Firms, Policies, Informality, and the Labor Market

Camila Cisneros-Acevedo[a]   Alessandro Ruggieri[b]

[a]University of Tübingen

[b]University of Nottingham

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Outline

Introduction

- Over 60 percent of workers in the world operate in the informal economy
  - Informality accounts for accounts for 35% of GDP in developing countries
  - Unproductive firms and low-paying jobs

$\Rightarrow$ Policy prescription: Reduce tax and regulatory burden on firms
  (De Soto 1989, Lagarde 2019)

- We focus on **Corporate Income Tax**
  - 15.4% of tax revenues in LACs, 10% in OECD countries, up to 25% in very low-income countries (OECD, 2018)
  - It correlates negatively with economic growth (Lee and Gordon 2005)
  - It is a major cause of informality (Perry 2007, Waseem 2018)

- **What is the effect of a reduction on corporate tax on informality (in registered and unregistered firms)?**

This Paper

1. Cross-country evidence (low - and middle income countries):
   - Informality is higher in countries with high corporate tax rates.
   - Unemployment and GDP per worker are lower in countries with high corporate tax rates.

2. We build a model of firm dynamics to interpret this evidence
   - Two sectors: self-employment vs wage-employment.
   - Search frictions into wage-employment.
   - Heterogeneous firms subject to imperfectly enforced regulation.
   - Informality along the extensive and the intensive margins.

3. We estimate the model using firm and worker-level data from Peru
   - 70% of the working age population employed informally.
   - Data availability on both margins of informality.

4. Counterfactual: Reduction in corporate taxes
   - Informality increases
   - Increase in productivity and lower aggregate prices
   - Jobs become scarcer

Reduction in Corporate tax: Two major mechanisms

1- Reallocation effect

- Increase Revenues in formal firms relative to informal firms.
    - Increase in the share of registered firms:
      ↓ Extensive margin of informality
    - Registered firms expand and change their composition towards formal workers (it is less expensive to create formal jobs):
      ↓ Intensive margin of informality
    - ⇒ **Reduction in Informality**

- Formal firms charge lower prices
    - Higher competition forces low-productivity informal firms to exit the market
    - Reallocation of employment from low-productivity to high-productivity firms
    - ⇒ **Increase in GDP per worker**

Reduction in Corporate tax: Two major mechanisms

2- Scale effect

- Because jobs become more formal: Average wage increases
- In eq., jobs concentrate on less firms (larger and more productive).
- Increase in labor market tightness: Less vacancies per number of unemployed workers
- Less matches

$\Rightarrow$ **Increase in Unemployment.**

Outline

Data

- Corporate taxes (Tax Foundation): Standard statutory corporate income tax rates levied on domestic businesses.

- Informality rate (ILO-stat): Own-account workers, contributing family workers, employees holding informal jobs.

- Unemployment rate (World-Bank): working age workers who are not in employment, or carry out activities to seek employment, or available to take up employment given a job opportunity.

- Real GDP per worker- *proxy aggregate productivity*, 2017 USD (World-Bank)

- Total Factor productivity - production side (Penn World Table)

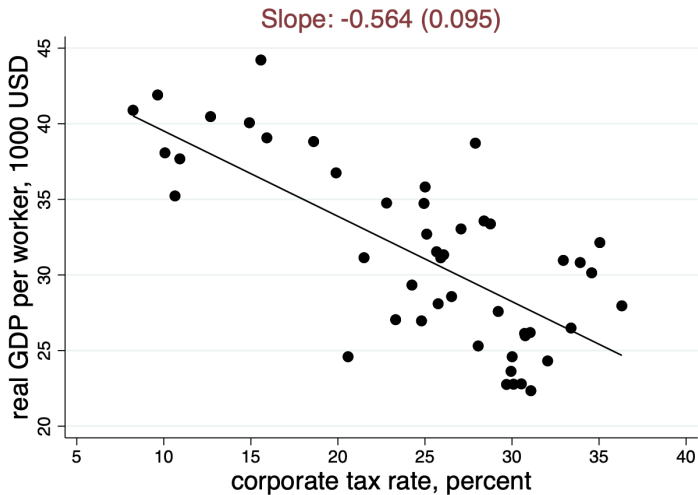- **Coverage:** 75 countries, 2010-2021: 1552 country-year observations
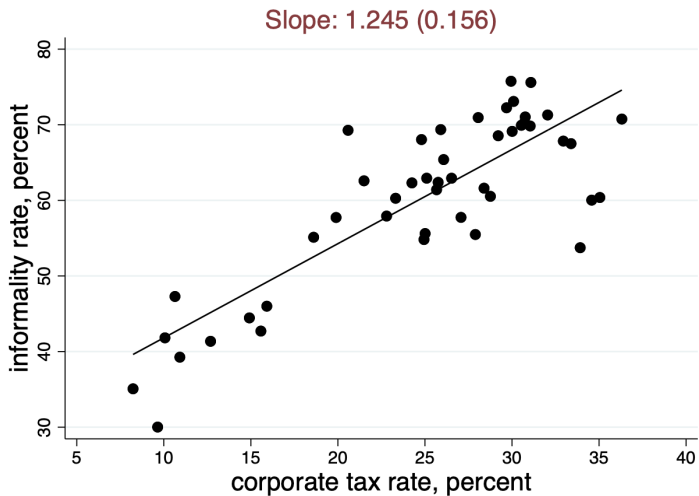
Summary statistics
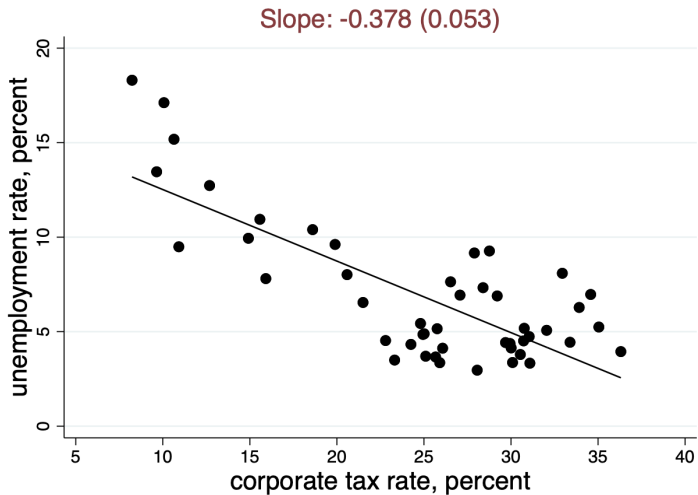
Real GDP per worker across countries ●

Slope: -0.564 (0.095)

Evidence

- Countries with higher corporate income tax rates have:
    - Higher informality employment
    - Lower unemployment rate
    - Lower GDP per worker

- Robustness:
    - Alternative measures of informality ●
    - Alternative measures of aggregate productivity ●
    - Country-specific unobserved heterogeneity ●

Outline

The Model: Key Elements

- Endogeneous firm dynamics (Restuccia and Rogerson, 2008)
  - Smaller firms in low-income countries (Bento and Restuccia, 2018)
  - Corporate income tax as a source of misallocation (Erosa and Gonzales, 2020)

- Search friction in the labor market (Bertola and Caballero, 1994)
  - Poorly functioning labor market in developing countries (Lagakos, 2020; Abebe et al., 2021; Amodio et al., 2022)
  - Frictions vary with development (Poschke, 2019; Martellini and Menzio, 2020)

- Informality along the extensive and intensive margins
  - Informality as a buffer against labor market shocks (Ulyssea and Ponczek, 2018; Dix-Carneiro and Kovac, 2019)
  - Two margins of informality (Ulyssea, 2020; Cisneros-Acevedo, 2022)

The Model: Firms and Workers-Consumers

Firms

- Ex-ante heterogenous in productivity, z, and cost of operating formally, c_f.
- Produce differentiated varieties, ω, subject to monopolistic competition.
- Decision to register:
    - If unregistered: They only hire workers off-the-books *(extensive margin)*.
        - They face per-worker expected cost of informality, $\kappa_i(z)$
    - If registered: They can hire workers formally and informally *(intensive margin)*.
        - They are subject to taxes on corporate income, τ_y
        - Formal hires: Payroll tax, τ_w
        - Informal hires: Expected cost of informality, $\kappa_f(z, \ell_i, \ell_f)$

Workers: Homogeneous and risk-neutral

- Infinitely lived
- Ex ante homogeneous but differ in their employment status: unemployed, self-employed or wage employed
    - If wage-employed: formal, intensive-informal or extensive-informal.

