Spatial Misallocation, Informality, and Transit Improvements: Evidence from Mexico City

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NBER SI Urban Economics

Introduction

- New literature on assessing the economic impact of transit infrastructure:
  - Governments have spent 2.5 trillion of USD building infrastructure (McKinsey, 2016).
  - The economy is perfectly efficient.

- Distortions play a very significant role in developing countries:
  - Generate factor misallocation across firms (Hsieh & Klenow, 2009).
  - Large presence of the informal economy: 2.1 billion workers in the world (ILO, 2018).

- New mechanism to account for TFPR differences:
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  - Study the role of distortions on the aggregate gains from transit infrastructure.
    - Interaction between transit improvements and informality.

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- Context:
  - I study this question in Mexico City.
  - The informal economy is very large in Mexico -57% of workers-.
  - The city experienced the construction of a major subway line in 2000.

- Main contributions:
  - Provide evidence on the relationship between informality and space.
  - Extend recent work in the urban literature by adding wedges from tax distortions:
    - Ahfeldt et al. (2016), Redding & Rossi-Hansberg (2017), Tsivanidis (2019).
  - Quantify and decompose the welfare gains from transit infrastructure:
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- Main findings:
  - Transit infrastructure decreases informality rates by 6% in "treated" areas.
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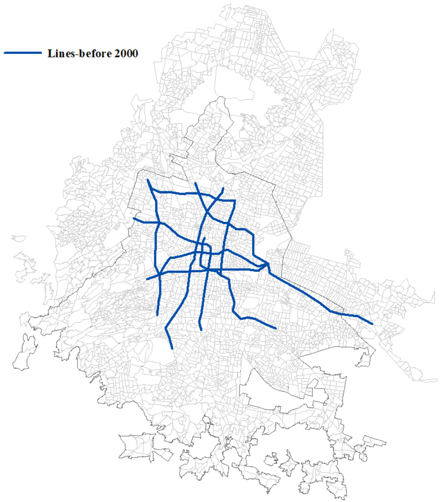
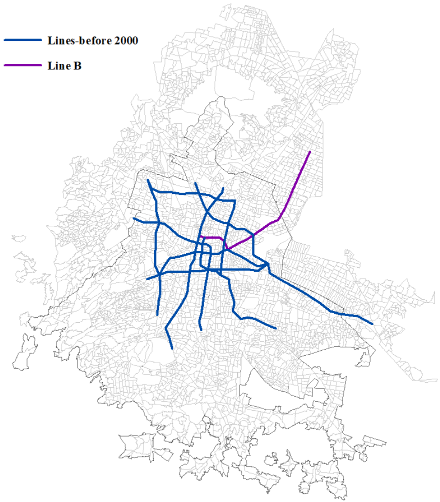
Transit system before 2000

Figure: Transit system before 2000



Transit system in 2000

Figure: New transit line in 2000



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- Censuses:
  - Economic Censuses from 1994, 1999, 2004, and 2009.
  - Population Censuses from 2000 and 2010.
- Origin-Destination surveys
  - The 2015 Inter-censal survey and Household survey data.
  - The 2017 Origin Destination survey and trip data from Google Maps.
- GIS data:
  - Network of roads.
  - Network of transportation system.
- The unit of analysis is the census tract in the Mexican microdata.
  - 3500 census tracts in Mexico City.

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Empirical Facts

1. Informal workers commute less and work closer to their residence. Evidence
   * The commuting elasticity is higher for informal jobs.

2. Most of the formal firms relative to informal firms are located in the CBD. Map
   * Workers have poor access to formal employment.

3. Informality rates decrease with transit improvements.
   * Delays in the openings of new stations.
   * Similar results comparing line B vs. planned lines of the subway.
   * Worker composition did not change.

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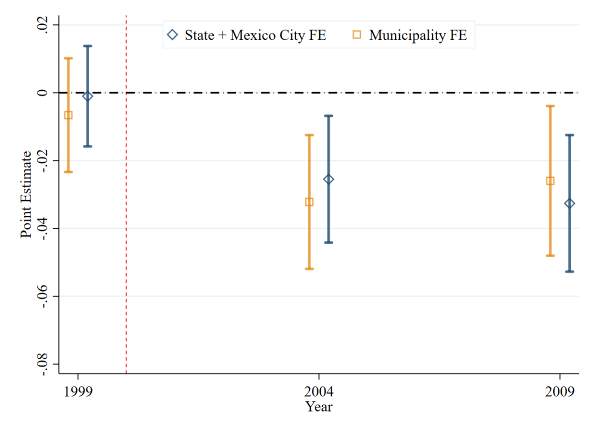
Informality rates decrease with transit infrastructure

$$y_{i,t} = \sum_{\tau \neq 1994} \beta_\tau \cdot \mathsf{T}_i + \delta_i + \delta_{s(i),t} + \gamma_t \cdot X_i + \epsilon_{i,t}$$

Figure: Difference-in-difference results-Workers' informality rates



Summary statistics | B vs. other lines | Formal workers | Informal workers

Informality rates decrease with transit infrastructure

$$\Delta\left(\ln L_{iF} - \ln L_{iI}\right) = \beta T_i + \gamma X_i + \delta_{s(i)} + \epsilon_i$$

Table: Difference-in-difference-Formal/informal residents   Bar graph   Other lines   Worker composition

	(1)	(2)	(3)	(4)
Outcome:		$\Delta\left(\ln L_{iF} - \ln L_{iI}\right)$		
Panel A: Continuous treatment measure				
$-\ln \text{distance}_i$	0.017**	0.034***	0.020**	0.038***
	(0.008)	(0.008)	(0.008)	(0.008)
R-squared	0.225	0.296	0.225	0.297
Panel B: Treatment using the dummy variable				
T_i	0.032*	0.076***	0.031*	0.076***
	(0.017)	(0.016)	(0.017)	(0.016)
R-squared	0.225	0.296	0.225	0.296
Distance	Meters	Meters	Minutes	Minutes
Distance controls	X	X	X	X
Population controls		X		X
Observations	3,206	3,205	3,206	3,205

Note: This table reports the results of a regression relating changes in the ratio between formal and informal workers with the line B. Columns 2 and 4 include population controls that are: log average income in 2000, log average hours worked in 2000, and the occupational share in 2000. Standard errors are clustered at the locality level and reported in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

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- Economic Geography-Closed city:
  - Multiple locations indexed by n (origin), i (destination).
  - Iceberg trade τ_{ni} and commuting costs d_{ni} across locations.

