Labor Market Power Across Cities

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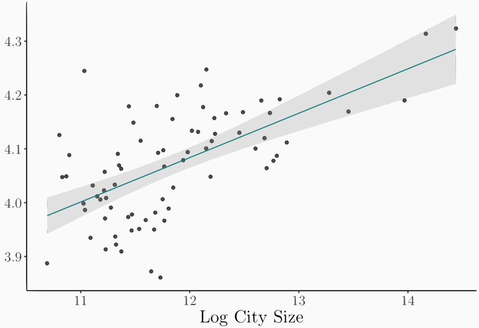
Labor Market Power and the City-Size Wage Premium

- Workers in larger cities are paid higher wages (city-size wage premium)
  - Productivity gains from agglomeration, sorting of more productive workers and firms to big cities
- With labor market power, wage differences do not fully reflect productivity differences
- Labor markets are more competitive in big cities (Manning 2010), so workers enjoy higher wages
- What fraction of the urban wage premium is due to lower labor market power in larger cities?
  - Estimate agglomeration economies controlling for workers sorting and labor monopsony power

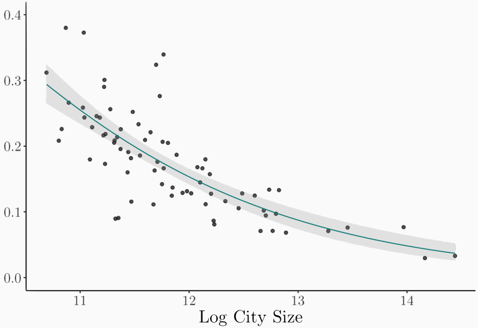
Motivation

Local labor markets in large cities pay higher wages and are less concentrated, on average

(i) Log Mean Wages



(ii) Mean HHI



Note: Spanish administrative data (MCVL), years 2005-2019. Mean wages and employment HHI computed for local labor markets and averaged across time at the city level. Labor markets are clusters of subindustries within cities, estimated to minimize cross-cluster worker flows. City size is population within 10km of the average resident (De la Roca and Puga 2017).

This Paper

- Rosen-Roback with mobile workers and firms, and labor market power
  - Cournot competition in the labor market (Arnold 2021, Azar and Vives 2021, Berger et al 2022)
  - Delivers aggregate facts, highlights source of endogeneity: LMP $\leftarrow$ Productivity $\rightarrow$ Wages
- Control for productivity to identify effect of LMP on wages
  - Heterogenous time trends (Bai 2009, Kneip et al 2012) and measured revenue productivity
- New instrument for LMP based on changes in the employment of local public firms
  - Show that such changes are unrelated to productivity (health and education related markets)
  - Results in line with IV estimates in the literature (Benmelech et al 2022, Prager and Schmitt 2022)
- 20–30% of city-size wage premium in Spain explained by labor market power
  - Lower than Hirsch et al 2022 ($\sim$50% GER), closer to quantitative literature – but still lower end of the estimates (Azkarate-Askasua and Zerecero 2022 36% FRA, Bamford 2021 37% GER) ▸ Literature

Model

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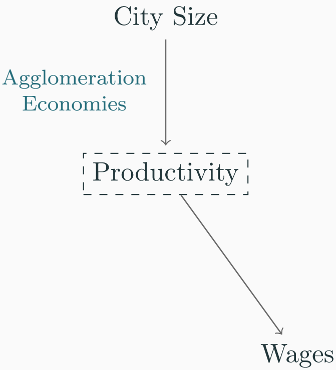

- Agglomeration economies: city size → wages
- Labor market power (LMP) introduces bias
- Model with mobile firms and workers
  - Wages depend on local LMP and productivity
  - Productivity exogenous, number of firms → LMP
  - Firms trade off high productivity of big cities and high labor market power of small cities
  - Workers may choose small cities for low prices
  - Workers mobility across cities limits LMP
- Identification: HHI → Wages
  - Keep productivity fixed or use an instrument
  - New aggl. elasticity: city size → wages net of LMP

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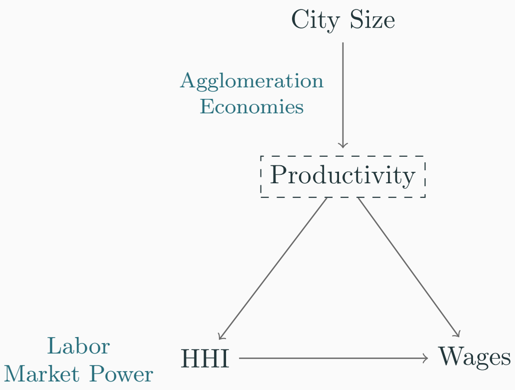