Production

- **Self-employed:** The homogeneous good is produced outside the industrial sector. The technology is linear in labor,

$$y_o = A_o L_o$$

where A_o is an exogenous productivity shifter

- **Industrial firms'** technology to produce differentiated varieties, $\omega \in [0, M]$:

$$\begin{cases} q_i(z, \ell_i) = Az\ell_i & \text{if unregistered} \\ q_f(z, \ell_i, \ell_f) = Az(\ell_i + \ell_f) & \text{if registered} \end{cases} \tag{1}$$

where A is an exogenous productivity shifter and ℓ_i and ℓ_f denote informal and formal workers

- Industrial firms' revenues:

$$\begin{cases} R_i(z, \ell_i) = D^{\frac{1}{\sigma}} y_i(z, \ell_i)^{\frac{\sigma-1}{\sigma}} & \text{if unregistered} \\ R_f(z, \ell_i, \ell_f) = D^{\frac{1}{\sigma}} y_f(z, \ell_i, \ell_f)^{\frac{\sigma-1}{\sigma}} & \text{if registered} \end{cases} \tag{2}$$

where $\sigma > 1$ is the elasticity of substitution between varieties and $D = P^{\sigma-1} \alpha \int_0^1 I_j dj$ is an aggregate demand shifter.

Preferences

Labor market

Jobless workers have the option of searching for a wage and salary job:

- **If they do not search**
  - Self-employed: Provide labor for the production of homogeneous good
  - They earn their marginal product, $w_o = A_o$

- **If they search**, they face search and matching frictions
  - The total number of matches that are formed each period,

$$m(V, U) = \frac{VU}{(V^\eta + U^\eta)^{\frac{1}{\eta}}} \qquad \eta > 0$$

  where U denotes workers searching for jobs, and $V = V_{ii} + V_{fi} + V_{ff}$ with V_{ii}, V_{fi} and V_{ff} are measures of informal and formal vacancies posted by unregistered and registered firms, respectively.

- Probability of filling a vacancy: $\phi = \frac{m(U,V)}{V}$
- Probability of finding a job: $\tilde{\phi} = \frac{m(U,V)}{U}$

Workers' Problem

Labor market

- Workers who get matched with a firm
  - Bargaining stage to determine the wage rate
- Workers who fail to match
  - Unemployed $\rightarrow$ Obtain a benefit, b

At the end of the matching process, the population of workers is split:

1. Unemployed: L_u
2. Employed in the outside sector (self-employed): L_o
3. Wage-employed in formal and informal firms: L_e
   $\hookrightarrow$ Ways to lose their jobs:
   -Exogenous separation shock (workers quit or get fired): δ_w
   -Unregistered firm exit: δ_i
   -Registered firm exit: δ_f

Workers' Timeline

Firms' employment decision: Informality costs

- **Unregistered firms** forego corporate and payroll taxes but they face an expected cost of informality: ●

$$\kappa_i(z) = \gamma_0 z^{\gamma_1} \qquad \gamma_0 > 0, \gamma_1 > 0$$

$\Rightarrow$ We assume the expected cost of informality per worker to be increasing in the productivity of the firm: It will be more expensive for more productive firms to hire an extra informal worker.

- **Registered firms** trade-off payroll taxes on formal workers with an expected cost of informality: ●

$$\kappa_f(z, \ell_i, \ell_f) = \gamma_2 z^{\gamma_3} \left(\frac{\ell_i}{\ell_i + \ell_f} \right)^{\gamma_4}$$

$\Rightarrow$ We assume that the cost is increasing in the number of informal workers, and decreasing with the total number of workers: More productive firms and firms with a high share of informal employment, will find it more costly to hire an extra informal worker.

Firms Decision

Firms: Registration decision

1. Potential employers draw their productivity, z, from distribution $\psi_z(z)$.
2. Decide whether to start their business or not.
3. After entry, employers draw an idiosyncratic cost, c_f, from a distribution ψ_c.
4. Decide whether to pay the cost and operate as a formal business, or stay informal and forgo the cost.

The value of operating is equal to:

$$\mathcal{V}(z) = \int_{c_f \in \mathcal{C}} \max\{\mathcal{V}_i(z), \mathcal{V}_f(z) - c_f\}\psi_c(c_f)dc_f$$

where $\mathcal{V}_i(z)$ and $\mathcal{V}_f(z)$ are the value of entering the industry for an unregistered and registered firm, respectively.

Entry decision: Free-entry condition

$$\mathcal{V}^e = \int_{z \in \mathcal{Z}} \max\{\mathcal{V}(z), 0\} \psi_z(z) dz \leq c_e$$

where c_e denotes a fixed cost of entry

- It holds with equality if the mass of entrants is strictly positive.
- A solution to this problem is a pair of thresholds, (z^*, c_f^*) which partitions the space of productivity and costs into three groups:
    - firms who do not enter
    - firms entering without registering
    - firms entering and registering.

Wage Bargaining

- Assumptions:
  - Workers collectively bargain with their employer after matching has taken place and the labor market has already closed.
  - If an agreement between the firm and the worker is not reached, the worker remains unemployed in the current period.
  - Production delay is the only credible threat $\Rightarrow$ Current-period payoffs the only relevant payoffs to split (Binmore et al. 1986)

- Wage of informal workers in unregistered firms:
$$w_i(z, \ell_i) = (1 - \zeta_i)b + \zeta_i \frac{R_i(z, \ell_i)}{\ell_i}$$

- Wage of informal workers in registered firms:
$$w_i(z, \ell_i, \ell_f) = (1 - \zeta_i)b + \zeta_i(1 - \tau_y) \frac{R_f(z, \ell_i, \ell_f)}{\ell_i + \ell_f}$$

- Wage of formal workers:
$$w_f(z, \ell_i, \ell_f) = \frac{(1 - \zeta_f)}{(1 - \zeta_f \tau_w^f)} b + \frac{\zeta_f}{(1 - \zeta_f \tau_w^f)}(1 - \tau_y) \frac{R_f(z, \ell_i, \ell_f)}{\ell_i + \ell_f}$$

where b denotes unemployment benefits, while ζ_i and ζ_f are informal and formal workers' bargaining powers

Outline

Data

Datasets	Years	Source
National Household Survey (ENAHO)	2007-2014	Peruvian National Institute of Statistics (INEI)
Enterprise Survey (ES)	2006, 2010, 2017	World-Bank
Informal Enterprise Survey (IFS)	2010	World-Bank

- Sample selection: 25-60 years old, wage-employees in non-military occupations, reporting positive hours worked and not self-employed.

- Formal companies defined as those registered with the Peruvian Tax Collection Agency (SUNAT)

- Informal workers:
  - *Extensive margin* - Those who declare to be employed by a firm that does not keep books in the online platform or software required by SUNAT.
  - *Intensive margin* - Salaried workers in registered firms who declare i) SUNAT does not deduct their income in any way and ii) employers do not pay health insurance on their behalf.