- Consumers and Firms: Labor demand
  - Multiple sectors indexed by $s \in I, F$: exogenous distortions t_{isL}.
  - Nested CES preferences + Monopolistic comp. and free entry.
  - Firm heterogeneity across sectors and locations.

- Workers: Labor supply
  - Random draws specific to each location, sector, and job place.

$$\lambda_{nis} = \underbrace{\left(\frac{B_n P_n^{-\alpha\eta} r_n^{-(1-\alpha)\eta} W_n^{\eta}}{\sum_{\ell} B_{\ell} P_{\ell}^{-\alpha\eta} r_{\ell}^{-(1-\alpha)\eta} W_{\ell}^{\eta}} \right)}_{\lambda_n = \text{Prob. of living in } n} \times \underbrace{\left(\frac{B_{ns} W_{ns|n}^{\kappa}}{\sum_k B_{nk} W_{nk|n}^{\kappa}} \right)}_{\lambda_{ns|n} = \text{Prob. of working in sector } s} \times \underbrace{\left(\frac{w_{is}^{\theta_s} d_{ni}^{-\theta_s}}{\sum_r w_{rs}^{\theta_s} d_{nr}^{-\theta_s}} \right)}_{\lambda_{nis|ns} = \text{Prob. of working in } i}$$

- Congestion forces:
  - Finite supply of residential and commercial floor space.

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The decentralized equilibrium is not efficient

- **Two sources of inefficiencies:**
  - $t_{isL} \rightarrow$ wedges, trade imbalances, and misallocation.

$$\frac{w_{is} l_{is}}{p_{is} y_{is}} \propto \underbrace{(1 + t_{isL})^{-1}}_{\text{Taxes}}$$

    The MRPL/MFCL does not equalize across firms - Second best allocation.

  - Endogenous entry + Love of variety $\rightarrow$ agglomeration externalities.

$$\frac{d \ln TFP_{is}}{d \ln L_{is}} = \frac{\beta_s}{\sigma_s - 1}$$

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$$\text{Direct effect} = -\sum_{n,i,s} \underbrace{[\alpha \beta_s \lambda_{nisL}]}_{\text{Value of Jobs}} \cdot \underbrace{d \ln d_{ni}}_{\Delta\text{Commuting Costs}} - \sum_{n,i,s} \underbrace{[\alpha \tilde{\lambda}_n \pi_{nis}]}_{\text{Value of Goods/Services}} \cdot \underbrace{d \ln \tau_{ni}}_{\Delta\text{Trade Costs}}$$

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Outline of the talk

Transit Shock

Data and Empirical Facts

Model

Estimation and Quantification

Estimation of the main parameters

- Key parameters:
  - Iceberg costs d_{ni}, τ_{ni} as a function of travel times: Nested Logit
  - Commuting/trade elasticities θ_s, σ_s from gravity equations: Gravity equations
  - The parameter that governs the sector reallocation is κ: CMA measures
    - CMA measures by sector that represent a wage index in each location.
    - Triple difference equation using the variation from the transit shock.
    - Point estimate of 1.7, which is consistent with the literature.

- Other parameters:

Description	Parameter	Value	Source of data
Expenditure in housing	$1-\alpha$	0.39	Household survey data
Labor share	β	0.70	Economic Census 1999
Labor wedge	t_{isL}		Labor cost/average value added within industries
Fixed Cost	F_s	0.15, 1.60	Number of firms and workers
Elasticity across sectors	ζ	1.24	Edmond et al. (2015)
Migration elasticity	η	1.50	Tsivanidis (2019)

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Counterfactual Analysis

- With data on wages and workers, I recover fundamentals: Model inversion
  - Productivity parameters: A_{is}
  - Amenity parameters: B_n, B_{ns}
- I compute commuting flows and trade flows across census tracts.
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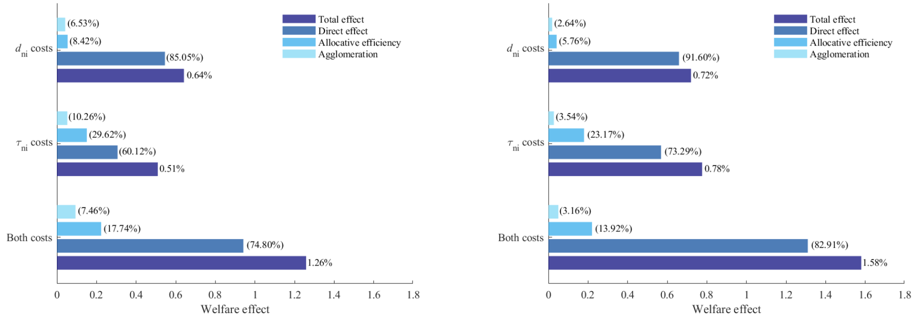
The indirect effects amplify the welfare gains

Figure: Counterfactual results

(a) No-Migration (b) Migration



Notes: This figure plots the counterfactual results. Panel (a) reports the results in the case in which the population is fixed in each location, and panel (b) the case in which there is reallocation of residents across the city after the shock.