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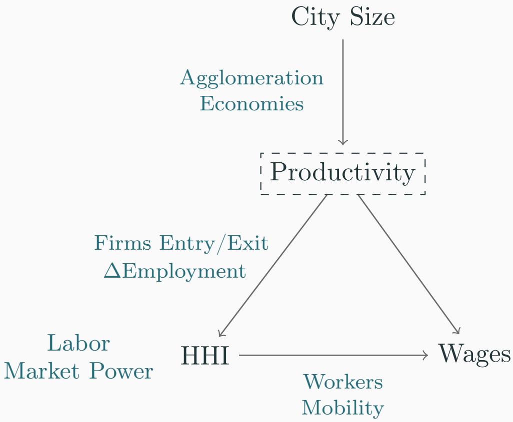

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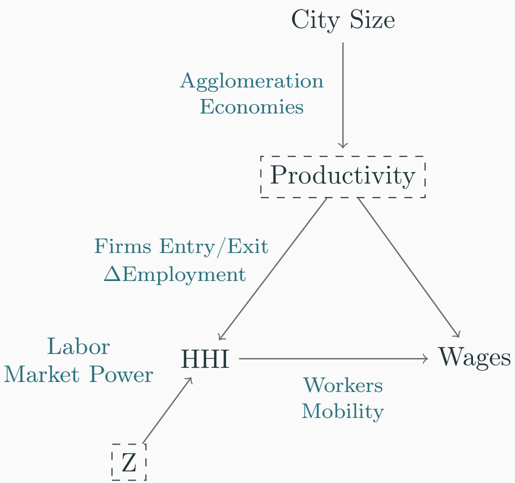

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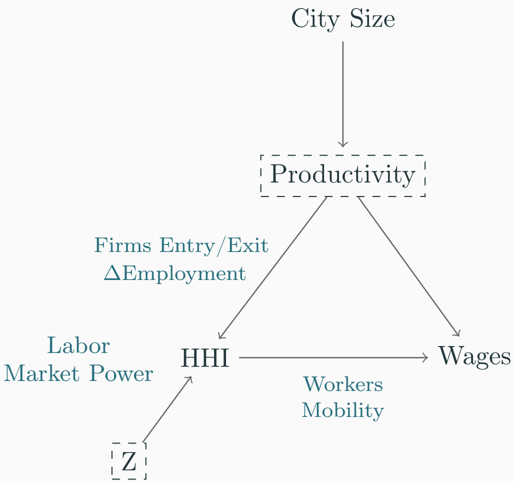
Equilibrium in Local Labor Markets



- Firms engage in Cournot competition for workers in local labor markets m within cities. They:
  - Have productivity A_{it} (higher on avg in big cities)
  - Choose employment share $s_{it} = \frac{l_{it}}{L_{mt}}$
  - Internalize labor supply elasticity η^{-1}

$$\max_{l_{it}} A_{it} f(l_{it}) - W(L_{mt}) l_{it}$$

$$\Rightarrow W_{mt}(1 + \eta^{-1} \underbrace{\textstyle\sum_i s_{it}^2}_{\text{HHI}_{mt}}) = \underbrace{\textstyle\sum_i s_{it} A_{it} f'(l_{it})}_{\text{AMRPL}_{mt}}$$

- Workers paid their marginal product if
  - perfect competition ($\text{HHI}_{mt} \to 0$) or
  - perfect labor mobility ($\eta^{-1} \to 0$)

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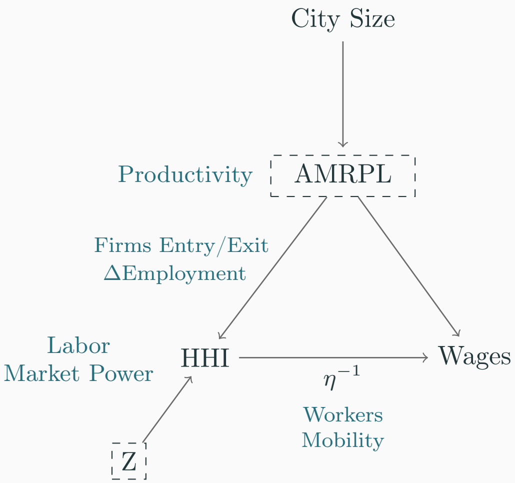

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  - perfect competition ($\mathrm{HHI}_{mt} \to 0$) or
  - perfect labor mobility ($\eta^{-1} \to 0$) HHI and LMP

Estimation

Data

- MCVL 2005-2019: Matched employer-employee data (4% sample workers)
  - Wages (private firms), worker observables, local unemployment rate, HHI ▸ Representativeness
- CdB 2005-2019: Balance sheet data on firms collected by Bank of Spain ($\sim$60% coverage)
  - Revenues, employment, sales concentration – linked to MCVL at the market level
- Other data sources:
  - National Statistics Institute: coverage of collective agreements (unions bargaining power)
  - Spanish Ministry of Industry, Trade and Tourism: export data
- Local labor markets are city-industry combinations (76 cities $\times$ 80 industries) ▸ Details
  - Cities group urban municipalities connected by commuting flows
  - Industries are clusters of subindustries estimated to minimize cross-cluster flows (Nimczik 2018)