Informality in Peru

Facts that we target in the estimation procedure:

- **Fact 1** - More than 60% of wage and salary employment in Peru is informal. One-third of it is made of informal workers employed in registered firms ●

- **Fact 2** - Informal workers are more likely to be employed in smaller firms. The share of informal workers in registered firms declines with firm size ●

- **Fact 3** - Formal firms are more productive than informal firms ●

- **Fact 4** - Formal workers are paid on average higher wages than informal workers, even among workers in registered firms ●

Outline

Estimation

- Functional form:
  - Productivity distribution: $z \sim \log\mathcal{N}(0, \varphi_z)$, with $\varphi_z > 0$
  - Registration cost distribution: $c_f \sim \mathcal{U}(0, \overline{c_f})$, with $\overline{c}_f > 0$
- 9 parameters calibrated outside the model ●
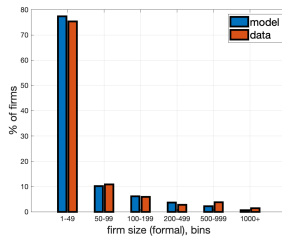- 15 parameters estimated using method of simulating moments ●

$$\vartheta := \{A_o, c_e, \overline{c_f}, c_v^i, c_v^f, \gamma_0, \gamma_1, \gamma_2, \gamma_3, \gamma_4, \alpha, \varphi_z, \zeta_i, \zeta_f, \eta\}$$

  - A_o: self-employment efficiency
  - c_e: entry cost
  - $\overline{c_f}$: registration cost, upper bound
  - c_v^i, c_v^f: vacancy costs, informal and formal
  - $\gamma_0, \gamma_1, \gamma_2, \gamma_3, \gamma_4$:: informality costs
  - α: consumption share
  - φ_z: productivity dispersion
  - ζ_i, ζ_f: bargaining power
  - η: matching elasticity, informal and formal

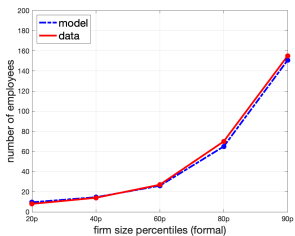- 40 worker- and firm-level targets ●, non-targeted moments ●
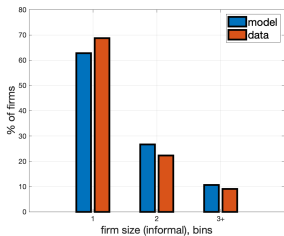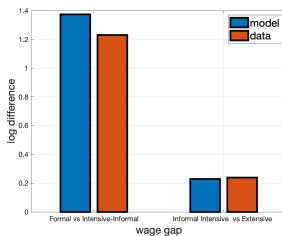
Informal firms, distribution — Formal firms, distribution — Formal firms, size percentiles — Earnings gap

Model Fit

The model captures:

- Informal firms are significantly smaller, the majority being composed of one or two workers.
- Formal firms are larger, and more than 10 percent of those have more than 100 employees.
- Share of intensive-informal within registered firms declines with firm size.
- Differences in wages across formal and informal workers.
- Wage gap between informal workers employed in registered firms relative to formal workers.

Outline

Counterfactual: Corporate Tax Reform

- We construct counterfactual economies that differ from the benchmark only in their corporate tax rate, τ_y.
- All other parameters remain fixed to their benchmark values.

- Each of these economies provides us with measures of
  - Informal employment
  - Unemployment
  - GDP per worker
- We compare these measures to the data.

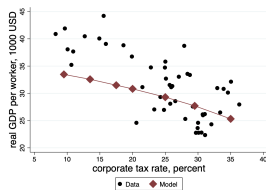# Counterfactual Corporate Tax Reform
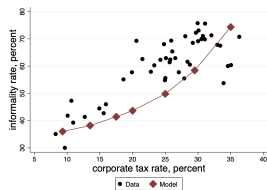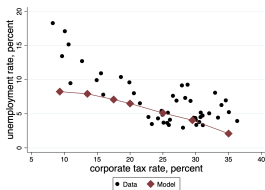
(a) Informality rate   (b) Unemployment rate   (c) Real GDP per worker

- Informal employment goes down with corporate taxes
  - Firms choose to register
  - Registered firms choose to hire formally.
- Reduction of corporate tax Increases GDP per worker in the model
  - Reallocation of jobs from low-productivity informal firms to high-productivity formal firms.

Mechanism: Reallocation of Firms
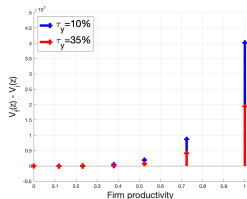
(d) Value of registering   (e) Formality threshold   (f) Informal firms
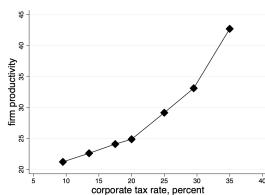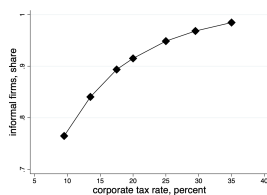
- Reduction in corporate income taxes increases the value of operating as a registered business against the value of operating informally (Figure d).

- But due to the tax relief: Low-productivity firms can cover the cost of formalization

- Then, Reduction in corporate tax from 35% to 10%:
    - Average productivity threshold above which firms become formal drops (Figure e)
    - The share of informal firms declines by more than 20 percentage points (Figure f)

Mechanism: Reallocation of jobs
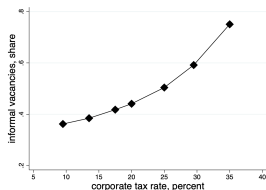
(g) Informal jobs, overall   (h) Informal jobs, extensive   (i) Informal jobs, intensive
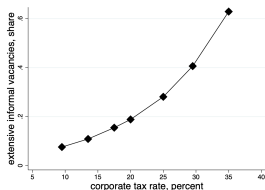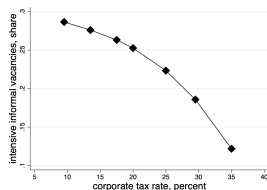
Reduction in corporate tax from 35% to 10%:

- Reduces the overall share of informal vacancies by more than 50 percentage points, from 75% to 36%.
  - Formalization of jobs along the extensive margin.
  - Increases share of intensive-informal employment, but not enough the overturn the trend.

Efficiency and prices
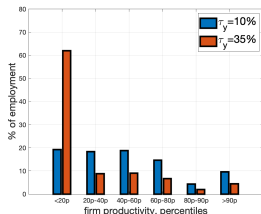
(j) Employment distribution
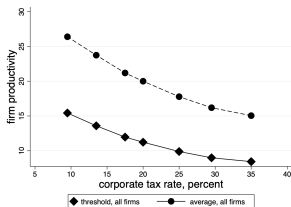
(k) Firm productivity
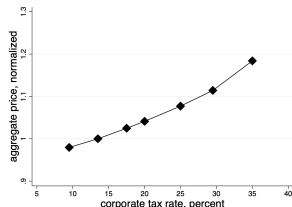
(l) Aggregate price index

- High-productivity (formal) firms charge a lower price and expand:
  Workers reallocate to high-productivity firms .

- Low-productivity (informal) firms driven out of the industry:
  The productivity threshold for incumbent firms rises, which makes aggregate productivity increase.

- Employment reallocation increases efficiency and lowers aggregate price.

Concentration in the labor market
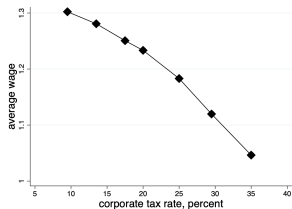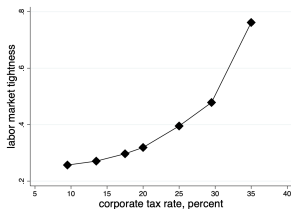
(m) Wage ratio   (n) Market tightness   (o) Measure of firms
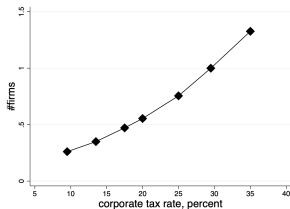
- Lower corporate taxes increase the average wage earnings, relative to earnings in self-employment
- No-arbitrage condition forces market tightness to adjust: Less vacancies per number of unemployed workers
- Employment concentrates on a smaller share of firms and jobs becomes scarcer

What else?

- Other Counterfactuals
  - How does informality interact with corporate taxes? ●
  - Differences in technologies across countries. ●

- Alternative Policies interventions ●
- Welfare Gains ●

Conclusion

- We study the distributional consequence of firm-level taxes reform in developing countries.

- We document how labor market outcomes vary with corporate income tax rates across countries.

- We build a two-sector model of firm dynamics with search frictions and informality along the intensive and extensive margin.

- We show that lower corporate income taxes induce:
    - Reallocation of jobs from low- to high-productivity firms: $\uparrow$ Productivity.
    - Reduces informality.
    - Increases unemployment.

- The model allows us to study the distributional implications of various firm- and labor-market policy interventions aiming at tackling informality along the extensive and intensive margins.

