.047	0.215	2.045
(0.2, 0.4)	-0.234	0.937	-0.491

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Table C.1 – continued from previous page

$(\lambda_{land}, \lambda_{labour})$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\beta}$
(0.2, 0.5)	-0.205	0.826	-0.102
(0.2, 0.6)	-0.197	0.797	0.002
(0.2, 0.7)	-0.194	0.783	0.051
(0.2, 0.8)	-0.192	0.775	0.079
(0.2, 0.9)	-0.190	0.770	0.097
(0.2, 1)	-0.190	0.766	0.110
(0.3, 0)	-0.175	0.723	0.322
(0.3, 0.1)	-0.170	0.703	0.386
(0.3, 0.2)	-0.158	0.653	0.553
(0.3, 0.3)	-0.040	0.183	2.120
(0.3, 0.4)	-0.231	0.949	-0.431
(0.3, 0.5)	-0.205	0.845	-0.085
(0.3, 0.6)	-0.198	0.816	0.011
(0.3, 0.7)	-0.195	0.803	0.055
(0.3, 0.8)	-0.193	0.795	0.081
(0.3, 0.9)	-0.192	0.790	0.098
(0.3, 1)	-0.191	0.786	0.110
(0.4, 0)	-0.178	0.753	0.303
(0.4, 0.1)	-0.173	0.734	0.362
(0.4, 0.2)	-0.161	0.683	0.521
(0.4, 0.3)	-0.028	0.120	2.264
(0.4, 0.4)	-0.228	0.964	-0.351
(0.4, 0.5)	-0.205	0.870	-0.060
(0.4, 0.6)	-0.199	0.843	0.023
(0.4, 0.7)	-0.196	0.831	0.062
(0.4, 0.8)	-0.194	0.823	0.085
(0.4, 0.9)	-0.193	0.818	0.100

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Table C.1 – continued from previous page

$(\lambda_{land}, \lambda_{labour})$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\beta}$
(0.4, 1)	-0.192	0.815	0.111
(0.5, 0)	-0.183	0.802	0.272
(0.5, 0.1)	-0.178	0.783	0.324
(0.5, 0.2)	-0.167	0.732	0.466
(0.5, 0.3)	0.004	-0.048	2.651
(0.5, 0.4)	-0.223	0.985	-0.241
(0.5, 0.5)	-0.206	0.908	-0.025
(0.5, 0.6)	-0.201	0.884	0.041
(0.5, 0.7)	-0.198	0.873	0.072
(0.5, 0.8)	-0.197	0.867	0.091
(0.5, 0.9)	-0.196	0.862	0.103
(0.5, 1)	-0.195	0.859	0.111
(0.6, 0)	-0.191	0.893	0.215
(0.6, 0.1)	-0.188	0.879	0.250
(0.6, 0.2)	-0.180	0.836	0.353
(0.6, 0.3)	0.369	-1.959	7.055
(0.6, 0.4)	-0.215	1.016	-0.079
(0.6, 0.5)	-0.206	0.969	0.034
(0.6, 0.6)	-0.203	0.953	0.071
(0.6, 0.7)	-0.202	0.946	0.089
(0.6, 0.8)	-0.201	0.941	0.100
(0.6, 0.9)	-0.200	0.938	0.107
(0.6, 1)	-0.200	0.936	0.113
(0.7, 0)	-0.214	1.129	0.067
(0.7, 0.1)	-0.216	1.139	0.047
(0.7, 0.2)	-0.222	1.177	-0.022
(0.7, 0.3)	-0.170	0.862	0.554

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Table C.1 – continued from previous page

