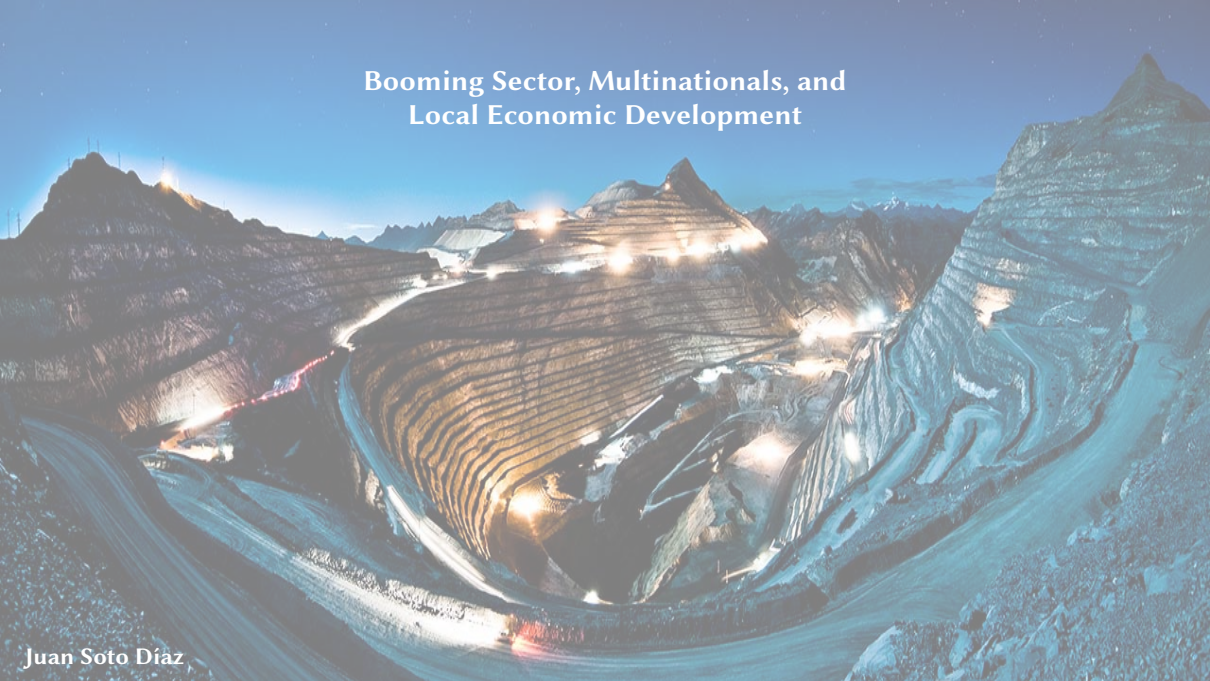
Booming Sector, Multinationals, and Local Economic Development



Juan Soto Díaz

- **Motivating context:**

1. Extractive industries are usually dominated by large **MNEs** integrated in global production networks
2. Incentives of MNEs and internationalization might imply low **linkages** of the sector with the local economy
3. This might reinforce the **"resource curse"** and hinder strategies of resource-based economic development

- **This paper:**
  1. Provides evidence of the **general equilibrium effects** of a resource boom and bust
  2. Characterizes the **heterogeneous impacts** between MNEs and Domestic firms in Local Labor Markets
  3. Formalizes the concept of **"modern enclave"** and highlight the relevance of local amenities

- **Methodology:**
  1. Incorporates MNEs into a **spatial equilibrium model** with "Dutch Disease" and productive linkages
  2. Identify the local economic impacts of mining activity by using variation from **predetermined geology**

- **Preview of (preliminary) empirical evidence:**

1. The resource boom increases local population, employment, wages and rents
2. Indicative evidence of multinationals having a larger effect on rents than domestic firms
3. The resource boom is inducing a decrease in manufacturing employment
4. No preliminary evidence of a loss of productivity spillovers (TFP)
5. Evidence of a decrease in relative social welfare with larger effects from multinationals