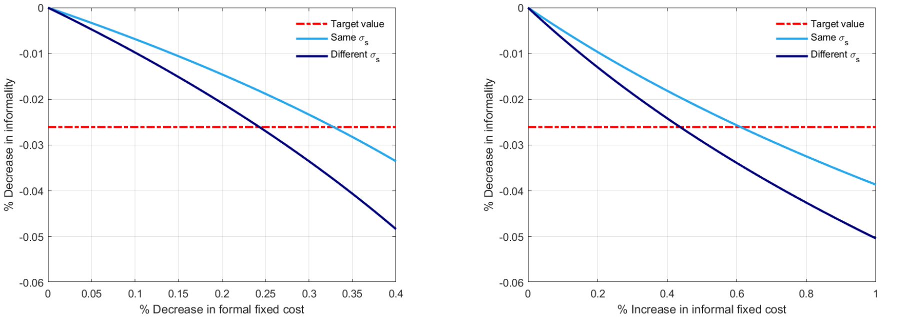
Other policies that can reduce informality

- The informality rate decreased by 2.6% at the aggregate level.

Figure: Counterfactual results-Fixed costs

(a) Decrease formality fixed costs

(b) Increase informality fixed costs



Notes: This figure plots the counterfactual results for other policies. Panel a shows the results for a counterfactual reducing the entry fixed costs for formal firms, and panel b for a counterfactual increasing the entry fixed costs for informal firms.

Conclusions

- Relationship between space and informality within a city:
  - High commuting costs → spatial misallocation.
  - Informal jobs are easier to substitute across locations.
- Transit improvements can be a good tool to reduce informality:
  - Transit infrastructure decreases informality rates by 6% in treated areas.
  - The allocative efficiency margin amplifies the welfare gains by 20%.
- Extensions/future applications:
  - Endogenize other types of distortions -labor market power-.
  - Allocation of future infrastructure.

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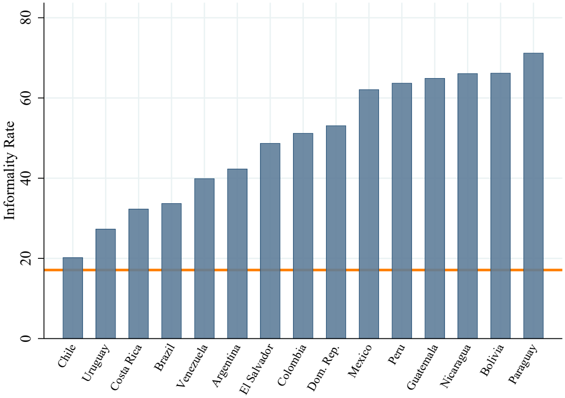
Outline of the talk

Informality Rates in Latin America

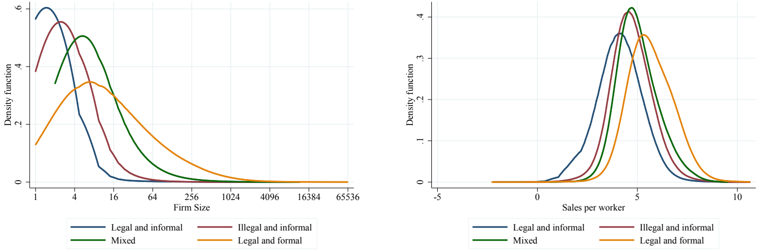
Figure: Informality Rates-Latin America and the Caribbean Back to context



Notes: This figure plots informality rates across countries from Latin America and the Caribbean. The data source is the online appendix from Ulyssea (2018). Informal workers are defined as those without social security. The orange line represents the average informality rate of countries from the OECD.

Firm Size and Productivity Distribution

Figure: Firm size and Productivity Distribution-Economic Census 2004



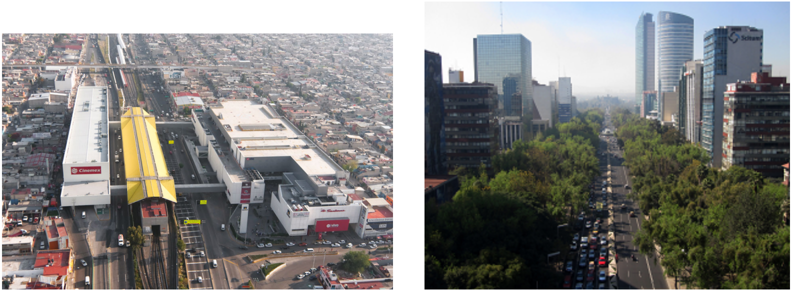
(a) Firm size (b) Productivity

Notes: This figure plots the firm size and productivity distribution for the four different categories of firms: 1) Legal and informal 2) Illegal and informal, 3) Mixed, and 4) Legal and formal. I use the 2004 economic census. Panel (a) plots the firm size distribution and panel (b) the productivity distribution. Firm size is measured as the number of workers, and productivity as the logarithm of sales per worker.

Back to context

Ecatelpec de Morelos and Paseo Reforma

Figure: Locations in Mexico City Back to context



(a) Ciudad Azteca

(b) Paseo de la Reforma (Center)

Notes: This figure plots two photos of locations in Mexico City. Panel A shows a photo of Ciudad Azteca, the last station of Line B in Ecatepec de Morelos. Panel B shows a photo of Paseo de la Reforma, a street in the central business district of the city. Line B connected census tracts around Ecatepec de Morelos with the center of the city.