$(\lambda_{land}, \lambda_{labour})$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\beta}$
(0.7, 0.4)	-0.204	1.066	0.182
(0.7, 0.5)	-0.207	1.085	0.146
(0.7, 0.6)	-0.208	1.093	0.132
(0.7, 0.7)	-0.209	1.097	0.125
(0.7, 0.8)	-0.209	1.099	0.120
(0.7, 0.9)	-0.210	1.101	0.117
(0.7, 1)	-0.210	1.102	0.115
(0.8, 0)	-0.402	3.079	-1.160
(0.8, 0.1)	-0.597	4.768	-2.774
(0.8, 0.2)	0.364	-3.591	5.213
(0.8, 0.3)	-0.113	0.562	1.245
(0.8, 0.4)	-0.182	1.160	0.674
(0.8, 0.5)	-0.209	1.399	0.446
(0.8, 0.6)	-0.224	1.528	0.322
(0.8, 0.7)	-0.233	1.609	0.245
(0.8, 0.8)	-0.240	1.664	0.193
(0.8, 0.9)	-0.244	1.704	0.154
(0.8, 1)	-0.248	1.734	0.125
(0.9, 0)	-0.072	-0.347	0.995
(0.9, 0.1)	-0.076	-0.190	1.080
(0.9, 0.2)	-0.084	0.052	1.213
(0.9, 0.3)	-0.096	0.476	1.444
(0.9, 0.4)	-0.124	1.403	1.951
(0.9, 0.5)	-0.235	5.060	3.949
(0.9, 0.6)	0.344	-14.114	-6.529
(0.9, 0.7)	0.046	-4.244	-1.135
(0.9, 0.8)	0.005	-2.881	-0.390

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Table C.1 – continued from previous page

$(\lambda_{land}, \lambda_{labour})$	$\hat{\gamma}$	$\hat{\alpha}$	$\hat{\beta}$
(0.9, 0.9)	-0.012	-2.339	-0.094
(0.9, 1)	-0.020	-2.048	0.065
(1, 0)	-0.124	0.198	0.652
(1, 0.1)	-0.120	0.226	0.757
(1, 0.2)	-0.112	0.281	0.962
(1, 0.3)	-0.089	0.435	1.539
(1, 0.4)	0.379	3.546	13.184
(1, 0.5)	-0.197	-0.289	-1.170
(1, 0.6)	-0.166	-0.078	-0.381
(1, 0.7)	-0.156	-0.013	-0.137
(1, 0.8)	-0.151	0.019	-0.018
(1, 0.9)	-0.148	0.038	0.052
(1, 1)	-0.146	0.050	0.098

Notes: Table displays estimates used to construct Figure 4.

D Effects on Input Prices and Input Demands

In this section we provide additional evidence on the relevance of the input competition channel, defined by an increase in the price of local inputs, as an explanation of the observed phenomena. This increase in local prices may occur if mines demand inputs (such as labour) that can also be used in agricultural production, or reduce the supply of land, for instance through land grabbings or changes in land use. Similarly, this may occur if mines generate a positive demand shock in the local economy. As highlighted by Moretti (2011), a local demand shock can induce an increase in price of local non-tradable goods (such as housing and services), and indirectly drive up local wages.

To study this potential phenomenon, we explore the relation between mining and input prices. As measure of input prices, we use the daily agricultural wage from the GLSS community module and the price of land per acre self-reported by farmers. We take the average of these variables by enumeration area, and divide them by the consumer price index to obtain relative input prices.

Columns 1 and 2 in Table D.1 display the results. We find that the relation between mining and input prices is insignificant. This result is consistent with several hypotheses. First, this could happen if input markets are not perfectly competitive so input prices reflect neither input productivity nor changes in local demand, effectively shutting down the input comeptition channel. Second, a similar result can be obtained if mines indeed increase demand for local inputs but this increase in demand is offset by decline of agricultural productivity. A third plausible explanation is that the increase in input demand due to mining is offset by the increase in supply of inputs, for instance due to worker migration. This argument is weakend by the observation that the size of migrant population has not increased and by the inelasticity of land supply.

Overall, the lack of changes on input prices does not rule out that mining could have generated a local demand shock (as in Aragon and Rud (2013)). However, this result weakens the argument that mining crowds out agriculture *only* through an increase in factor prices. Instead, it points out to a decline in productivity as an important driver of the reduction in agricultural output.