Estimation of Wage Markdowns

- Market first-order condition estimated in logs:

$$\mathrm{W}_{mt} = \mathrm{AMRPL}_{mt} \overbrace{(1+\gamma \mathrm{HHI}_{mt})^{-1}}^{\text{Markdown}} \Rightarrow$$

$$\log \mathrm{W}_{mt} = \alpha_m + \alpha_t + \gamma \mathrm{HHI}_{mt} + \alpha \mathrm{X}_{mt} + \epsilon_{mt}$$

- α_m market fixed productivity, α_t trend and $\log(1+\gamma \mathrm{HHI}_{mt}) \simeq \gamma \mathrm{HHI}_{mt}$ (as $\hat{\gamma}\mathrm{HHI}_{mt}$ is small)
- X_{mt} measures market observables:
  - Mean workers experience and tenure, education, job tasks, contract type, gender and native shares
  - Product market power: Sales HHI, share of production exported
  - Unions bargaining power: share workers covered by collective agreements (Arellano et al 2001)
- Assume for now that γ is estimated consistently
  - Productivity advantages of large cities can be estimated by regressing α_m against city size
  - Endogeneity of γ: control for measured productiviy and local unemployment rate; instrument HHI

Estimation of Agglomeration Economies

- Estimate productivity advantages of large cities:

$$\text{Step 1:}\ \ \log \mathrm{W}_{mt} = \alpha_m + \alpha_t + \gamma \mathrm{HHI}_{mt} + \alpha \mathrm{X}_{mt} + \epsilon_{mt}$$

$$\text{Step 2:}\ \ \hat{\alpha}_m = \alpha_j + \delta_{\mathrm{HHI}} \log\mathrm{CitySize}_c + \upsilon_m$$

- If labor market power is ignored, biased estimate $\hat{\delta}$ of agglomeration economies:

$$\text{Step 1:}\ \ \log \mathrm{W}_{mt} = \alpha_m + \alpha_t + \alpha \mathrm{X}_{mt} + \epsilon_{mt}$$

$$\text{Step 2:}\ \ \hat{\alpha}_m = \alpha_j + \delta \log\mathrm{CitySize}_c + \upsilon_m$$

- Hypothesis: $\hat{\delta}_{\mathrm{HHI}} < \hat{\delta} \ \rightarrow$ % of city-size wage premium due to LMP: $\frac{\hat{\delta} - \hat{\delta}_{\mathrm{HHI}}}{\hat{\delta}}$ Details
  - If production has DRS and amenities correlate with city size, further bias in δ Details
- $\mathrm{CitySize}_c$: population within 10km of the average resident (De la Roca and Puga 2017)
  - Instrument city size with historical determinants of population, e.g. roman roads and geography

Results

Interactive Market-Year Fixed-Effects

$$\text{Step 1: } \log \mathrm{W}_{mt} = \alpha_m + \alpha_t + \gamma \mathrm{HHI}_{mt} + \alpha \mathrm{X}_{mt} + \epsilon_{mt}$$

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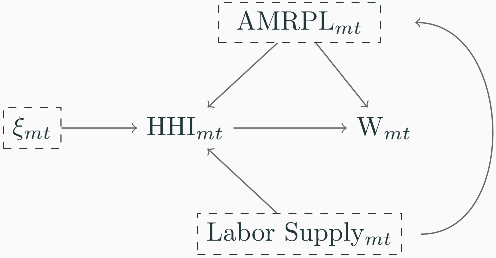

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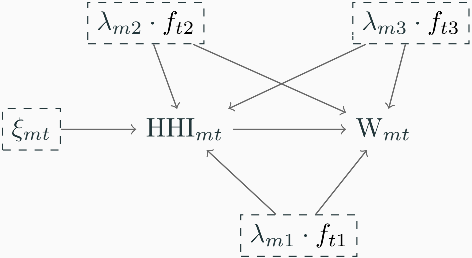

Interactive Market-Year Fixed-Effects

Step 1: $\log \mathrm{W}_{mt} = \alpha_m + \alpha_t + \alpha_{m1} \cdot \alpha_{t1} + \gamma \mathrm{HHI}_{mt} + \alpha \mathrm{X}_{mt} + \epsilon_{mt}$

Step 2: $\hat{\alpha}_m = \alpha_j + \delta \mathrm{logCitySize}_c + \upsilon_m$

$$
\begin{tikzcd}
 & \alpha_m \arrow[d] \arrow[drr] & & \alpha_t \arrow[dll] \arrow[d] \\
\boxed{\xi_{mt}} \arrow[r] & \mathrm{HHI}_{mt} \arrow[rr] & & \mathrm{W}_{mt} \\
 & & \alpha_{m1} \cdot \alpha_{t1} \arrow[ul] \arrow[ur] &
\end{tikzcd}
$$