Descriptive statistics 1999 Back to results

Table: Descriptive Statistics 1999 and 2000

Panel A: Outcomes				
Variable	Mean	Sd	Min	Max
Share informal workers	60.25%	33.37%	0.00%	100.00%
Share informal and non-salaried workers	43.47%	29.60%	0.00%	100.00%
Share informal firms	84.15%	18.26%	0.01%	100.00%
Share informal residents	46.77%	11.34%	0.00%	100.00%
Share informal high-skilled residents	35.64%	8.26%	0.00%	100.00%
Share informal low-skilled residents	50.34%	11.39%	0.01%	100.00%
Panel B: Treatment Variables				
Variable	Mean	Sd	Min	Max
Euclidean Distance to new stations (meters)	10623.33	6436.72	90.32	30903.58
Walking Distance to new stations (minutes)	119.16	70.57	1.02	382.82
Dummy variable (dist<2000)	10.00%	29.90%	0.00%	100.00%
Dummy variable (minutes<25)	10.00%	29.90%	0.00%	100.00%

Notes: This table reports summary statistic of the main variables. The unit of observation is the census tract. Panel A presents the statistics for the outcomes of interests: workers' informality rates from the Economic Census in 1999 and residents' informality rates from the Population Census in 2000. Panel B for the different definitions of the treatment groups.

Initial characteristics-Treated locations

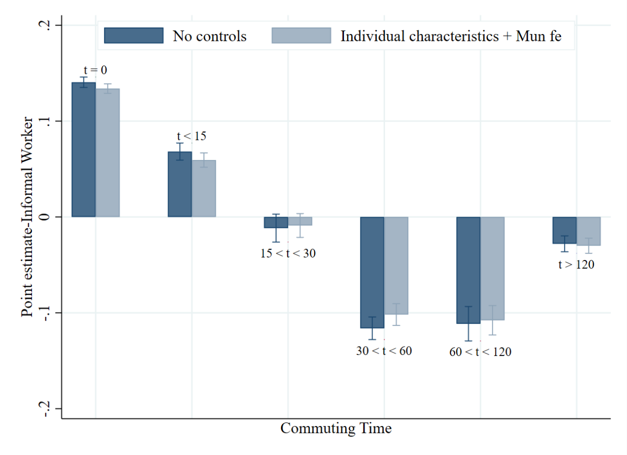
Table: Results: Census tract characteristics 1999 and 2000 vs. Treatment

	(1)	(2)	(3)
Outcome:	ln Income	High Skill Share	Informality Rates
T_i	-0.038***	-0.044***	0.021***
	(0.009)	(0.008)	(0.006)
Observations	3,330	3,330	3,330
R-squared	0.249	0.196	0.093

Notes: This table reports the results of a regression relating census tract characteristics with a treatment dummy variable. Standard errors are clustered at the census tract level and reported in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Informal workers spend less time commuting

Figure: Commuting Time- Informal vs. Formal Back

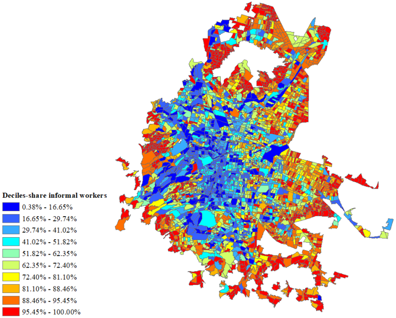


Notes: This figure plots the point estimate and 95th percentile confidence interval of a linear probability model that relates the probability of commuting within some window of time with an informal dummy variable. The dark-blue bar does not include controls, while the light-blue bar includes individual controls and municipality fixed effects. Standard errors are computed with clusters at the municipality level.

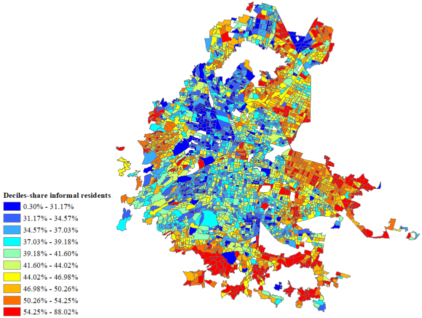
Formal firms and workers are located in the center of the city

Figure: Spatial distribution of informality Back

(a) Informality rates - jobs



(b) Informality rates - residents

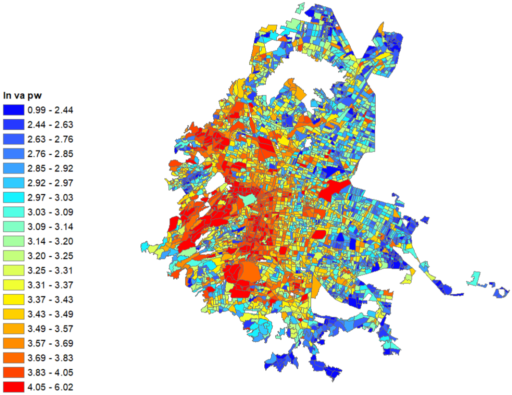


Notes: This figure plots a map of Mexico City with the spatial distribution of informality rates. Panel (a) plots a heat map of jobs' informality rates by deciles in 1999. Panel (b) plots a heat map of residents' informality rates by deciles in 2000.

Spatial dist. productivity Market access formal vs. informal 1999

Spatial distribution of productivity

Figure: Spatial distribution of productivity

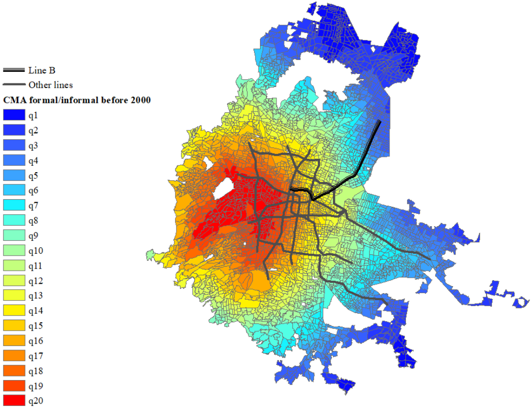


Notes: This figure plots a map of Mexico City with the spatial distribution of productivity measured as value added per worker.