To further examine this interpretation, we study the relationship between mining and input demands. Note that in the contex of the analytical framework discussed in Section 2.1, a negative shock to total factor productivity would (weakly) decrease input use, even if input prices do not change.

To estimate input demands, we regress input use on measures of input prices (averaged by enumeration area), farmer's endowments and proxies of total factor productivity, including mine activity.[1] This specification is motivated by the analytical framework discussed in Section 2.1 and has the flavor of the model used by Benjamin (1992) to explore input separability.

The results on input demands are consistent with our interpretation that mining is associated to a reduction in agricultural productivity. Despite no changes in input prices, demand for

[1]We check the robustness of these results to using annual gold production, instead of cumulative production, as proxy of mining activity, and including agricultural output as an additional control in the estimation of input demands (see Table D.2).

labour decreases with mining. This is expected in the presence of a negative productivity shock, as discussed in Section 2.1. The lack of response of input prices to this productivity shock could be due to imperfect input markets. In turn, this may explain why land demand does not change while labour demand decreases. As laid out in the analytical framework, in the absence of input markets, the opportunity cost of land is low such that the entire endowment is used. In contrast, labour use is more responsive to productivity shocks since the labour endowment can always be consumed as leisure.

Table D.1: *Mining, Input Prices and Input Demands*

	ln(relative wage) (1)	ln(relative land rent) (2)	ln(labour) (3)	ln(land) (4)
Cumulative gold prod. within 20 km.	-0.012	-0.040	-0.144**	-0.007
	(0.029)	(0.078)	(0.062)	(0.037)
ln(relative wage)			-0.093	0.019
			(0.153)	(0.117)
ln(relative land rent)			-0.085	0.009
			(0.071)	(0.038)
ln(nr. adult equivalents)			0.528***	0.022
			(0.062)	(0.021)
ln(land owned)			0.130***	0.914***
			(0.029)	(0.030)
Farmer's controls	No	No	Yes	Yes
District fixed effects	No	No	Yes	Yes
Observations	194	201	1,342	1,342
R-squared	0.277	0.007	0.267	0.803

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include survey fixed effects and an indicator of being within 20 km of a mine. Columns 3 and 4 also include district fixed effects, and a set of farmer controls similar to regressions in Table 3.

Table D.2: *Mining, Input Prices and Input Demands - Robustness Checks*

	ln(relative wage) (1)	ln(relative land rent) (2)	ln(labour) (3)	ln(land) (4)
Annual gold prod. within 20 km	0.220 (0.627)	1.326 (1.558)		
Cumulative gold prod. within 20 km.			-0.123** (0.055)	0.008 (0.035)
ln(relative wage)			-0.101 (0.157)	0.013 (0.119)
ln(relative land rent)			-0.097 (0.070)	0.000 (0.039)
ln(nr. adult equivalents)			0.507*** (0.061)	0.008 (0.020)
ln(land owned)			0.064** (0.029)	0.867*** (0.041)
ln(real agric. output)			0.095*** (0.025)	0.067*** (0.021)
Farmer's controls	No	No	Yes	Yes
District fixed effects	No	No	Yes	Yes
Observations	194	201	1,342	1,342
R-squared	0.277	0.009	0.279	0.808

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions include survey fixed effects and an indicator of being within 20 km of a mine. Columns 1 and 2 use annual instead of cumulative gold production (see notes of Table 5 for details). Columns 3 and 4 replicate results in Table D.1 adding a measure of agricultural output as additional control variable.