Interactive FE

Controlling for Firms' Revenues

Step 1a: $\log \mathrm{W}_{mt} = \alpha_m + \alpha_t + \alpha_{m1} \cdot \alpha_{t1} + \beta \log \widetilde{\mathrm{AMRPL}}_{mt} + \gamma \mathrm{HHI}_{mt} + \alpha \mathrm{X}_{mt} + \epsilon_{mt}$

Step 1b: $\log \mathrm{W}_{mt} - \hat{\gamma} \mathrm{HHI}_{mt} = \alpha_m + \alpha_t + \alpha \mathrm{X}_{mt} + \epsilon_{mt}$

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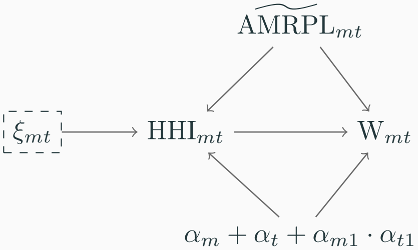

▸ Measuring AMRPL

Wages and Labor Market Power

Labor market concentration is associated with lower labor earnings

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	log W		
	(1)	(2)	(3)
HHI	-0.0738***	-0.0613***	-0.0813***
	(0.0141)	(0.0200)	(0.0098)
Sales HHI	-0.0101	-0.0050	-0.0141*
	(0.0072)	(0.0074)	(0.0078)
Labor Market Controls	✓	✓	✓
Interactive Market-Year FE			✓
City-Year, Industry-Year FE		✓	Absorbed
Year FE	✓	✓	✓
Market FE	✓	✓	✓
R^2	0.85	0.86	0.95
Observations	64,246	64,246	48,270

Note: Clustered standard errors by market in (1) and (2). *p<0.1, **p<0.05, ***p<0.01.

- Perfect competition → Single employer (HHI $= 0 \rightarrow 1$) decreases wages by $\sim 8\%$
  - (1): Time trend common across markets
  - (2): Trends heterog. across cities and industries
  - (3): Trends heterog. across markets (Bai 2009)
- Similar results if:
  - Exclude recession years ▸ Table
  - Control for revenue productivity ▸ Table
  - Control for local unemployment rate ▸ Table

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  - Control for revenue productivity Table
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Productivity and City Size

After accounting for labor market power, lower estimates of agglomeration economies

$$\text{Step 2: } \hat{\alpha}_m = \alpha_j + \delta \text{logCitySize}_c + \upsilon_m$$

	$\hat{\alpha}_m$	
	(1)	(2)
Log City Size	0.0929***	0.0733***
	(0.0059)	(0.0054)
Industry FE	✓	✓
R^2	0.38	0.38
Observations	5,027	5,027
Step 1 with HHI		✓
$\hat{\gamma}$ (coef. HHI)	0	−0.081

Note: Clustered standard errors by industry. *p<0.1, **p<0.05, ***p<0.01.

- Labor market power explains ∼20% of the city-size wage premium
  - Fraction by which agglomeration economies estimate ($\hat{\delta}$) decreases when accounting for HHI in Step 1
- Similar results if:
  - Control for city amenities Table
  - Instrument city size Table

IV for Labor Market Power

Step 1: $\log \mathrm{W}_{mt} = \alpha_m + \alpha_t + \gamma \mathrm{HHI}_{mt} + \alpha \mathrm{X}_{mt} + \epsilon_{mt}$

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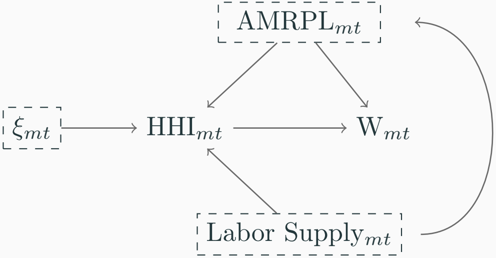

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$$\text{Step 1b (OLS): } \log \mathrm{W}_{mt} - \hat{\gamma} \mathrm{HHI}_{mt} = \alpha_m + \alpha_t + \alpha \mathrm{X}_{mt} + \epsilon_{mt}$$

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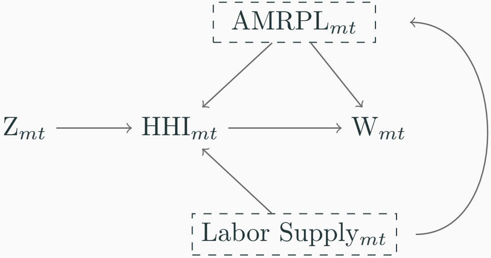
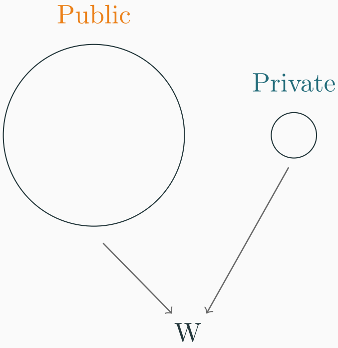