Back to informality

Difference CMA formal vs. informal before 2000

Figure: Δ_s in CMA$_s$ 2000

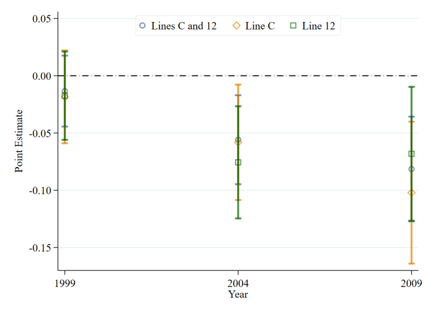


Notes: This figure plots a map of Mexico City with the difference in CMA between the formal and the informal economy..

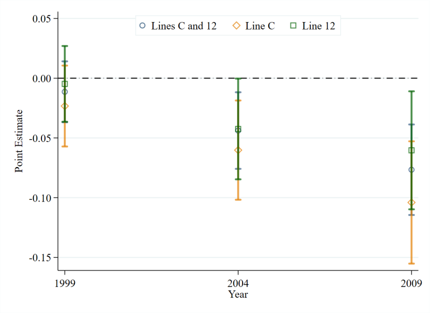
Back to informality

Results: line B vs. other lines

Figure: Robustness checks-Workers' informality rates Back



(a) Buffer: 1500 meters



(b) Buffer: 2000 meters

Notes: This figure depicts the point estimates and 95th percentile confidence interval from the difference-in-difference specification using different buffers and different control groups. Standard errors are clustered at the census tract level.

Results: Formal number of workers/firms

Table: Results: Number of formal workers and firms (arcsin) Back

	(1)	(2)	(3)	(4)
	ln L_{iFt}	ln L_{iFt}	ln M_{iFt}	ln M_{iFt}
	Panel A: Continuous Treatment Measure			
-ln distance$_i$ × 1999	0.031	0.020	0.019	0.013
	(0.029)	(0.031)	(0.017)	(0.018)
-ln distance$_i$ × 2004	-0.001	-0.007	-0.018	-0.030
	(0.038)	(0.041)	(0.021)	(0.022)
-ln distance$_i$ × 2009	0.093**	0.093**	0.047**	0.045**
	(0.041)	(0.044)	(0.020)	(0.022)
R-squared	0.894	0.894	0.910	0.910
	Panel B: Treatment using the dummy variable			
T_i × 1999	0.143*	0.052	0.072	-0.004
	(0.080)	(0.081)	(0.051)	(0.052)
T_i × 2004	0.084	0.121	0.066	0.033
	(0.117)	(0.125)	(0.065)	(0.072)
T_i × 2009	0.238**	0.264**	0.178***	0.151**
	(0.121)	(0.130)	(0.063)	(0.069)
R-squared	0.892	0.892	0.911	0.911
Observations	13,040	13,040	13,040	13,040
Distance	Meters	Minutes	Meters	Minutes
Mean number of workers/firms	653.38	653.38	21.55	21.55

Note: This table reports the results of a regression relating changes in the total number of formal workers and firms with the line B. Standard errors are clustered at the locality level and reported in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Results: Informal number of workers/firms

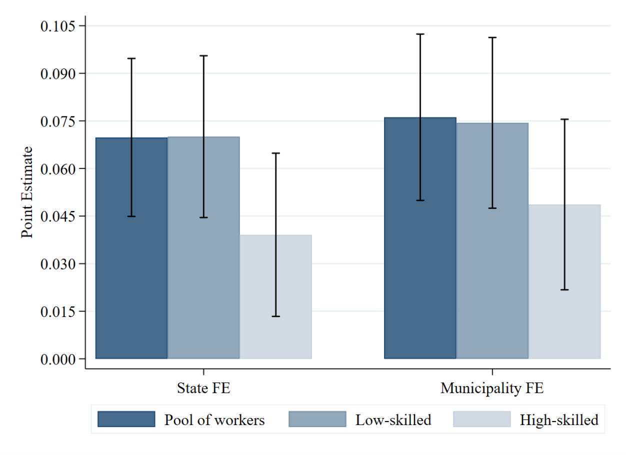
Table: Results: Number of informal workers and firms (arcsin) Back

	(1)	(2)	(3)	(4)
	ln L_{iFt}	ln L_{iFt}	ln M_{iFt}	ln M_{iFt}
	Panel A: Continuous Treatment Measure			
-ln distance$_i$ × 1999	-0.022	-0.022*	-0.012	-0.010
	(0.015)	(0.013)	(0.009)	(0.010)
-ln distance$_i$ × 2004	-0.076**	-0.071***	-0.024*	-0.021
	(0.037)	(0.021)	(0.013)	(0.014)
-ln distance$_i$ × 2009	-0.084*	-0.081***	-0.032**	-0.030*
	(0.043)	(0.024)	(0.016)	(0.017)
R-squared	0.908	0.908	0.913	0.913
	Panel B: Treatment using the dummy variable			
T_i × 1999	-0.050	-0.024	-0.033*	-0.023
	(0.036)	(0.035)	(0.017)	(0.016)
T_i × 2004	-0.184***	-0.176***	-0.057**	-0.057**
	(0.054)	(0.053)	(0.028)	(0.026)
T_i × 2009	-0.206***	-0.199***	-0.069**	-0.074**
	(0.053)	(0.054)	(0.029)	(0.029)
R-squared	0.908	0.908	0.913	0.913
Observations	13,040	13,040	13,040	13,040
Distance	Meters	Minutes	Meters	Minutes
Mean number of workers/firms	325.77	325.77	125.21	125.21

Note: This table reports the results of a regression relating changes in the total number of informal workers and firms with the line B. Standard errors are clustered at the locality level and reported in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Residents' informality rates-Diff-in-diff results

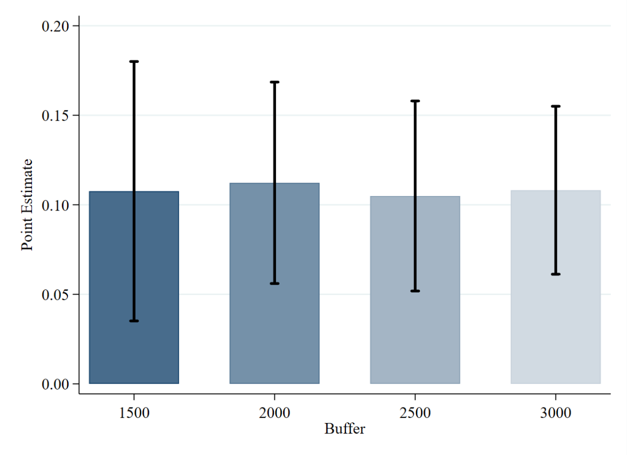
Figure: Difference in Difference Results-Residents' Informality Share Back



Notes: This figure depicts the point estimate and 90th percentile confidence interval of a regression that relates the change over time in the log of the ratio between formal and informal residents with the transit shock.