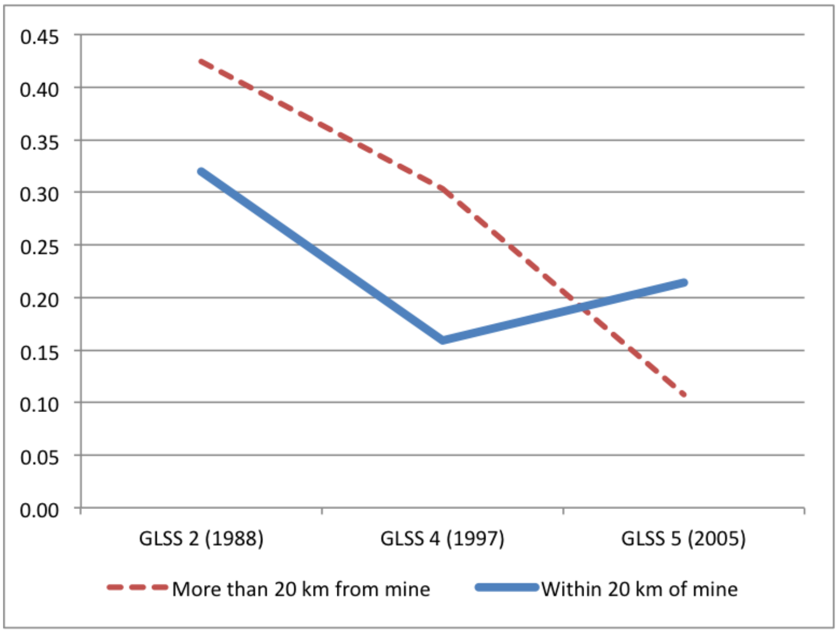
E Effects on Poverty - Methodology and Additional Results

In this section, we explain the methodology used to estimate the relationship between mining and poverty discussed in Section 4 of the paper and present additional results on expenditure and children health.

E.1 Methodology

Figure E.1 depicts the evolution over time of poverty headcount in areas close and far from mines. There are two relevant observations. First, poverty declined steadily between 1988 and 2005 in areas far from mines. This trend is similar to the dramatic poverty reduction experienced in the rest of Ghana since the early 1990s (Coulombe and Wodon, 2007). Second, during the 1990s, mining areas were less poor than non-mining areas, and poverty evolved similarly in both areas. Since 1997, however, poverty increased in mining areas and they have become poorer than non-mining areas.[2] Note that this increase in poverty parallels the reduction in agricultural output (see Figure A.1).

Figure E.1: *Evolution of Poverty Headcount*



To formally examine the relation between poverty and mining, we estimate the following

[2] Recall that during this period, gold production reached higher levels and the number of mines increased.

regression:

$$poverty_{idvt} = \phi_1 S_{vt} + \phi_2 W_i + \delta_d + \omega_{it} \tag{E.1}$$

where *poverty* is an indicator of the household being poor, and W_i is a set of household controls. The rest of the specification is similar to equation (2). We also estimate this model by OLS using sample weights and clustering the errors at district level. In this specification, the parameter of interest, ϕ_1, captures the difference in the evolution of poverty in mining areas, relative to non-mining areas.

We obtain household poverty status we use the poverty line used by the Ghana Statistical Service, i.e., 900,000 cedis per adult per year in 1999 Accra prices. The poverty line includes both essential food and non-food consumption (Ghana Statistical Service, 2000). We check the robustness of the results to alternative poverty lines such as USD 1.25 PPP a day.

We estimate equation (E.1) using only data from the last two rounds of the GLSS. We do not use data from GLSS 2, which are available, in order to keep the estimates comparable to the results on agricultural productivity. The results including this survey round are similar.

We also check the robustness of the results to using real household expenditure as an outcome variable (see Table E.1). To construct the measure of real expenditure, we deflate nominal expenditure per capita with the index of local agricultural prices used to obtained measures of real agricultural output. The results using the official consumer price index are, however, similar.

E.2 Child Malnutrition and Health

As a complement to the results on poverty, we also examine other relevant measures of living standards, namely child malnutrition and health, which may also be affected by the increase in poverty and pollution. As the GLSS does not have information on these outcomes, we use data from the Ghana Demographic and Health Surveys (DHS). Specifically, we use a dataset of repeated cross-sections covering the years 1993, 1998, 2003 and 2008, and focus on the same study area as in previous results, i.e. Western, Ashanti and Central regions.