Changes in Employment of Local Public Firms as IV



- Big public firm, small private firm
- In $t+1$ public firm shrinks and private firms grows
- $\uparrow$ Labor market competition $\rightarrow \uparrow$ Wages

IV strategy:

- $\widehat{\text{HHI}}_{\text{pub}}$: impact on HHI of local public firms' employment changes
- Check: AMRPL $\not\rightarrow \widehat{\text{HHI}}_{\text{pub}}$
  - Sample restricted to education and health markets
  - 60% of total public employment is in education and health
  - 55% employment in these markets in public firms (rest in private)
- Outcome: Private firms' wages
  - $\widehat{\text{HHI}}_{\text{pub}} \rightarrow \text{W}_{\text{priv}}$ if public-private belong same local labor market
  - 10-20% of job switches is public $\leftrightarrow$ private
  - Public and private wages similarly affected by HHI

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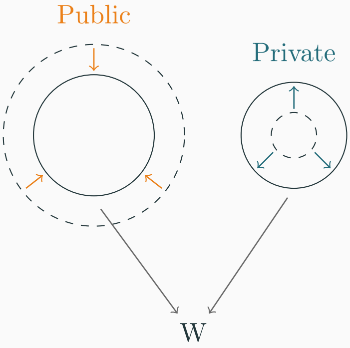

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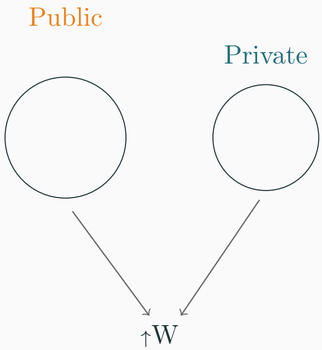

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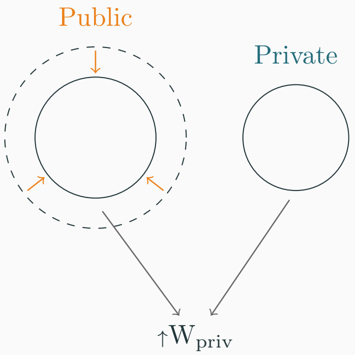

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IV strategy: IV Construction

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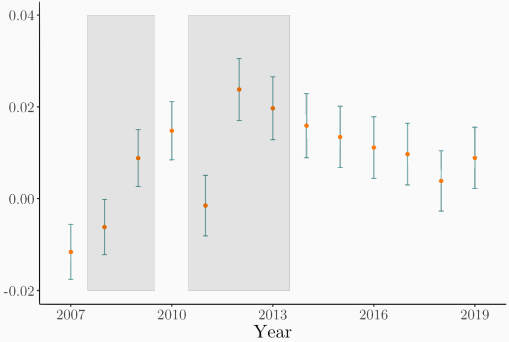
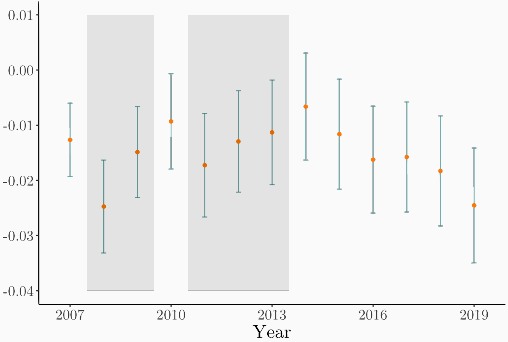
Instrument is Weakly Procyclical

(i) $\widehat{\text{HHI}}_{\text{priv}}$: change in HHI coming from private firms



(ii) $\widehat{\text{HHI}}_{\text{pub}}$: change in HHI coming from public firms



Note: Market fixed-effects included. Recession years in gray.

▸ Education and Health Markets

Local Productivity Unrelated to Instrument

	$\widehat{\text{HHI}}_{\text{priv}}$		$\widehat{\text{HHI}}_{\text{pub}}$	
	(1)	(2)	(3)	(4)
Log Productivity (AMRPL)	-0.0403**	-0.0314	0.0829*	0.0409
	(0.0169)	(0.0425)	(0.0451)	(0.0352)
Labor Market Controls	✓	✓	✓	✓
Market FE	✓	✓	✓	✓
Year FE	✓	✓	✓	✓
R^2	0.68	0.72	0.80	0.83
Observations	59,979	10,292	10,007	6,385
All Markets	✓		✓	
Education and Health Markets		✓		✓

Note: Labor market controls include average worker experience and tenure years, share of workers with high school and university education level, share of jobs by task content (five skill levels), share of workers covered by collective agreements (unions), contract types shares (temporary or permanent), share of spanish native citizens, share of male workers, share of exported revenue. Logit model. Standard errors are clustered at the market level. *$p<0.1$, **$p<0.05$, ***$p<0.01$.