Residents' informality rates-Other lines

Figure: Difference in Difference Results-Residents' Informality rates Back



Notes: This figure depicts the point estimate and 90th percentile confidence interval of a regression that relates the change over time in the log of the ratio between formal and informal residents with the transit shock using as a control group census tracts close to the planned lines.

Household composition

Table: Change in covariates after the transit shock Back

Outcome	(1) High skill share	(2) High skill share	(3) Student share	(4) Student share
T_i	-0.002	-0.003	-0.006	-0.005
	(0.003)	(0.006)	(0.004)	(0.006)
Observations	3,214	3,214	3,212	3,212
R-squared	0.164	0.236	0.316	0.332
State FE	X		X	
Municipality FE		X		X
Controls	X	X	X	X

Notes: This table reports the results of a difference-in-difference specification relating changes in household composition with the transit shock. Odd columns include state fixed effects, and even columns municipality fixed effects. Standard errors are clustered at the census tract level and reported in parentheses.

Labor supply equation

- The indirect utility of worker ω living in n and working in i and sector s is:

$$V_{nis\omega} = \frac{w_{is}(1+\bar{t})d_{ni}^{-1}\epsilon_{nis\omega}}{P_n^{\alpha} r_n^{1-\alpha}},$$

  - The share of workers living in n, working in i and sector s is:

$$\lambda_{nis} = \underbrace{\left(\frac{B_n P_n^{-\alpha\eta} r_n^{-(1-\alpha)\eta} W_n^{\eta}}{\sum_{\ell} B_{\ell} P_{\ell}^{-\alpha\eta} r_{\ell}^{-(1-\alpha)\eta} W_{\ell}^{\eta}}\right)}_{\lambda_n = \text{Prob. of living in } n} \times \underbrace{\left(\frac{B_{ns} W_{ns|n}^{\kappa}}{\sum_k B_{nk} W_{nk|n}^{\kappa}}\right)}_{\lambda_{ns|n} = \text{Prob. of working in sector } s} \times \underbrace{\left(\frac{w_{is}^{\theta_s} d_{ni}^{-\theta_s}}{\sum_r w_{rs}^{\theta_s} d_{nr}^{-\theta_s}}\right)}_{\lambda_{nis|ns} = \text{Prob. of working in } i}$$

  - Parameters:
    - W_n, $W_{ns|n}$, P_n wage and price indices with geography: $W_{ns|n} = \left(\sum_i w_{is}^{\theta_s} d_{ni}^{\theta_s}\right)^{\frac{1}{\theta_s}}$.
    - B_n, B_{ns} measure how attractive is a location and sector.
    - Labor supply elasticity across sectors: κ.
    - The gravity relationship of commuting is captured by $\theta_I > \theta_F$.

Back to model

Labor demand equation

- Production:
  - The technology to produce x units of output is: $x_{is} = A_{is} l_{is}^{\beta_s} z_{is}^{1-\beta_s}$.
  - Firms face a production fixed cost in F_s in terms of labor and floor space.

- Market structure:
  - Firms compete monopolistically.

$$p_{nis} = \underbrace{\tilde{\sigma}_s}_{\text{Markup}} \underbrace{(w_{is}[1+t_{isL}])^{\beta}}_{\text{Labor cost}} \underbrace{(q_i[1+t_{isZ}])^{1-\beta}}_{\text{Floor space cost}} \underbrace{A_{is}^{-1}}_{\text{Productivity}} \underbrace{\tau_{ni}}_{\text{Trade cost}}$$

  - Endogenous entry + LOV generate agglomeration forces:

$$M_{is} \propto L_{is}^{\beta_s} Z_{is}^{1-\beta_s} \quad \rightarrow \quad P_{ns} = \left(\sum_{i,s} M_{is} p_{nis}^{1-\sigma_s} \right)^{\frac{1}{1-\sigma_s}}$$

Back to model

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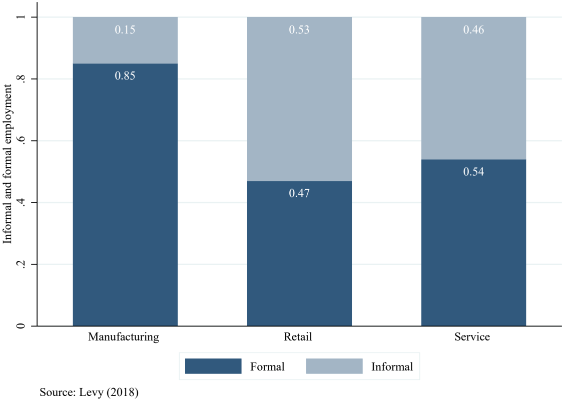
Back to model

Informality/formality-trade gravity equations

- Trips to restaurants, retail shops, and outlets to estimate σ:

Figure: Informal/formal sector by industry



Notes: This figure plots the share of employment by industry between the formal and informal sector.