APPENDIX

Outline

Summary statistics

	Obs	Mean	St.dev.	Min	Max
GDP per capita, 2017 USD	1552	5677.28	3897.49	370.301	16950.3
GDP per worker, 2017 USD	1552	31124.1	16035.1	2583.41	72420.6
TFP, PPP (US=100)	800	59.1	19.1	23.3	124.9
Corporate tax rate, %	1552	24.9	7.36	9.21	38.5
Informality rate, %	367	60.4	21.6	9.90	96.9
Unemployment rate, %	735	6.88	6.22	0.21	29.3

- Yearly GDP per capita (at 2017 price level): 5,677 USD.
  - The poorest, Malawi: GDP per capita= 1 USD per day (370 USD yearly).
  - The richest, Barbados: GDP per capita = 16,950 USD.
- GDP per worker - standard measure of aggregate productivity.
  - Analogous measure for the US in 2021 = 134,363 USD (4.3 times larger than average).
- Average TFP= 60% of the value for the US.
- Informality: Highest in sub-Saharan countries (e.g. Benin, Chad, and Mali).
- Unemployment: Heterogeneous across countries. It is almost zero in Cambodia and Myanmar.

Back

Informality across countries
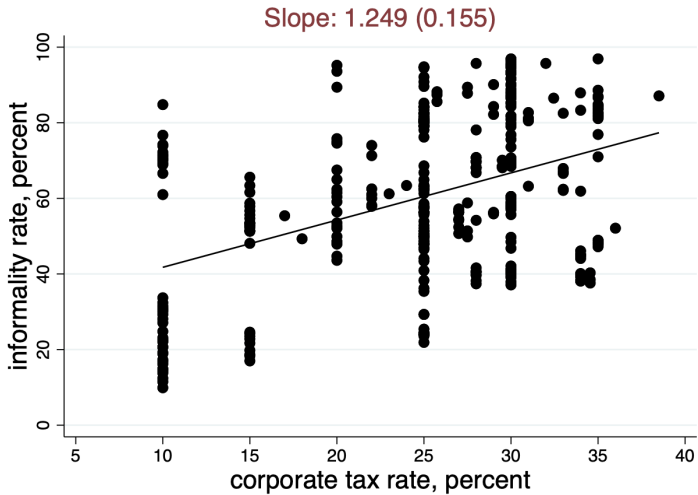
Unemployment across countries

GDP per worker across countries

Slope: -0.577 (0.095)
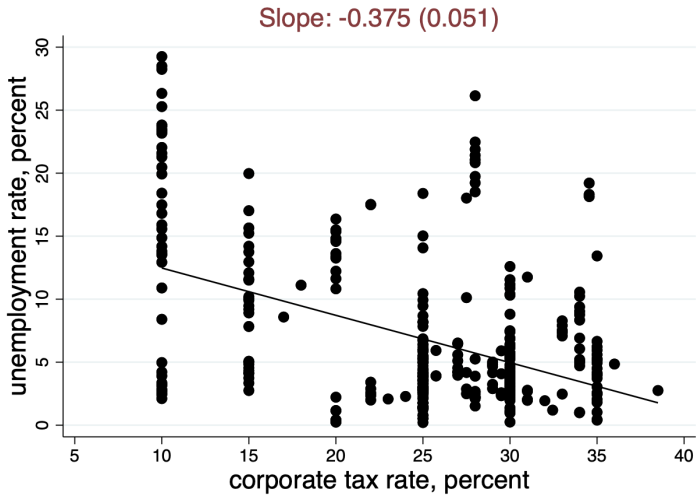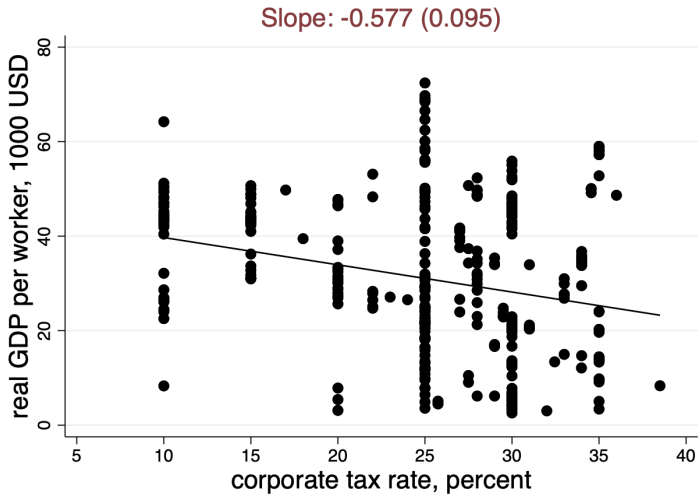
Firms formally registered when they started operations
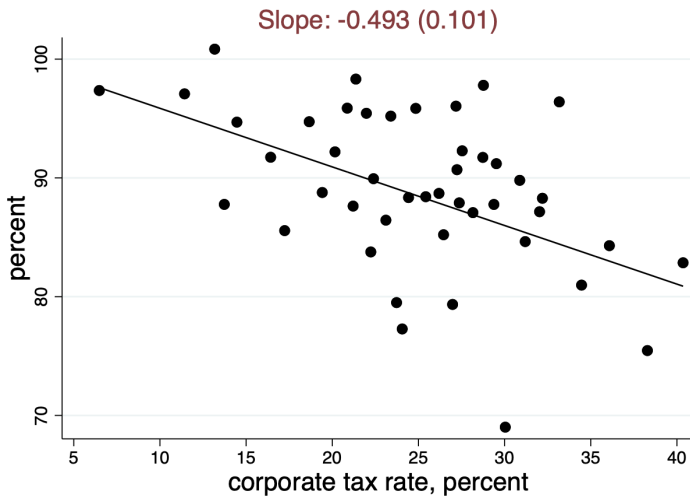
Employed workers covered by social security

Slope: -1.253 (0.417)

Total factor productivity

Country unobserved heterogeneity

	Informal employment, %			Formal firms that started informally, %			Employed workers w/o social security, %		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Corporate tax rate, τ_{it}	0.301*	0.280	0.290	-0.316***	-0.272***	-0.242*	-0.632*	-0.548	-0.615
	(0.174)	(0.174)	(0.177)	(0.120)	(0.121)	(0.128)	(0.341)	(0.379)	(0.396)
Observations	370	370	370	139	139	139	132	132	132
R-squared	0.370	0.394	0.397	0.256	0.277	0.299	0.354	0.393	0.417
Continent FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Time FE		✓	✓		✓	✓		✓	✓
Continent trend			✓			✓			✓

	Unemployment rate			Real GDP p.w. (1000 USD)			Real TFP (US=100)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Corporate tax rate, τ_{it}	-0.164***	-0.168***	-0.167***	-0.338***	-0.331***	-0.336***	-1.058***	-1.067***	-1.070**
	(0.0355)	(0.0366)	(0.0362)	(0.0840)	(0.0838)	(0.0834)	(0.166)	(0.167)	(0.167)
Observations	735	735	735	1552	1552	1552	800	800	800
R-squared	0.272	0.279	0.316	0.306	0.307	0.311	0.142	0.145	0.146
Continent FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Time FE		✓	✓		✓	✓		✓	✓
Continent trend			✓			✓			✓

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Country unobserved heterogeneity

	Informal employment, %			Formal firms that started informally, %			Employed workers w/o social security, %		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Corporate tax rate, τ_{it}	0.970***	0.958***	0.982***	-0.537***	-0.389***	-0.367***	-1.328***	-1.280***	-1.353***
	(0.197)	(0.194)	(0.188)	(0.114)	(0.137)	(0.145)	(0.399)	(0.435)	(0.466)
Observations	370	370	370	137	137	137	130	130	130
R-squared	0.372	0.390	0.417	0.194	0.232	0.285	0.195	0.228	0.263
Cluster FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Time FE		✓	✓		✓	✓		✓	✓
Cluster trend			✓			✓			✓

	Unemployment rate			Real GDP p.w. (1000 USD)			Real TFP (US=100)		
	(1)	(2)	(3)	(1)	(2)	(3)	(1)	(2)	(3)
Corporate tax rate, τ_{it}	-0.198***	-0.203***	-0.202***	-0.985***	-0.985***	-0.984***	-1.052***	-1.055***	-1.064***
	(0.0294)	(0.0299)	(0.0299)	(0.0798)	(0.0799)	(0.0804)	(0.111)	(0.112)	(0.109)
Observations	728	728	728	1550	1550	1550	800	800	800
R-squared	0.229	0.240	0.251	0.173	0.173	0.176	0.187	0.191	0.197
Cluster FE	✓	✓	✓	✓	✓	✓	✓	✓	✓
Time FE		✓	✓		✓	✓		✓	✓
Cluster trend			✓			✓			✓

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Outline

Preferences

- Workers derive utility from the consumption of a homogeneous good, s, and a CES bundle c of differentiated varieties $\omega \in [0, M]$, defined as follows:

$$c = \left(\int_0^M c(\omega)^{\frac{\sigma-1}{\sigma}} d\omega \right)^{\frac{\sigma}{\sigma-1}}$$

where $\sigma > 1$ is the elasticity of substitution between varieties.