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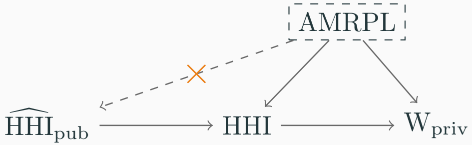
All Markets	✓		✓	
Education and Health Markets		✓		✓

Note: Labor market controls include average worker experience and tenure years, share of workers with high school and university education level, share of jobs by task content (five skill levels), share of workers covered by collective agreements (unions), contract types shares (temporary or permanent), share of spanish native citizens, share of male workers, share of exported revenue. Logit model. Standard errors are clustered at the market level. *$p<0.1$, **$p<0.05$, ***$p<0.01$.

Instrument Exogeneity

	$\widehat{\text{HHI}}_{\text{pub}}$
Log Productivity (AMRPL)	0.0409
	(0.0352)
Labor Market Controls	✓
Market FE	✓
Year FE	✓
R^2	0.83
Observations	6,385
Education and Health Markets	✓

Note: Clustered standard errors by market.

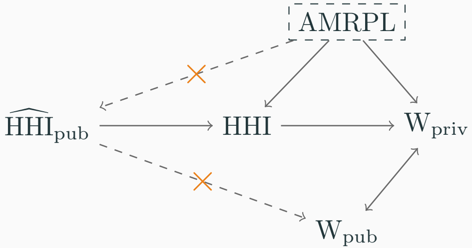


- Productivity does not predict the instrument
- IV does not predict outside option wages

Instrument Exogeneity

	$\log W_{pub}$
$\widehat{HHI}_{pub}$	-0.0260
	(0.1326)
Labor Market Controls	✓
Market FE	✓
Year FE	✓
R^2	0.31
Observations	8,246
Education and Health Markets	✓

Note: Clustered standard errors by market.



- Productivity does not predict the instrument
- IV does not predict outside option wages

IV Results

	log W_{priv}		
	(1)	(2)	(3)
HHI	-0.0734***	-0.1044***	-0.1449**
	(0.0132)	(0.0279)	(0.0623)
Labor Market Controls	✓	✓	✓
Market FE	✓	✓	✓
Year FE	✓	✓	✓
R^2	0.85	0.82	0.33
Observations	70,569	13,572	13,572
Estimation Method	OLS	OLS	IV
F-test (First Stage)	–	–	2,561
All Markets	✓		
Education and Health Markets		✓	✓

Note: Clustered standard errors by market. *p<0.1, **p<0.05, ***p<0.01.

First Stage

- Labor market power explains ∼30% of the city-size wage premium
  - IV results in line with literature (Benmelech et al 2022, Prager and Schmitt 2022)
- Nonlinear first stage: Random Forest
  - Alternative: Logit first stage Table
- Comparable IV results if:
  - Control for revenue productivity Table
  - Restrict to health and educ. markets with highest public-private flows Table
  - Include all mkts (not only health-edu) Table

Conclusion

- Labor markets in big cities are on average more competitive
  - Can explain urban wage premium, same as agglomeration economies and sorting
- Labor market power driven by productivity, which complicates estimation of wage markdowns
- Mobilize two strategies:
  - Control for revenues per worker of local firms and for heterogeneous trends across markets
  - Develop a new instrument for HHI based on changes in the employment of local public firms
- Labor market power is a first-order determinant of the city-size wage premium (20–30%)
  - Lower estimates than in previous studies (different countries and variation exploited)

Appendix

Literature

- Source of labor market power is static, not dynamic (as in e.g. Manning 2003)
    - ◇ Fix concentration, let labor supply elasticity vary (Bamford 2021, Datta 2022)
    - ◇ Fix labor supply elasticity, let concentration vary (Arnold 2021, Azar et al 2018, Benmelech et al 2022)

→ New instrument for HHI based on changes in the employment of local public firms

→ Take criticisms to HHI seriously (definition of market, endogeneity)

- Estimate agglomeration economies (De la Roca and Puga 2017)
    - ◇ Empirical (Hirsch et al 2022) and quantitative (Azkarate-Askasua and Zerecero 2022, Bamford 2021) literature that takes labor market power into account

→ New (lower) estimates: different country and source of variation exploited

Rosen-Roback Model With Labor Market Power

- Based on Moretti 2011
- Two cities, s (small) and b (big), and unit mass of workers
- Indirect utility of worker ι in city c is

$$U_{\iota c} = \log(W_c) - r_c + b_c + e_{\iota c}$$

  where r_c is cost of housing, b_c local amenities and $e_{\iota c}$ idiosyncratic preferences for city c, with relative preferences distributed as

$$e_{\iota s} - e_{\iota b} \sim U[-z, z]$$

- City b is chosen if $U_{\iota b} > U_{\iota s}$, city employment $\log(L_s)$ and $\log(L_b)$ endogenously determined