Welfare decomposition-Hat algebra

Back

- Following Holmes et al. (2014) and assuming that $\beta = 1$, welfare in location n is :

$$U_n = \underbrace{\left[\frac{\bar{y}_n^{ND}}{P_n^{ND}}\right]}_{\text{Efficiency term}} \times \underbrace{\left[\frac{(1+\bar{t}) \cdot MD_n}{MU_n}\right]}_{\text{ToT/ToC term}} \times \underbrace{\left[\frac{P_n^{ND} \cdot MU_n}{P_n} \times \frac{\bar{y}_n}{\bar{y}_n^{ND} \cdot MD_n}\right]}_{\text{Allocation/Agglomeration}}$$

where:

$$\frac{1}{MU_n} \equiv \sum_s \pi_{ns} \sum_l \pi_{nls} \cdot (1+\tau_{lsL})^{\frac{-\theta_s}{\sigma_{Ls}+\theta_s}}$$

$$MD_n \equiv \sum_s \lambda_{ns} \sum_l \lambda_{nls|ns} \cdot (1+\tau_{lsL})^{\frac{-\sigma_{Ls}}{\sigma_{Ls}+\theta_s}},$$

then

$$\hat{U} = \left(\sum_n \lambda_n \hat{U}_n^{\eta}\right)^{\frac{1}{\eta}} \tag{3}$$

Model: Labor force participation Back

- Random productivity draws are specific to:
  - Location to live
  - Home production vs. market production
  - Formal vs. informal
  - Job place

- Preferences has an additional nest of home vs. market production:
  - The share of workers that decide to home produce in n are:

$$\lambda_{nH|n} = \frac{B_{nH} W_{nH}^{\epsilon}}{B_{nH} W_{nH}^{\epsilon} + B_{nM} W_{nM}^{\epsilon}} \tag{4}$$

  - Welfare in location n is:

$$U_n = \gamma_\epsilon \cdot \frac{\left(B_{nH} W_{nH}^{\epsilon} + B_{nM} W_{nM}^{\epsilon}\right)^{\frac{1}{\epsilon}}}{P_n^{\alpha} r_n^{1-\alpha}}$$

  - Transit infrastructure increases labor force participation.

Labor force participation increases with transit infrastructure

Table: Difference-in-difference: labor force participation

	(1)	(2)	(3)	(4)
Outcome:	Δ Occ. share	Δ Occ. share	Δ Occ. share	Δ Occ. share
T_i	0.012***	0.014***	0.009***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)
Distance Controls	X	X	X	X
Population Controls		X		X
State Fe	X	X		
Municipality FE			X	X
Observations	3,323	3,321	3,323	3,321
R-squared	0.020	0.195	0.063	0.248

Notes: This table reports the results of a regression relating the change in the share of workers that participate in the labor market with the transit shock. The treatment group is defined as census-tract, which centroid is within a 25 minutes walking range. Standard errors are clustered at the census-tract level and reported in parentheses. $*p < 0.1$, $**p < 0.05$, $***p < 0.01$.

Model: Firm sorting Back

- Firms make two decisions:
  - Firms receive a signal of their productivity: formal vs. informal.
    - Pareto distribution with shape parameter γ.
  - The productivity of the firm is realized and decides its location.
    - Extreme value type shocks with parameter ψ.

- If a firm is informal, there is a distortion that increases with size:
  - Probability of getting caught:

$$\pi_{iI} = \pi_{iI}^{OP} \cdot (1 - p^{I}(r_{iI}))$$

(Dix Carneiro et al., 2019; Ulyssea, 2018; Scheinkman, 2007)

- Entry and exit:
  - There is no production fixed cost.
  - Firms face an entry fixed cost f_F^e and f_I^e to enter into each sector.
  - Firms exit at a exogenous rate δ_s.

Firm's decision of being formal vs. informal Back

- The expected value of entry for a firm with pre-entry signal z is:

$$V_s^e(z, \vec{w}_{is}) = \frac{z^{\sigma_s - 1}}{\delta_s} \left(\sum_i \left[\left(A_{is}(w_{is} \cdot (1 + t_{isL}))^{-\beta} q_i^{-(1-\beta)} \right)^{\sigma_s - 1} \sum_n \tau_{ni}^{1-\sigma_s} \tilde{X}_{ns} \right]^{\psi} \right)^{\frac{1}{\psi}} \tag{5}$$

- A firm decides to enter and operate in k if:

$$V_k^e(z, \vec{w}) - E_k \geq \max\{V_{-k}^e(z, \vec{w}) - E_{-k}, 0\} \tag{6}$$

  - There is a single firm $\tilde{z}$ that is indifferent between being formal or informal.
  - If entry is positive, firms $\bar{z}_F$ and $\bar{z}_I$ determine free-entry by:

$$V_I^e(\bar{z}_I, \vec{w}) = E_I$$
$$V_F^e(\bar{z}_F, \vec{w}) = V_I^e(\bar{z}_F, \vec{w}) + (E_F - E_I)$$

Estimation of commuting/trade costs

Table: Nested Logit Back

Costs:	(1) *Commuting* Trips to Work	(2) *Trade* Trips to Shops
minutes_{nim}	-0.010***	-0.012***
	(0.001)	(0.001)
Bus	-0.037***	-0.058***
	(0.004)	(0.002)
Metro	-0.082***	-0.151***
	(0.004)	(0.002)
Metrobus	-0.115***	-0.212***
	(0.004)	(0.001)
Car	0.531***	-0.067***
	(0.012)	(0.002)
λ public	0.247***	0.514***
	(0.022)	(0.013)
Observations	34,640	163,280
Trips	6,928	32,656
Iceberg cost before (mean)	6.661	13.821
Iceberg cost after (mean)	6.173	12.223

Notes: This table reports the results of a nested logit using the 2017 OD survey considering only trips that use one transportation mode. The first column reports the results for commuting that consider only trips from work to home or viceversa between 6am to 10am, and between 5pm to 9pm.