Outline of Talk

Introduction

Theory

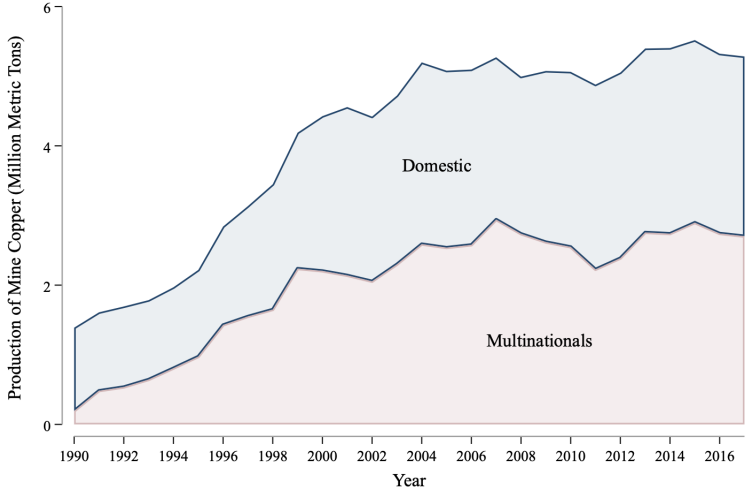
Data

Empirical Evidence

Conclusions

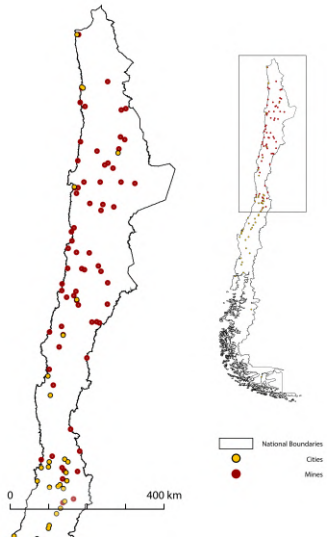
Background

Capacity Expansion of the Chilean Copper Industry



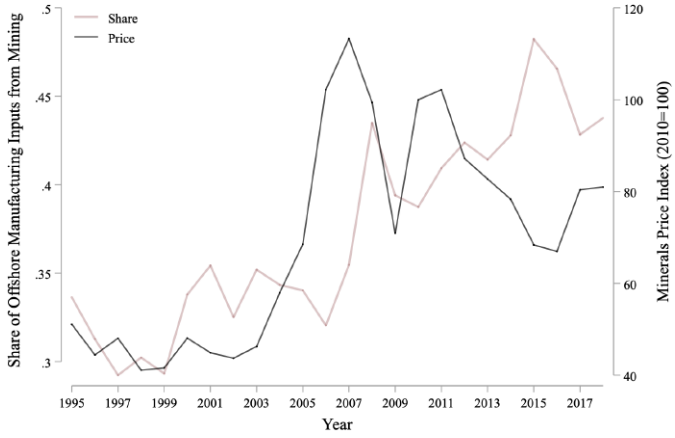
Background

Spatial Distribution of Cities and Mines



Background

Offshoring and the Mineral Price Boom



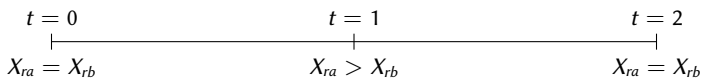
General setting

- Small open economy with two cities, indexed by $c \in \{a, b\}$ endowed with L_c amounts of labor
- Labor is imperfectly mobile across cities but perfectly mobile across sectors
- Three final goods sectors, indexed by $j \in \{m, l, r\}$
  - m tradable good (manufacturing)
  - l local (non-tradable) good (services)
  - r booming sector good (natural resources)
- One non-tradable differentiated intermediate goods sector z
- Two types of firms $k = \{DOM, MNC\}$ in each final good sector
  - Multinationals use more intensively intermediate goods than labor
  - Multinationals offshore a larger proportion of intermediate inputs
- One housing sector h, with absentee landlords, that does not require labor, with $P_{hc} = H_0 L_c^h$

The Resource Boom and Bust

A resource boom is modeled as an exogenous shock to the revenue productivity of r

- The revenue productivity of a final good sector j in city c is denoted by $X_{jc} \equiv P_{jc}A_{jc}$
- There are three time periods $t \in \{0, 1, 2\}$, where
  - $t = 0$ is the initial symmetric equilibrium, i.e. $X_{ra} = X_{rb}$
  - in $t = 1$, city a experiences a resource boom, i.e. $X_{ra} > X_{rb}$ (e.g., mine discovery or price boom)
  - in $t = 1$, the resource boom implies $X_{ra,t=1} > X_{ma,t=1}$
  - in $t = 2$, the resource boom ends (resource bust), and $X_{ra} = X_{rb}$