- The discounted individual utility at time T is equal to:

$$\mathcal{U}_T = \sum_{t=T}^{\infty} \frac{c_t^{\alpha} s_t^{1-\alpha}}{(1+r)^t}$$

where r is the discount rate, $\alpha \in (0,1)$ is the elasticity of the composite good in total consumption.

- Price of the homogeneous good: numeraire of the economy.
- $p(\omega)$: price of a variety ω.
- Utility maximization for a worker j with income I_j yields a demand for the homogeneous good s and for variety ω equal to

$$s = (1-\alpha)I_j \qquad \text{and} \qquad c(\omega) = \alpha \frac{I_j}{P} \left(\frac{p(\omega)}{P} \right)^{-\sigma} \qquad \forall \omega \in [0, M]$$

where

$$P = \left(\int_0^M p(\omega)^{1-\sigma} d\omega \right)^{\frac{1}{1-\sigma}}.$$

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Problem of the unregistered firm

The value of entering the industry for an unregistered firm with productivity z:

$$\mathcal{V}_i(z) = \max_{v_i} \quad -c_v^i v_i + \frac{1-\delta_i}{1+r} \tilde{\mathcal{V}}_i(z, \ell_i) \tag{3}$$

$$\text{s.t.} \quad \ell_i = \phi v_i$$

$\tilde{\mathcal{V}}_i(z, \ell_i)$ is the continuation value after entry:

$$\tilde{\mathcal{V}}_i(z, \ell_i) = \max_{v_i'} \quad \pi_i(z, \ell_i) - c_v^i v_i' + \frac{1-\delta_i}{1+r} \tilde{\mathcal{V}}_i(z, \ell_i') \tag{4}$$

$$\text{s.t.} \quad \ell_i' = (1-\delta_w)\ell_i + \phi v_i$$

where $\pi_i(z, \ell_i)$ denotes profits, equal to

$$\pi_i(z, \ell_i) = R_i(z, \ell_i) - w_i(z, \ell_i)\ell_i - \kappa_i(z)\ell_i$$

- δ_i: exogenous exit probability for informal firms
- c_v^i: cost of posting informal vacancies (v_i)
- $\kappa_i(z)$: per-worker expected cost of informality
  - It captures the probability of detection by the government and subsequent fines
  - Bigger firms are more visible to the government $\rightarrow$ higher probability of inspection $\rightarrow$ higher monetary fines issued by the tax authority.

Back

Problem of the registered firm

The value of entering the industry for a registered firm with productivity z is then equal to:

$$\mathcal{V}_f(z) = \max_{v_i, v_f} \quad -\sum_{j \in \{i,f\}} c_v^j v_j + \frac{1 - \delta_f}{1 + r} \tilde{\mathcal{V}}_f(z, \ell) \tag{5}$$

$$\text{s.t.} \quad \ell_j = \phi v_j \qquad \forall j \in \{i, f\}$$

$\tilde{\mathcal{V}}_f(z, \ell_i, \ell_f)$ is the continuation value after entry:

$$\tilde{\mathcal{V}}_f(z, \ell) = \max_{v_i', v_f'} \quad \pi_f(z, \ell) - \sum_{j \in \{i,f\}} c_v^j v_j' + \frac{1 - \delta_f}{1 + r} \tilde{\mathcal{V}}_f(z, \ell') \tag{6}$$

$$\text{s.t.} \quad \ell_j' = (1 - \delta_w)\ell_j + \phi v_j' \qquad \forall j \in \{i, f\}$$

where profits are:

$$\pi_f(z, \ell) = (1 - \tau_y)R_f(z, \ell) - w_i(z, \ell)\ell_i - w_f(z, \ell)(1 + \tau_w)\ell_f - \kappa_f(z, \ell)\ell_i$$

- δ_f: exogenous exit probability
- v_j: vacancies posted for both types of workers (v_i and v_f)
- $\ell = (\ell_i, \ell_f)$
- τ_y: corporate income tax rate
- τ_w: payroll tax rate
- $\kappa_f(z, \ell)$: per-worker expected cost of informality

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Workers' Problem (1/3)

Only workers who are not already employed in a wage-job can look for it. Hence, they chose to look for it or stay self-employed:

$$\mathcal{J}^n = \max\{\mathcal{J}^o, \mathcal{J}^s\} \tag{7}$$

where the value of self-employment is

$$\mathcal{J}^o = w_o + \frac{1}{1+r}\mathcal{J}^n, \tag{8}$$

and the value of searching for a job is

$$\mathcal{J}^s = (1 - \tilde{\phi})\mathcal{J}^u + \tilde{\phi}\mathsf{E}\mathcal{J}^e \tag{9}$$

where the value of being unemployed at the end of the period is

$$\mathcal{J}^u = b + \frac{1}{1+r}\mathcal{J}^n \tag{10}$$

where b is the transfer in unemployment.

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Workers' Problem (2/3)

- Workers who **choose the outside sector** earn a wage w_o and have the option of searching again next period.
- Workers who **choose to search**: fail to get matched to a firm with probability $1 - \tilde{\phi}$.

The worker's problem is:

$$\mathcal{J}^n = \max\left\{ w_o + \frac{1}{1+r}\mathcal{J}^n, (1 - \tilde{\phi})\mathcal{J}^u + \tilde{\phi}\mathsf{E}\mathcal{J}^e \right\}$$

The expected value of matching to a firm is:

$$\begin{aligned}
\mathsf{E}\mathcal{J}^e = {} & \frac{V_{ii}}{V}\int_z\int_{\ell_i} \mathcal{J}_i^e(z, \ell_i)\nu_{ii}(z, \ell_i)dzd\ell_i \\
& + \frac{V_{if}}{V}\int_z\int_{\ell_i}\int_{\ell_f} \mathcal{J}_i^e(z, \ell_i, \ell_f)\nu_{if}(z, \ell_i, \ell_f)dzd\ell_i d\ell_f \\
& + \frac{V_{ff}}{V}\int_z\int_{\ell_i}\int_{\ell_f} \mathcal{J}_f^e(z, \ell_i, \ell_f)\nu_{ff}(z, \ell_i, \ell_f)dzd\ell_i d\ell_f
\end{aligned}$$

- $\nu_{ii}(z, \ell_i), \nu_{if}(z, \ell_i, \ell_f), \nu_{ff}(z, \ell_i, \ell_f)$ are distributions of informal vacancies in unregistered and registered firms, and formal vacancies

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Workers' Problem (3/3)

- Today: workers receive their wage
- Future:
    - Loose job: search again or go to self-employment, $\mathcal{J}^n$.
    - Retain job

The values of being employed (extensive-informally, intensive-informally and formally):

$$\mathcal{J}_i^e(z, \ell_i) = w_i(z, \ell_i) + \frac{\left[(\delta_w + (1-\delta_w)\delta_i)\mathcal{J}^n + (1-\delta_w)(1-\delta_i)\mathcal{J}_i^e(z, \ell_i) \right]}{1+r}$$

$$\mathcal{J}_i^e(z, \ell_i, \ell_f) = w_i(z, \ell_i, \ell_f) + \frac{\left[(\delta_w + (1-\delta_w)\delta_f)\mathcal{J}^n + (1-\delta_w)(1-\delta_i)\mathcal{J}_i^e(z, \ell_i, \ell_f) \right]}{1+r}$$

$$\mathcal{J}_f^e(z, \ell_i, \ell_f) = w_f(z, \ell_i, \ell_f) + \frac{\left[(\delta_w + (1-\delta_w)\delta_f)\mathcal{J}^n + (1-\delta_w)(1-\delta_f)\mathcal{J}_f^e(z, \ell_i, \ell_f) \right]}{1+r}$$