Trade/commuting elasticities are larger in the informal sector

Table: Gravity equations Back

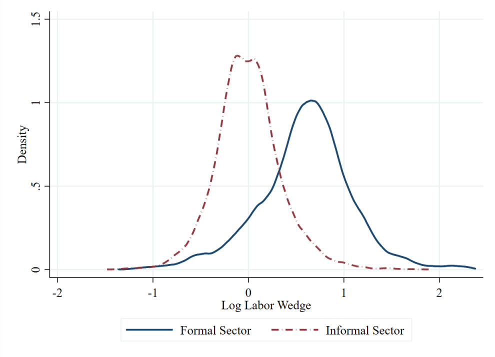
	(1)	(2)	(3)	(4)
Panel A: Commuting gravity equations				
	λ_{niF}	λ_{niF}	λ_{niI}	λ_{niI}
Minutes	-0.033***	-0.032***	-0.044***	-0.042***
	(0.002)	(0.001)	(0.003)	(0.002)
Observations	2,304	2,304	2,304	2,304
R-squared	0.806	0.709	0.804	0.712
Implied θ	**3.31**	**3.22**	**4.39**	**4.22**
Panel B: Trade gravity equations				
	π_{niF}	π_{niF}	π_{niI}	π_{niI}
Minutes	-0.037***	-0.034***	-0.050***	-0.049***
	(0.003)	(0.003)	(0.004)	(0.005)
Observations	2,304	2,304	2,304	2,304
R-squared	0.707	0.617	0.792	0.738
Implied σ	**4.08**	**3.83**	**5.17**	**5.08**
Origin -Transportation mode FE	X	X	X	X
Destination -Transportation mode FE	X	X	X	X
IV		X		X
F-stat first stage		$>$500		$>$500

Notes: This table reports the results of a gravity equation regression for commuting and trade using the PPML method. Column 1 and 2 present the results for the formal sector and columns 3 and 4 for the informal sector. Standard errors are clustered at the municipality of origin level and reported in parentheses. *$p < 0.1$, **$p < 0.05$, ***$p < 0.01$.

Labor Wedge across sectors and locations

$$\frac{w_{is}\tilde{L}_{is}}{p_{is}y_{is}} = \beta(1 + t_{isL})^{-1}$$

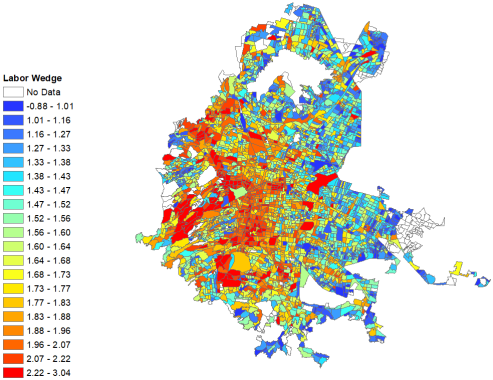
Figure: Distribution of the labor wedge by sector Back to estimation



Notes: This figure plots the distribution of the labor wedge by sector across the different census tracts. The blue line depicts the labor wedge distribution for the formal sector, and the red line for the informal sector.

Spatial distribution of the labor wedge

Figure: Spatial Distribution of the Labor Wedge Back



Notes: This figure plots a map of Mexico City with the spatial distribution of the average labor wedge in each location. Census tracts in the central areas of the city face larger wedges.

Other parameters of the model

- Expenditure in housing α from household survey data.
- Labor share β from the 1999 Economic Censuses.
- The fixed costs F_s for each sector are derived from the number of firms:

$$\ln M_{is} = \beta \ln L_{is} + (1-\beta) \underbrace{\ln Z_{is}}_{\frac{w_{is} L_{is}}{q_i}} - \underbrace{\ln \sigma_s - \ln F_s}_{\gamma_s}$$

- I take the other parameters from the literature:
  * $\xi = 1.24$ from Edmond et al. (2015).
  * $\eta = 1.51$ from Tsivanidis (2019).

Speed calibration

- Speed calibration using trips from Google maps

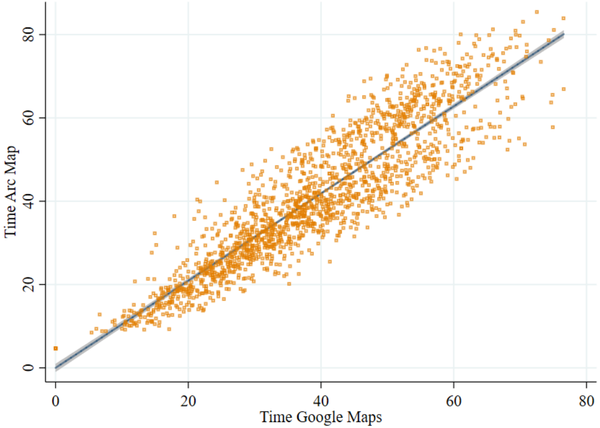
Table: Calibration of speeds using trips from Google Maps Back

Type	Speed
Panel A: Public transit system	
Subway Lines	601.24 m/min
Metrobus	308.13 m/min
Bus	216.67 m/min
Walking	80.00 m/min
Panel B: Types of roads for cars	
Autopista	752.03 m/min
Avenida	266.84 m/min
Boulevard	608.12 m/min
Calle	198.56 m/min
Callejón	69.643 m/min
Calzada	169.98 m/min
Carretera	623.38 m/min
Cerrada	123.39 m/min
Circuito	304.69 m/min
Corredor	160.75 m/min
Eje vial	273.98 m/min
Pasaje	240.71 m/min
Periférico	673.43 m/min
Viaducto	399.99 m/min

Note: This table reports a calibration of speeds using Google maps trips. The calibration uses 10,000 trips. The information was downloaded with the command gmaps distance in R that uses the Distance Matrix Api from Google.

Travel times-Arcmap and Google maps-

Figure: Arcmap vs. Google maps-travel time car Back



Note: This figure compares travel times using Google maps vs. travel times using the network analysis toolkit from Arcmap for the car transportation mode.