Production

- Production function can be expressed in the Dixit-Stiglitz-Ethier form, as

$$Q_{jc}^{k} = A_{jc}^{k}(\Omega_{jc}^{k})^{\eta_k}\left(\frac{L_{jc}^{k}}{\delta_k}\right)^{\delta_k}\left(\frac{L_{zjc}^{k}}{1-\delta_k}\right)^{1-\delta_k} \tag{1}$$

  where $\Omega_{jc} \equiv \lambda_{jc}^{k} N_{jc}^{k}$, $\lambda_{jc}^{k} \in (0,1)$, and $\eta_k \equiv \frac{(1-\delta_k)(1-\alpha)}{\alpha} = \frac{(1-\delta_k)}{\theta_k}$
- The production of multinationals and domestic firms vary in the input elasticities and domestic input demand
  - MNCs use more intensively intermediate goods ($\delta_{MNC} < \delta_{DOM} \Longrightarrow \eta_{MNC} > \eta_{DOM}$)
  - MNCs offshore a larger proportion of intermediate inputs ($\lambda_{jc}^{MNC} < \lambda_{jc}^{DOM}$)
- Productive linkages in each city are given by

$$L_{zc}^{k} = \alpha\left(\frac{1-\delta_k}{\delta_k}\right)\sum_{j} w_{jc}\lambda_{jc}^{k} L_{jc}^{k} \tag{2}$$

Agglomeration and Learning Externalities

- Physical productivity A_{jc} evolves over time due to *agglomeration effects* and *learning-by-doing* according to

$$A_{jct+1} = A_{jct}^{\psi_j} L_{ct}^{\Lambda} L_{jct}^{\phi_j} \zeta_j \tag{3}$$

  - Learning-by-doing imply that $\phi_j > 0$; i.e. sectors current productivity increases with sector past employment (equivalent to localization economies -sector-specific scale economies-)
  - Agglomeration spillovers imply that $\Lambda > 0$; i.e. sectors current productivity increases with past local population (equivalent to urbanization economies -cross-sectoral scale economies-)

Consumption

- Cobb-Douglass preferences over l, m, and h

$$U_{ic} = C_{il}^{\gamma} C_{im}^{o} H_i^{\varphi} B_c \epsilon_{ic} \tag{4}$$

- Budget constraint $p_{lc} C_{il} + C_{im} + r_c H_i = w_c$
- P_{lc} is endogenous, P_m is the numeraire and $r_c = H_0 L_c^h$
- The indirect utility is

$$U_{ic} = \frac{w_c B_c \epsilon_{ic} \kappa_u}{p_{lc}^{\gamma} r_c^{\varphi}} \tag{5}$$

where ϵ_{ic} is distributed type I extreme value with scale parameter ξ^2 with $\xi \in (0, \infty)$

Equilibrium

- Assuming spatial equilibrium $u_{ic} = \overline{u}$, *relative population* is

$$\log \hat{L} = \rho\tau \left(\log \hat{X}_n + (1+\eta) \log \hat{L}_n \right) + \gamma\tau \left(\log \frac{\hat{A}_l}{\hat{L}_l} - \eta \log \hat{L}_l \right) + \tau \log \hat{B} \tag{6}$$

- *Relative wages* are given by

$$\log \hat{w} = (1-\rho\tau) \left(\log \hat{X}_n + (1+\eta) \log \hat{L}_n \right) - \gamma\tau \left(\log \frac{\hat{A}_l}{\hat{L}_l} - \eta \log \hat{L}_l \right) - \tau \log \hat{B} \tag{7}$$

- And *relative housing rents* are

$$\log \hat{r} = \rho\tau h \left(\log \hat{X}_n + (1+\eta) \log \hat{L}_n \right) + \gamma\tau h \left(\log \frac{\hat{A}_l}{\hat{L}_l} - \eta \log \hat{L}_l \right) + \tau h \log \hat{B} \tag{8}$$

where $\hat{X}_n \equiv \lambda_{jc}^{\eta} \sum_{j=m,r} \hat{p}_j \hat{A}_j$

Long-term social welfare

- Relative social welfare, assuming that the social planner only focus on permanent residents, is

$$\log U_c = \sum_t \log U_{ct} = \sum_t \zeta^t \left(\log w_{ct} - \gamma \log p_{lct} - \varphi \log r_{ct} + \log B_{ct} \right) \tag{9}$$