Local Labor Supply

- h_c denotes (log) housing units, and housing supply is given by

$$r_c = r + kh_c$$

- Each worker consumes one housing unit, $\log(L_c) = h_c$
- Marginal worker is indifferent between cities → local labor supply in city b:

$$\log(W_b) = \underbrace{g(s) - b_b}_{\log(\beta_{b,s})} + \underbrace{(z + k)}_{\eta^{-1}} \log(L_b),$$

$g(s) = \log(W_s) + b_s - (z + k) \log(L_s)$ measures city s attractiveness

- Labor supply in city s is symmetric

Equilibrium in Local Labor Markets

- Firms compete à la Cournot for workers in city c, but have no product market power ($P_c = 1$)
  - They are perfectly mobile across cities, but entry takes one period (N_c endogenous firms in the city)
  - Wlog, assume firms are symmetric. Their productivity A_c depends on their current city

$$\max_{l_c} A_c l_c^\theta - W(L_c) l_c$$

$$\Rightarrow W_c = \underbrace{(1 + \eta^{-1}\text{HHI}_c)^{-1}}_{\text{Markdown}} \underbrace{\theta A l_c^{\theta-1}}_{\text{AMRPL}_c}, \quad \text{HHI}_c = \frac{1}{N_c}$$

  Assume CRS ($\theta = 1$) for simplicity. Then, profits are given by

$$\pi_c = \frac{1}{(1 + N_c)^2} \frac{A_c^2}{\beta}$$

- There could also be several labor markets m within each city c (e.g. different worker types)
  - Firms and workers move across cities, but markets are islands within c
  - Firms only employ in their own market, workers don't move across markets

Equilibrium Across Cities (Firms)

- Firms pay city specific fixed cost F_c each period
  - If F_c varies over time differently across cities, exogenous variation in HHI_c (entry-exit of firms)
- Free entry commands $\pi_c = F_c$, so that

$$\frac{1}{(1+N_s)^2}\frac{A_s^2}{\beta_{s,b}} - F_s = \frac{1}{(1+N_b)^2}\frac{A_b^2}{\beta_{b,s}} - F_b = 0$$

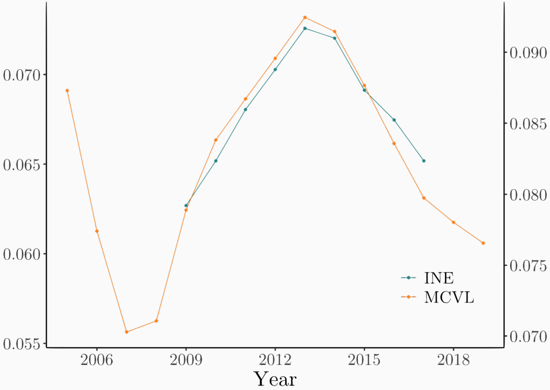
- If $\beta_{b,s} \simeq \beta_{s,b},\ F_b \simeq F_s$, then $A_b > A_s \Rightarrow N_b > N_s$ $(\text{HHI}_b < \text{HHI}_s)$:
  - Big cities are more attractive to firms, and higher firm entry means lower labor market power
  - Firms in big cities are forced to share more profits with workers $\rightarrow$ city-size wage premium

HHI and Labor Market Power

- Cournot competition used extensively in recent labor economics literature (e.g. Arnold 2021).
  - HHI is the sufficient statistic of labor market power in this class of models
- Long debate in Empirical IO that led to discard the HHI (Berry et al 2019). Main critiques:
- Definition market:
  - Supervised machine learning algorithm that estimates local labor markets which are self-contained in terms of job-to-job worker flows. Also, robustness exercises with different market definitions
- Endogeneity of HHI (e.g. short-run productivity shocks or long-run demographic changes)
  - Endogeneity is explicitly modelled and addressed with a battery of regressions (IFE, IV) and robustness checks (e.g. no recession years, measured productivity control). Short-run analysis.
- In some models, HHI and market power go in opposite direction (Vives 2008)
  - Limitations of HHI have to be set against limitations of other methods. Large literature finding consistent results when estimating monopsony power with HHI or by directly using elasticity of labor supply. Many intuitive models of LMP isomorphic to Cournot (Arnold 2021, WP)

HHI Computed in the Sample is Representative

(i) Mean HHI

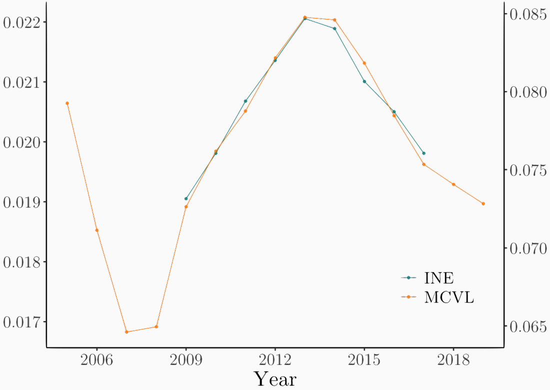


Note: National Statistics (INE) data on universe of firms and employer-employee (MCVL) data. HHI at the region-industry level (CCAA), averaged by year. INE series starts in 2009; it stops in 2017 due to a change in methodology.