We focus on nutrition and health of children under 5 years. As a measure of nutritional status, we use Z-scores of weight-for-age and height-for-age. The first one measures current nutritional status, while the second can highlight stunting due to chronic malnutrition. We

Table E.1: *Mining and Household Expenditure*

	ln(real expenditure per capita)					
			Rural			Urban
	All households		All	Farmers	Non-farmers	
	(1)	(2)	(3)	(4)	(5)	(6)
Cumulative gold prod. within 20 km.	-0.055		-0.048	-0.084*	0.041	-0.115
	(0.053)		(0.065)	(0.045)	(0.111)	(0.073)
Within 20 km of mine × GLSS 5		-0.214**				
		(0.102)				
Observations	5,527	5,527	3,393	2,540	853	2,134
R-squared	0.570	0.571	0.489	0.446	0.583	0.585

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions are estimated using ordinary least squares, and include district and year fixed effects as well as household controls, such as: age, age^2, religion, place of birth and literacy status of household head, household size, and an indicator of urban areas. All columns include an indicator of being within 20 km of a mine.

also study two measures of child health: incidence of diarrhea and acute respiratory disease (ARD). Height and weight are based on anthropometric measures, while child health indicators are based on reporting of symptoms by the mother.

To examine the effect of mining on these outcomes, we estimate the following model:

$$D_{idvt} = \lambda_1 \ln S_{vt} + \lambda_2 M_{it} + \delta_d + \upsilon_{it}, \qquad \text{(E.2)}$$

where D is the nutrition or health indicator of child i in year t; v and d represent the sampling cluster, the DHS equivalent of enumeration area, and district respectively; M_{it} is a vector of mother and child controls such as mother's education, age, gender, access to piped water, an indicator of being in a rural area, and year fixed effects; S_{vt} is our preferred measure of mining activity, cumulative gold production within 20 km of the household.[3]

Table E.2 shows the estimates of regression (E.2). In line with the increase in poverty, column 1 finds a reduction in the average weight of children under 5. This results suggests a direct effect on nutritional intake for children in affected areas. Columns 2 and 3 show no effect on indicators of height or incidence of diarrhea. This result may be driven by avoidance behavior of the local population. There is, for example, anecdotal evidence that the local population is aware of the location of contaminated water and avoids these sources of water (WACAM, 2010). Finally, column 4 shows a slight increase in acute respiratory diseases that might result from lower quality of air near mining sites.

[3]We obtain measures of distance to mines using coordinates of sampling clusters reported by the DHS. Note, however, that the DHS reports geographical coordinates with a random error of 5 km in rural areas and 2 km in urban areas. This introduces a measurement error that may attenuate the estimates.

Table E.2: *Mining, Child Nutrition and Health*

	Under 5 weight-for-age		Under 5 height-for-age		Diarrhea		Acute respiratory disease	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Ln(cumul. gold prod. within 20 km	-1.144		-1.099		0.001		0.004**	
	(1.049)		(1.084)		(0.003)		(0.002)	
Within 20 km of mine x post 2003		-26.407**		2.852		0.020		0.054*
		(12.570)		(14.785)		(0.032)		(0.031)
Observations	2,554	3,304	2,486	3,236	2,711	3,522	2,712	3,520
R-squared	0.047	0.039	0.206	0.190	0.047	0.048	0.041	0.033

Notes: Robust standard errors in parentheses. Standard errors are clustered at district level. * denotes significant at 10%, ** significant at 5% and *** significant at 1%. All regressions are estimated using OLS and include district and survey fixed effects, an indicator of being within 20 km of a mine, and mother and child controls. Mother and child controls include: mother education, child age and its square, child gender, access to piped water, and an indicator of being in a rural area.

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