In equilibrium, relative population is a sufficient statistic for welfare

$$\log \hat{U} = \sum_t \zeta^t \xi \log \hat{L}_t \tag{10}$$

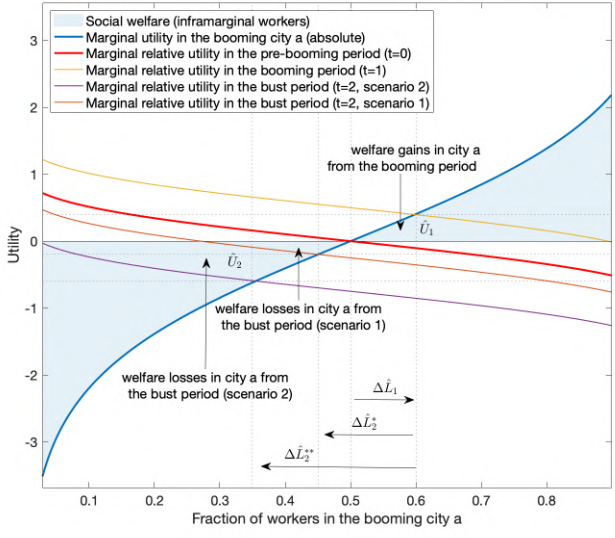
Booming Sector, Multinationals, and Local Economic Development

Table 1: **Qualitative Relative Predictions of a Resource Boom and Bust**

	Overall Effects	Comparison MNEs/Domestic
Booming Period (short-term)		
Population/Employment	↑	↓
Wages/Prices (non-tradables)	↑	↑
Manufacturing Employment (tradable)	↓	↓
Bust Period (long-term)		
Manufacturing Productivity (tradable)	↓	↑
Social Welfare	↓	↑

Note: social welfare effects assumes amenities negatively correlated with the boom.

Booming Sector, Multinationals, and Local Economic Development



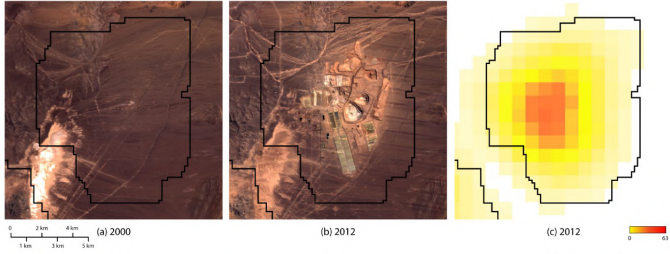
Data

- **Workers**
  - Households Surveys (cross section)
    - Chile: 2000, 2003, 2006, 2009, 2011, 2013
- **Firms**
  - National Tax Agency (cross section)
    - Chile: 2005-2015
  - Census of Manufactures (panel)
    - Chile: 2001-2007
- **Mines**
  - Mining Reports
  - Remote Sensing Data
    - LanSat L8-9, Sentinel

Measuring Local Exposure to Mining Activity

$$R_{ct} = \sum_{k} Q_{kt} \left(d_{c,k}\right)^{-1}$$

- Q_{kt} = nighttime lights by area of plants (proxy of production) of a mining site k, in year t
- $d_{c,k}$ = euclidean distance between a city c and a mining plant k



Validation Example

Empirical Strategy

$$\Delta \log Y_{ct} = \beta \log R_{ct-1} + \mathbf{X'}_{ct0}\gamma + \delta_t + \epsilon_{ct}$$

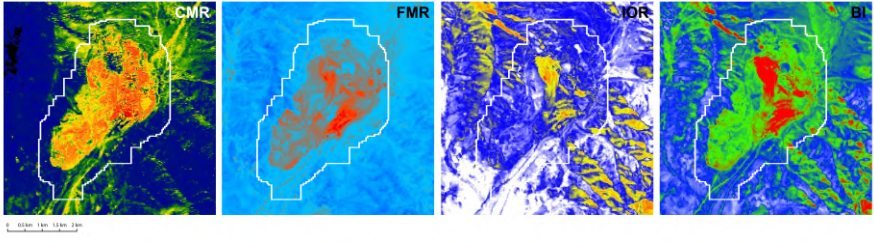
- Y_{ct} = population, employment, wages, rents, revenue, and tfp in the manufacturing sector
- R_{ct} = exposure to shocks in the mining sector
- δ_t = year fixed effects
- X_{ct} = is a vector of city/firms characteristics at the initial period
- standard errors are clustered at the regional level
- identification comes from:
  - variation in the concentration of minerals within mining plants, with first stage given by