- $w_i(z, \ell_i)$, $w_i(z, \ell_i, \ell_f)$, $w_f(z, \ell_i, \ell_f)$: wage for extensive-informal, intensive-informal and formal workers
- δ_w: worker separation
- δ_f and δ_i: firms exit

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Figure: Firms' decisions
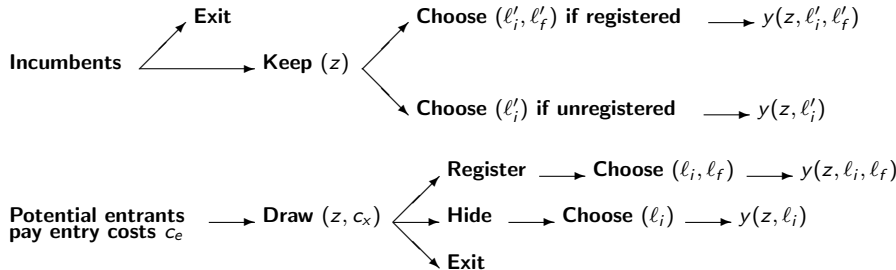
Figure: Workers' timeline
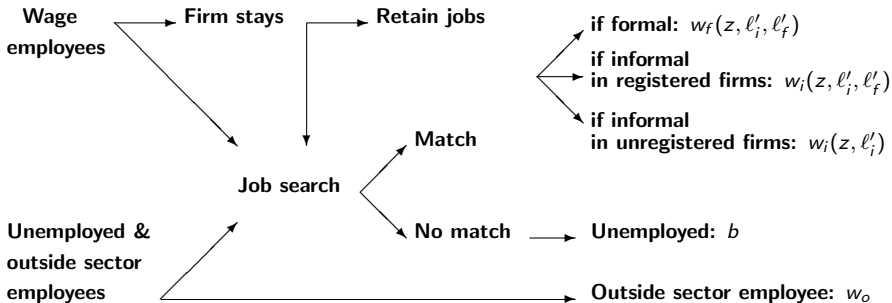
Recursive Stationary Competitive Equilibrium

- **Optimality**: Policy functions solve the problem of workers and firms, and value functions attain their maximum.

- **No-arbitrage**: workers non-employed in a wage and salary job are indifferent between searching for a wage and salary job or being self-employed.

- **Free-entry**: the measure of entrants is such that the free entry condition holds with equality.

- **Bargaining**: wages are determined as the solution to the bargaining problems.

- **Aggregate consistency**: the distributions of firms and workers replicate themselves. over time through the policy functions, firm dynamics and job turnover.

- **Market clearing**: the labor market for salary job and product market for the self-employment good clear.

Outline

Employment composition
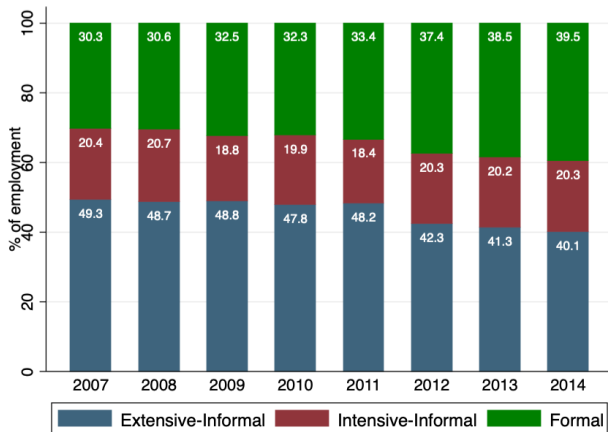
- More than 60% of wage and salary employment in Peru is informal.
- More than one-third of it is made of informal workers employed in registered firms

Composition of formal and informal employment
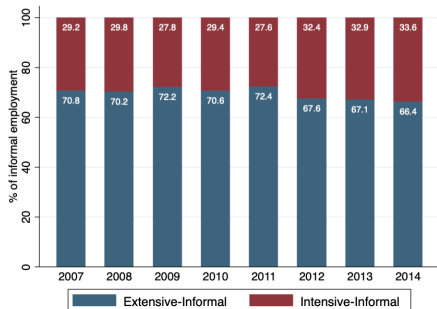
(a) Informal employment
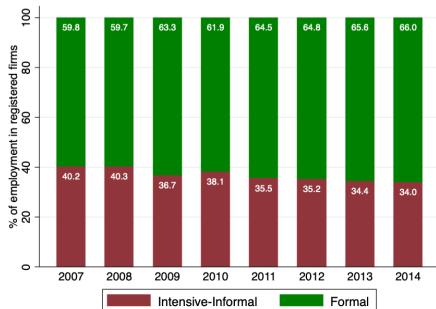
(b) Employment in registered firms

Firm size across formal and informal workers
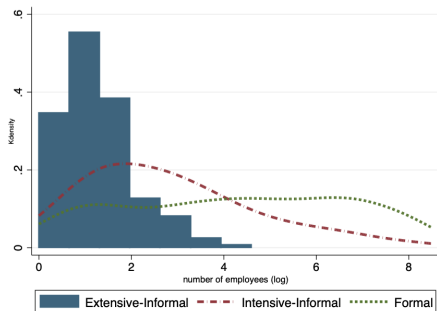
(c) Distribution of firm-size
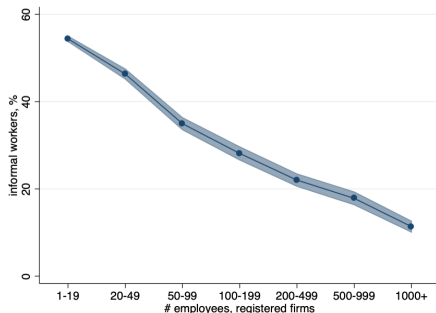
(d) Informal workers in registered firms

- Informal workers are more likely to be employed in smaller firms. The share of informal workers in registered firms declines with size.

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Productivity of formal and informal firms
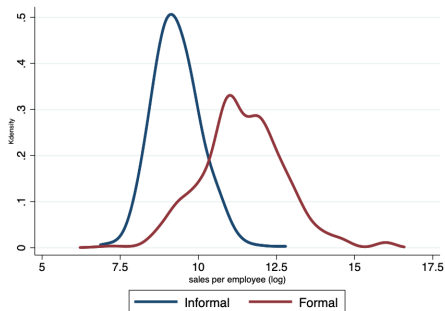
(e) Sales per employee
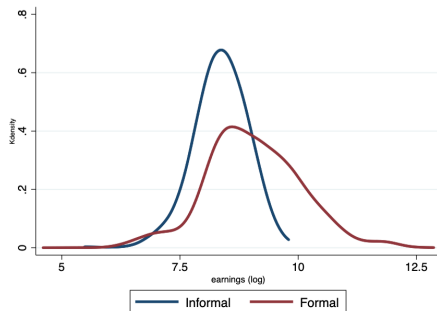
(f) Payroll per employee

- Sales per employee of formal firms are 2.3 log-points higher compared to informal firms.
- Labor payroll of formal firms is on average 0.85 log-points higher than that of informal firms.

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Earnings gap of informal workers

	Log monthly earnings			
	(1)	(2)	(3)	(4)
$\mathbf{1}[\text{Formal}]_{it}$	0.984	1.129	0.583	0.828
	(0.004)	(0.006)	(0.006)	(0.009)
$\mathbf{1}[\text{Int.Mg.Inform}]_{it}$		0.316		0.335
		(0.007)		(0.009)
Observations	127,640	127,640	67,253	67,253
R-squared	0.3145	0.3297	0.5635	0.5743
Time F.E.	✓	✓	✓	✓
Controls			✓	✓

- Formal workers earn on average twice as much as informal workers.
- Intensive-Informal workers face a wage premium of 0.3 log points relative to extensive-informal workers.
- Intensive-Informal workers enjoy a wage penalty of more than 1.13 log points extensive-informal workers.