$$\log R_{ct} = \rho \log(Minerals_{ct-1}) + \mu_{ct}$$

Instrumental Variable

$$Minerals_{ct} = P_{mt} \sum_{k} M_{ckt}$$

- P_{mt} = price of the mineral m in year t
- M_{ckt} = the intensity of mineral indices on plant k in year t (within 500km from a city c)
- Intensity of minerals in soil is measure as the median of the product of:
  - Clay Minerals Ratio (CMR)
  - Ferrous Minerals Ratio (FMR)
  - Iron Oxide Ratio (IOR)
  - Bare Soil Index (BI)



Empirical Evidence

1. Does the resource boom induced **local growth**?
   - The resource boom increases local population, employment, wages and rents $\Longrightarrow$
   - Indicative evidence of multinationals having a larger effect on rents than domestic firms $\Longrightarrow$
2. Does the **size and productivity** of the tradable sector (manufacturing) shrinks?
   - The resource boom is inducing a decrease in manufacturing employment $\Longrightarrow$
   - No preliminary evidence of a loss of productivity spillovers $\Longrightarrow$
3. Is the resource boom **welfare** improving?
   - Evidence of a decrease in relative social welfare with larger effects from multinationals $\Longrightarrow$

Does the resource boom induced local growth?

Relative effects on local labor markets

Table 2: **Relative Effects on Population and Employment**

	Change in Log Population						Change in Log Employment					
	Overall		Domestic		Multinationals		Overall		Domestic		Multinationals	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
Log Exposure	0.007	0.011	0.015	0.016	0.013	0.003	0.006	0.008	0.006	0.009	0.008	0.009
	(0.004)	(0.005)	(0.004)	(0.005)	(0.006)	(0.005)	(0.001)	(0.002)	(0.002)	(0.003)	(0.003)	(0.006)
Year FE + Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Adjusted R^2	0.093		0.140		0.102		0.145		0.144		0.144	
Observations	365	365	365	365	365	365	365	365	365	365	365	365
First-Stage:												
K-P F-stat		39.427		77.681		218.893		39.427		77.681		218.893
Mineral Intensity		0.792		0.628		0.514		0.792		0.628		0.514
		(0.126)		(0.071)		(0.035)		(0.126)		(0.071)		(0.035)

Note: Standard errors are clustered at the regional level. Years: 2000, 2003, 2006, 2009, 2011, 2013. All estimates include year fixed-effects and local controls.

Results

Does the resource boom induced local growth?

Relative effects on local labor markets

Table 3: **Relative Effects on Wages and Rents**

	Change in Log Wages						Change in Log Rents					
	Overall		Domestic		Multinationals		Overall		Domestic		Multinationals	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS	OLS	2SLS
Log Exposure	0.004	0.008	0.004	0.010	0.005	0.014	0.021	0.022	0.010	0.022	0.031	0.067
	(0.003)	(0.004)	(0.003)	(0.007)	(0.004)	(0.005)	(0.007)	(0.009)	(0.009)	(0.016)	(0.014)	(0.012)
Year FE + Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Adjusted R^2	0.785		0.785		0.785		0.757		0.900		0.901	
Observations	365	365	365	365	365	365	365	365	365	365	365	365
First-Stage:												
K-P F-stat		44.995		80.227		328.827		44.995		80.227		328.827
Mineral Intensity		0.791		0.627		0.510		0.791		0.627		0.510
		(0.118)		(0.070)		(0.028)		(0.118)		(0.070)		(0.028)

Note: Standard errors are clustered at the regional level. Years: 2000, 2003, 2006, 2009, 2011, 2013. All estimates include year fixed-effects and local controls.

Results

Relative Effects in the Labor Market

Local Sectoral Employment

Table 4: **Relative Heterogeneous Effects on Employment**

	Change in Log Employment											
	Manufacturing						Services					
	Overall		Domestic		Multinationals		Overall		Domestic		Multinationals	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS	(7) OLS	(8) 2SLS	(9) OLS	(10) 2SLS	(11) OLS	(12) 2SLS
Log Exposure	-0.011	-0.039	-0.027	-0.038	-0.020	-0.053	0.010	0.012	0.016	0.013	0.017	0.003
	(0.010)	(0.020)	(0.017)	(0.022)	(0.014)	(0.022)	(0.006)	(0.009)	(0.009)	(0.014)	(0.010)	(0.011)
Year FE + Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Adjusted R^2	0.198		0.200		0.198		0.108		0.109		0.108	
Observations	365	365	365	365	365	365	365	365	365	365	365	365
First-Stage:												
K-P F-stat		39.427		77.681		218.893		39.427		77.681		218.893
Mineral Intensity		0.792		0.628		0.514		0.792		0.628		0.514
		(0.126)		(0.071)		(0.035)		(0.126)		(0.071)		(0.035)

Note: Standard errors are clustered at the regional level. Years: 2000, 2003, 2006, 2009, 2011, 2013. All estimates include year fixed-effects and local controls.

Results

Relative Effects in Productivity

Aggregate Local Sectoral Productivity

Table 5: **Relative Heterogeneous Effects on Aggregate Revenue**

	Change in Log Revenue											
	Manufacturing						Services					
	Overall		Domestic		Multinationals		Overall		Domestic		Multinationals	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS	(7) OLS	(8) 2SLS	(9) OLS	(10) 2SLS	(11) OLS	(12) 2SLS
Log Exposure	0.052	0.055	0.078	0.023	0.097	0.095	0.139	0.166	0.183	0.192	0.217	0.157
	(0.030)	(0.046)	(0.055)	(0.061)	(0.052)	(0.048)	(0.047)	(0.058)	(0.040)	(0.058)	(0.055)	(0.061)
Year FE + Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Adjusted R^2	0.133		0.139		0.137		0.203		0.230		0.209	
Observations	365	365	365	365	365	365	365	365	365	365	365	365
First-Stage:												
K-P F-stat		39.875		53.598		119.803		39.875		53.598		119.803
Mineral Intensity		0.751		0.584		0.548		0.751		0.584		0.548
		(0.119)		(0.080)		(0.050)		(0.119)		(0.080)		(0.050)

Note: Standard errors are clustered at the regional level. Years: 2000, 2003, 2006, 2009, 2011, 2013. All estimates include year fixed-effects and local controls.

Results

Relative Effects on Productivity

Firm Level TFP

Table 6: **Relative Effects on the Productivity of Manufacturing Firms**

	Change in Log TFP											
							Olley-Pakes method					
	Overall		Domestic		Multinationals		Overall		Domestic		Multinationals	
	(1) OLS	(2) 2SLS	(3) OLS	(4) 2SLS	(5) OLS	(6) 2SLS	(7) OLS	(8) 2SLS	(9) OLS	(10) 2SLS	(11) OLS	(12) 2SLS
Log Exposure	0.060	0.088	0.078	0.023	0.097	0.095	0.048	0.051	0.025	0.017	0.075	0.067
	(0.028)	(0.033)	(0.055)	(0.061)	(0.052)	(0.048)	(0.027)	(0.031)	(0.020)	(0.022)	(0.030)	(0.036)
Year FE + Controls	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Adjusted R^2	0.037		0.139		0.137		0.030		0.029		0.029	
Observations	2,215	2,215	2,215	2,215	2,215	2,215	2,215	2,215	2,215	2,215	2,215	2,215
First-Stage:												
K-P F-stat		17.762		112.169		112.169		17.762		112.169		112.169
Mineral Intensity		0.333		0.525		0.525		0.333		0.525		0.525
		(0.079)		(0.050)		(0.050)		(0.079)		(0.050)		(0.050)

Note: Standard errors are clustered at the regional level. Years: 2000, 2003, 2006, 2009, 2011, 2013. All estimates include year fixed-effects and local controls.

Relative Effects on Welfare

$$\hat{W} = \frac{1}{14} \sum_{t=2000}^{T=2013} \left[\Delta \log R_t \left(T - t + 1 \right) \left(\hat{\beta}_{wage} - 0.3 \hat{\beta}_{rent} - \hat{\beta}_{amenity} \right) \right]$$