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Outline

Parameters calibrated outside the model

Table: Parameters Calibrated Without Solving the Model

Parameters	Description	Value	Source/Targets
r	Interest rate, %	1.08	Real lending rate= 13.80%
A	Aggregate productivity	1	normalization
σ	Elasticity of substitution	6.40	Anderson and Van Wincoop (2001)
δ_f	Exit rate, % formal firm	5.68	Average age= 17.62 y.o.
δ_i	Exit rate, % informal firm	10.4	Average age= 9.61 y.o.
δ_w	Workers' separation rate, %	7.60	Monthly E-U rate= 7.6%
τ_y	Corporate tax rate, %	29.5	SUNAT (2016)
τ_w	Payroll tax rate, %	22.0	SUNAT (2016)
b	Transfer to the unemployed	0	OECD (2019)
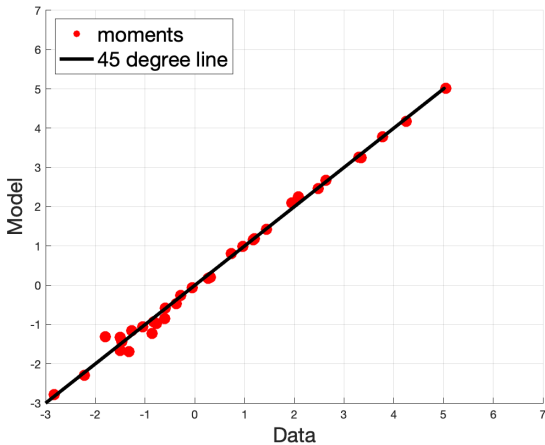
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Estimation Fit

Some estimates ●

Parameters	Description	Estimates (LCU, 2010)	C.I. (± S.E.)		Estimates (USD, 2010)
c_e	Entry cost	3832.66	3780.66	3884.66	1352.9
$\overline{c_f}$	Registration cost, upper bound	98010.8	13144.7	182876	34597
c_v^i	Vacancy cost, informal workers.	10425.8	8491.78	12359.9	3680.3
c_v^f	Vacancy cost, formal workers	18532.0	14305.8	22758.2	6541.8
A_o	Self-employment efficiency	1051.92	1040.40	1063.44	371.33

- The average entry cost for formal firms amounts to \$18652.
  - comparable estimates for the manufacturing sectors are \$27532 in Cosar et al (2016) for Colombia and \$25000 in Fagjelbaum (2021) for Argentina
- The average entry cost amounts to \$1901.
  - Dix-Carneiro et al. (2021) estimate it equal to \$1,818 and \$705 for manufacturing and service sector firms in Brazil
- The estimate for A_0 implies a yearly earnings from self-employment of \$4456
  - 89% of the average wage and salary earnings

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Table: Parameters Estimated with Simulated Method of Moments

Parameters	Description	Estimates	C.I. ($\pm$ S.E.)	
c_e	Entry cost	3832.66	3780.66	3884.66
$\overline{c_f}$	Formal entry cost, upper bound	98010.8	13144.7	182876
c_v^i	Vacancy cost, informal workers.	10425.8	8491.78	12359.9
c_v^f	Vacancy cost, formal workers	18532.0	14305.8	22758.2
A_o	Productivity of the outside sector	1051.92	1040.40	1063.44
γ_0	Informality cost, informal firms	44.553	38.025	51.080
γ_1	Informality cost, informal firms	1.1603	1.1148	1.2059
γ_2	Informality cost, formal firms	96.482	77.698	115.27
γ_3	Informality cost, formal firms	1.6464	1.4793	1.8135
γ_4	Informality cost, formal firms	0.9486	0.9105	0.9866
α	Share of industrial goods	0.5516	0.3128	0.7904
φ_z	Productivity dispersion	0.9795	0.9549	1.0041
η	Elasticity of the matching function	2.1119	1.8970	2.3267
ζ_f	Bargaining power, formal workers	0.5065	0.3929	0.6201
ζ_i	Bargaining power, informal workers	0.2062	0.1603	0.2521

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Selected Targeted Moments

Moment	Data	Model	Moment	Data	Model
Firm-level moments			*Worker-level moments*		
Informal firms			*Labor market outcomes*		
Average log-revenues, $E[\log R_i]$	7.061	8.146	Wage employment rate	0.450	0.444
Average log-size, $E[\log \ell_i]$	0.266	0.186	Wage employment, share extensive-informal	0.436	0.395
Log-size dispersion, $\%std[\log \ell_i]$	0.425	0.295	Wage employment, share intensive-informal	0.221	0.189
			Share intensive informal, 1-19 employees	0.544	0.429
Formal firms			Share intensive informal, 20-49 employees	0.461	0.379
Average log-revenues, $E[\log R_f]$	11.97	11.76	Share intensive informal, 50-99 employees	0.351	0.349
Average log-size, $E[\log(\ell_i + \ell_f)]$	3.227	3.186	Share intensive informal, 100-199 employees	0.281	0.317
Log-size dispersion, $std[\log(\ell_i + \ell_f)]$, %	1.303	1.187	Share intensive informal, 200+ employees	0.166	0.268
Log-size, 20th cutoff	2.079	2.257			
Log-size, 40th cutoff	2.639	2.678	*Aggregate outcomes*		
Log-size, 60th cutoff	3.296	3.256	Job finding rate (overall)	0.437	0.437
Log-size, 80th cutoff	4.249	4.173	Job finding rate (informal)	0.283	0.260

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Non-targeted moments

Moment	Data	Model
Wage dispersion std[log w]	0.875	0.517
Unemployment rate	0.037	0.042

- The model accounts for more than 60% of the observed wage dispersion across workers.
- In the model workers are ex-ante homogeneous.
- The model generates wage dispersion due to firms' differences in productivity and in differences in bargaining power in the wage determination.

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Outline

Counterfactual corporate tax reform

Slope Coefficient: Model vs Data

| | Corporate Tax | | |
Moment	Data	Model	Explained
Informality rate	1.245	1.437	110%
	(0.480)	(0.244)	-
Unemployment rate	-0.378	-0.244	61%
	(0.154)	(0.023)	-
Real GDP per worker	-0.564	-0.262	45%
	(0.253)	(0.017)	-

- The model explains 60% of cross-country variation in unemployment rate and 45% of real GDP per worker

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Tax Reform ($\downarrow \tau_y$): Role of informality

Table: Corporate tax reform with and without informality

	Baseline (1)	Only extensive informality (2)	No informality (3)
Informality rate	-38.32	-65.52	-
Unemployment rate	+6.158	+10.72	+13.89
Real GDP per worker	+1.322	+1.443	+1.271

Notes: Each entry denotes a percentage point change following a reduction in corporate income tax from 35% to 10%.

- *Informality as a buffer*: Firms create informal jobs instead of formal to survive.
- *Informality is not a buffer in terms of the worker*: Workers still go into unemployment (less informal jobs available).

- Output per capita:
  - Being able able to hire workers off the books reduces search frictions:
  - Unregistered firms amplify the missalocation costs of corporate taxes

Back: Mechanisms   Back: What else?

The role of Aggregate Productivity (A)

	Low-tax high-productivity (1)	High-tax low-productivity (2)	Low-tax low-productivity (3)	Explained $\frac{(1)-(3)}{(1)-(2)}$
Corporate income tax rate, τ_y	10%	35%	10%	-
Aggregate productivity, A	1.202	0.997	0.997	-
Self-employment efficiency, A_o (LCU)	1264.20	1048.76	1048.76	-
Entry cost, c_e (LCU)	4606.09	3821.16	3821.16	-
Unemployment rate	0.189	0.033	0.055	85.9%
Informality rate	0.356	0.712	0.366	2.8%
Real GDP per worker	1.443	0.916	1.205	45.2%

- Controlling for changes in aggregate productivity, corporate income tax rates account for:
  - 3% of differences in informality rate
  - 86% of differences in unemployment rate
  - 46% of differences in real GDP per worker
  - ⇒ Large fraction of cross-country differences can be attributed to differences in corporate taxes.