Table 7: **Relative Welfare Effects**

	(1)		(2)		(3)	
	Aggregate Effect		Induced by Domestic Firms		Induced by Multinationals	
	OLS	2SLS	OLS	2SLS	OLS	2SLS
Wage elasticity	0.004	0.008	0.004	0.010	0.005	0.014
	(0.003)	(0.004)	(0.003)	(0.007)	(0.004)	(0.005)
Rent elasticity	0.021	0.022	0.010	0.022	0.031	0.067
	(0.007)	(0.009)	(0.009)	(0.016)	(0.014)	(0.012)
$\hat{\beta}_{wage} - 0.3\hat{\beta}_{rent}$	-0.002	0.002	0.000	0.004	-0.004	-0.006
Annual average real wage (log points)	-0.002	0.002	0.000	0.002	-0.005	-0.007
Population elasticity	0.007	0.011	0.015	0.016	0.013	0.003
	(0.004)	(0.005)	(0.004)	(0.005)	(0.006)	(0.005)
Annual average population gain (log points)	0.003	0.005	0.001	0.001	0.008	0.002

Note: Period 2000-2013. Cities 73.

Conclusions

- Multinationals might reinforce the local negative impacts of a resource boom
  - Although preliminary evidence suggest that MNEs also induce positive productivity spillovers
- This could lead to an equilibrium with enclave characteristics (local growth with limited welfare gains), which might justify policies such as
  - Protection of the lagging sector
  - Investment in local amenities (welfare compensation)
  - An heterogeneous taxation scheme between MNEs and domestic firms
- The evidence seems to be consistent with the hypothesis of a modern enclave generated by the mining sector
- However, there is no preliminary evidence suggesting that multinational mining companies foster the enclave equilibrium more than domestic firms

Back-Up Slides

Booming Sector, Multinationals, and Local Economic Development

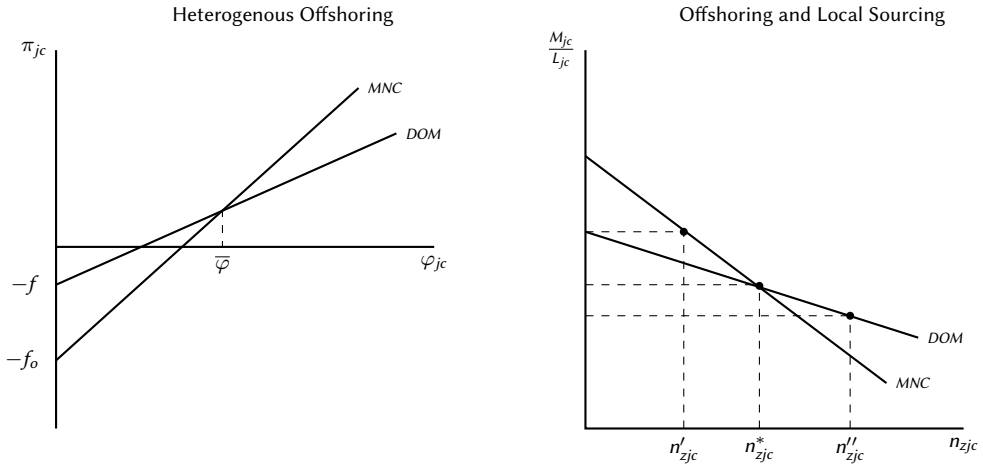


Figure 1: **Patterns of Offshoring in local labor markets**

Booming Sector, Multinationals, and Local Economic Development

A **"modern enclave"** equilibrium is characterized by

1. Local Dutch Disease
2. Limited local productive linkages
3. Loss of productivity spillovers
4. Amenities negatively correlated with the boom

Measuring Local Exposure to Mining Activity

Validation

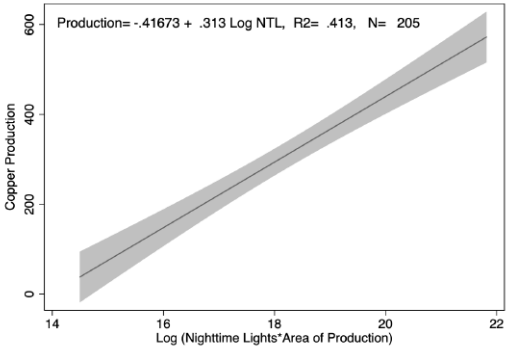


Figure 2: Individual Plant Production

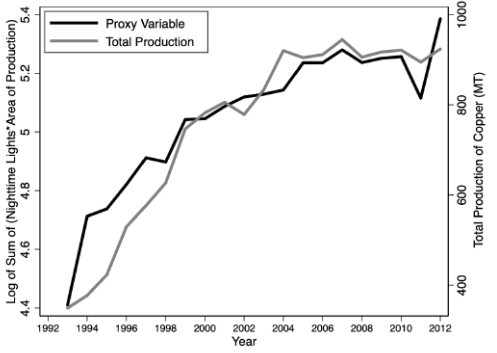


Figure 3: Total Annual Production

Instrumental Variable

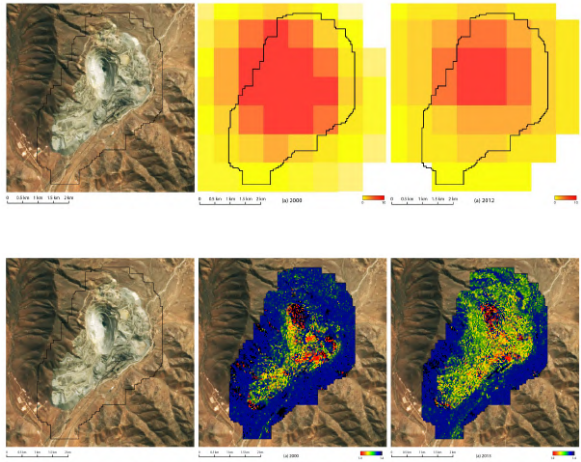


Figure 4: Illustration of Nighttime Lights and Spectral Indices for El Romeral, Iron Mine

Relative Effects in the Labor Market

Local Population and Employment

$$\log Y_{ct} = \beta \log R_{ct-1} + \mathbf{X'}_{ct0}\gamma + \delta_t + \epsilon_{ct}$$

Table 8: **Relative Effects in Local Population and Employment**

	Change in Log Population				Change in Log Employment			
	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) OLS	(6) OLS	(7) OLS	(8) 2SLS
Log Exposure	0.008	0.018	0.007	0.011	0.004	0.005	0.006	0.008
	(0.004)	(0.005)	(0.004)	(0.005)	(0.002)	(0.001)	(0.001)	(0.002)
Year FE		✓	✓	✓		✓	✓	✓
Local Controls			✓	✓			✓	✓
Adjusted R^2	0.028	0.133	0.093		0.000	0.147	0.145	
Observations	365	365	365	365	365	365	365	365
First-Stage:								
K-P F-stat				39.427				39.427
Mineral Intensity				0.792 (0.126)				0.792 (0.126)

Note: Standard errors are clustered at the regional level. Years: 2000, 2003, 2006, 2009, 2011, 2013.

Results

Table 9: **Heterogeneous Effects on Population and Employment**

Panel a) Effect from Domestic Mining Companies:								
	Change in Log Population				Change in Log Employment			
	(1) OLS	(2) OLS	(3) OLS	(4) 2SLS	(5) OLS	(6) OLS	(7) OLS	(8) 2SLS
Log Exposure	0.017	0.016	0.015	0.016	0.003	0.006	0.006	0.009
	(0.004)	(0.005)	(0.004)	(0.005)	(0.002)	(0.002)	(0.002)	(0.003)
Year FE		✓	✓	✓		✓	✓	✓
Local Controls			✓	✓			✓	✓
Adjusted R^2	0.079	0.106	0.140		-0.002	0.148	0.144	
Observations	365	365	365	365	365	365	365	365
First-Stage:								
K-P F-stat				77.681				77.681
Mineral Concentration				0.628 (0.071)				0.628 (0.071)
Panel b) Effect from Multinationals Mining Companies:								
	Change in Log Population				Change in Log Employment			
	(9) OLS	(10) OLS	(11) OLS	(12) 2SLS	(13) OLS	(14) OLS	(15) OLS	(16) 2SLS
Log Exposure	0.012	0.015	0.013	0.003	0.003	0.007	0.008	0.009
	(0.004)	(0.005)	(0.006)	(0.005)	(0.003)	(0.002)	(0.003)	(0.006)
Year FE		✓	✓	✓		✓	✓	✓
Local Controls			✓	✓			✓	✓
Adjusted R^2	0.029	0.069	0.102		-0.002	0.147	0.144	
Observations	365	365	365	365	365	365	365	365
First-Stage:								
K-P F-stat				218.893				218.893
Mineral Concentration				0.514 (0.035)				0.514 (0.035)

Note: Standard errors are clustered at the regional level. Years: 2000, 2003, 2006, 2009, 2011, 2013. Cities: 73.