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Alternative Policies

- Evaluation of alternative firm-policy interventions
  - Monetary Costs of hiring for unregistered firms ($\Delta\gamma_0$) ●

  $$\kappa_i(z) = \gamma_0 z^{\gamma_1}$$

  - Change in taxes paid by registered firms on formal workers: payroll taxes, τ_w^f. ●
  - Monetary costs of hiring informal workers for registered firms ($\Delta\gamma_2$) ●

  $$\kappa_f(z, \ell_i, \ell_f) = \gamma_2 z^{\gamma_3} \left(\frac{\ell_i}{\ell_i + \ell_f} \right)^{\gamma_4}$$

- Labor market policy interventions
  - Change in Unemployment Benefits, b ●
  - Introduction of Minimum Wage, $\underline{w}$ ●

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Efficiency-equity trade-off
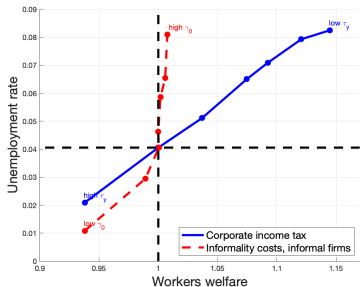
(g) Extensive-margin policies

(h) Intensive-margin policies

- Low corporate tax ensures high welfare for the same level of unemployment.
- low costs of informality for unregistered firms generate a lower unemployment rate for the same level of welfare.

- Low monetary fines to registered firms for hiring workers off-the-book unambiguously dominate low payroll taxes: High welfare and low unemployment.

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Payroll taxes on formal workers for registered firms

Payroll tax rate, τ_w	0	0.10	0.20	0.30	0.40
Firm-level outcomes					
Informal firms, share	0.9513	0.9614	0.9671	0.9748	0.9790
Informal vacancies, share	0.4765	0.5326	0.5778	0.6585	0.7097
Average firm size	4.1359	3.6054	3.3072	2.8946	2.7012
Aggregate Outcomes					
Informality rate	0.4706	0.5255	0.5702	0.6511	0.7025
- , extensive margin	0.2647	0.3265	0.3944	0.4766	0.5435
- , intensive margin	0.2060	0.1990	0.1920	0.1745	0.1590
Measure of firms	0.0897	0.1071	0.1200	0.1420	0.1549
Market tightness	0.2885	0.4040	0.4619	0.6319	0.6726
Unemployment rate	0.0744	0.0493	0.0419	0.0271	0.0250
Average real wage	1.2126	1.1721	1.1313	1.0913	1.0388
Real GDP per worker	1.0406	1.0309	1.0080	0.9778	0.9433

Payroll tax rate in the baseline: $\tau_w = 0.22$

- Qualitatively similar to a change in corporate income tax.

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Expected informality cost for informal firms, $\Delta\kappa_i$

Informality cost, γ_0	33.41	41.66	44.55*	55.69	66.83
Firm-level outcomes					
Informal firms, share	0.9930	0.9771	0.9683	0.9322	0.8198
Informal vacancies, share	0.8698	0.6623	0.5918	0.4756	0.3863
Average firm size	2.7679	2.9469	3.2498	4.3123	8.1875
Aggregate Outcomes					
Informality rate	0.8652	0.6546	0.5842	0.4702	0.3835
- , extensive margin	0.7946	0.4916	0.3948	0.2252	0.1015
- , intensive margin	0.0706	0.1630	0.1894	0.2450	0.2820
Measure of firms	0.1563	0.1401	0.1243	0.0868	0.0436
Market tightness	1.1452	0.6012	0.4785	0.4145	0.3426
Unemployment rate	0.0108	0.0295	0.0406	0.0463	0.0586
Average wage	1.0158	1.0783	1.1198	1.2336	1.3123
Real GDP per worker	0.9308	0.9856	1	1.0279	1.0386

Cost of informality in the baseline: $\gamma_0 = 44.55$

- An increase in the expected informality cost for informal firms mirrors the effect of reducing corporate income tax rates.
    - The share of informal firms and the share of informal vacancies decline.
    - $\Rightarrow$ The informality rate declines (driven only by the extensive margin)
    - $\Rightarrow$ Productivity improvements $\to$ higher average wages, GDP per worker, and unemployment rate.
- Quantitatively, doubling the expected cost of informality (γ_0:33.41 $\to$ 66.83) increases real wages in the industrial sector by 29.6% and real GDP per worker by 11.5%.

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Expected informality cost for formal firms

Informality cost, γ_2	48.24	72.36	144.72	289.45	385.93
Firm-level outcomes					
Informal firms, share	0.9259	0.9587	0.9780	0.9863	0.9884
Informal vacancies, share	0.6264	0.5966	0.6175	0.6706	0.7032
Average firm size	4.2281	3.4523	2.8811	2.5350	2.4539
Aggregate Outcomes					
Informality rate	0.6222	0.5902	0.6092	0.6618	0.6943
- , extensive margin	0.2484	0.3425	0.4819	0.5958	0.6451
- , intensive margin	0.3739	0.2477	0.1273	0.0660	0.0493
Measure of firms	0.0989	0.1182	0.1389	0.1597	0.1676
Market tightness	0.6415	0.5206	0.4506	0.4985	0.5744
Unemployment rate	0.0271	0.0364	0.0434	0.0386	0.0318
Average real wage	1.0603	1.0973	1.1105	1.0950	1.0933
Real GDP per worker	1.0060	1.0029	0.9830	0.9625	0.9567

Baseline: $\gamma_2 = 96.482$

- Informality rate does not react monotonically to changes in κ_f:
    - For low values of κ_f, intensive margin increase enough to overturn the pattern of formalization in the extensive margin.
- Wages follow an inverted U-shape as κ_f falls
- formal

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Unemployment benefits

Unemployment benefits, b	0^*	$0.05w_o$	$0.10w_o$	$0.15w_o$	$0.20w_o$
Firm-level outcomes					
Informal firms, share	0.9683	0.9680	0.9665	0.9663	0.9641
Informal vacancies, share	0.5918	0.5862	0.5713	0.5680	0.5546
Average firm size	3.2498	3.2745	3.4204	3.4115	3.5672
Aggregate Outcomes					
Informality rate	0.5842	0.5785	0.5642	0.5609	0.5480
- , extensive margin	0.3948	0.3875	0.3687	0.3653	0.3486
- , intensive margin	0.1894	0.1910	0.1954	0.1956	0.1995
Measure of firms	0.1243	0.1186	0.1090	0.1054	0.0960
Market tightness	0.4785	0.4345	0.3876	0.3360	0.2769
Unemployment rate	0.0406	0.0448	0.0506	0.0594	0.0728
Average wage	1.1198	1.1630	1.2217	1.2638	1.3197
Real GDP per worker	1	1.0150	1.0357	1.0501	1.0700

Benefit in the baseline $b = 0$

- Qualitatively similar results to a reduction in corporate income tax. However, firm-level and aggregate outcomes change by a smaller magnitude.

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Minimum wage for formal workers in registered firms

Minimum wage, $\underline{w}$	0*	$1w_o$	$1.5w_o$	$2w_o$	$2.5w_o$	$3w_o$
Firm-level outcomes						
Informal firms, share	0.9683	0.9683	0.9683	0.9782	0.9860	0.9905
Informal vacancies, share	0.5918	0.5918	0.5918	0.7316	0.8572	0.9159
Average firm size	3.2498	3.2498	3.2498	2.3329	2.0616	2.0246
Aggregate Outcomes						
Informality rate	0.5842	0.5842	0.5842	0.7241	0.85202	0.9127
- , extensive margin	0.3948	0.3948	0.3948	0.5918	0.76641	0.8540
- , intensive margin	0.1894	0.1894	0.1894	0.1323	0.0856	0.0587
Measure of firms	0.1243	0.1243	0.1243	0.1772	0.2088	0.2148
Market tightness	0.4785	0.4785	0.4785	0.6043	0.7619	0.9986
Unemployment rate	0.0406	0.0406	0.0406	0.0294	0.0215	0.0139
Average wage	1.1198	1.1198	1.1198	1.0601	1.0053	1.0017
Real GDP per worker	1	1	1	0.9545	0.8960	0.8610

Minimum wage in the baseline: $\underline{w} = 0$

- It only produces any effect when it is large enough ($2w_0$).
- Firms and jobs move out of formality.

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