More Precise

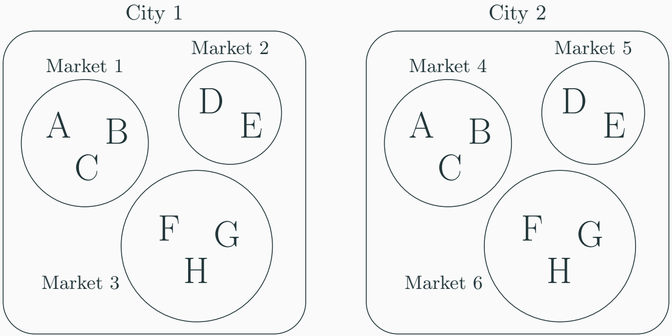
HHI Computed in the Sample is Representative

(i) Mean HHI



Note: National Statistics (INE) data on universe of firms and employer-employee (MCVL) data. HHI at the region-industry level (CCAA), averaged by year. INE series starts in 2009; it stops in 2017 due to a change in methodology.

Local Labor Markets



Note: Example of six markets in two cities, grouping industries (indexed by letters A-H) with self-contained worker flows.

Local Labor Markets

- Cities: urban areas constructed by Spain's Ministry of Housing in 2008
  - Urban municipalities connected by commuting and employment patterns
- Industries: clusters of subindustries that minimize cross-cluster and max. intra-cluster flows
  - Supervised machine learning procedure, based on Nimczik 2018
  - Degree-Corrected Stochastic Block Model using: i. j-j flows across subindustries, ii. # mkts as input
  - # mkts = 80 (like # of 2-digit industries, popular choice in the literature)
  - Model microfounded in Nimczik 2018: each firm in some subindustry belongs to latent market k
    - Two subindustries is same mkt if utility costs (of employed workers) of moving to other subind. in the city are identical (time and efficiency costs of adapting, skill transferability costs, difference in amenities)
  - Maximum likelihood estimation to recover latent industries given the inputs

Agglomeration Economies with Labor Market Power

- $\log(\text{AMRPL}_{mt})$ is unobserved
- With CRS, we have that

$$\log(\text{AMRPL}_{mt}) = \log(A_{mt}),$$

and we assume that

$$\log(A_{mt}) = \log(A_m) + \log(A_t) + \log(A_m \cdot A_t) + \epsilon^A_{mt}$$

$$\log(A_m) = \log(A_c) + \log(A_k) + \log(A_c \cdot A_k) + \epsilon^A_m$$

$$\log(A_c) = \log(A) + \underbrace{\delta}_{>0} \log(\text{density}_c) + \epsilon^A_c$$

where δ is the agglomeration elasticity.

Agglomeration Economies with Labor Market Power - Temporary Slide

- The agglomeration elasticity can be estimated in two steps:

$$\log(W_{mt}) = \underbrace{\alpha_m}_{\log(A_m)} + \underbrace{\alpha_t}_{\log(A_t)} + \underbrace{\alpha_m \cdot \alpha_t}_{\log(A_m \cdot A_t)} + \alpha X_{mt} + \underbrace{\gamma}_{<\ 0} \text{HHI}_{mt} + \underbrace{\varepsilon_{mt}}_{\epsilon^A_{mt} + \upsilon_{mt}}$$

$$\hat{\alpha}_m = \alpha_k + \delta \log(\text{density}_c) + \upsilon_m$$

where

- We control for time trends heterogeneous across markets (factor model)
- We assume $\mathbb{E}(\varepsilon_{mt} | \log(A_m), \log(A_t), \log(A_m \cdot A_t), X_{mt}, \text{HHI}_{mt}) = 0$

Agglomeration Economies with Labor Market Power - Temporary Slide

- If

$$\text{HHI}_{mt} = h_m + h_t + h_m \cdot h_t + \epsilon^h_{mt}$$

$$h_m = h + h_k + \underbrace{\lambda}_{<\,0} \log(\text{density}_c) + \epsilon^h_m$$

and we don't control for HHI_{mt} in step one, i.e., we estimate

$$\log(W_{mt}) = \underbrace{\alpha_m}_{\log(A_m)+\gamma h_m} + \alpha_t + \alpha_m \cdot \alpha_t + \alpha X_{mt} + \varepsilon_{mt}$$

$$\hat{\alpha}_m = \alpha_k + (\delta + \underbrace{\gamma\lambda}_{>\,0}) \log(\text{density}_c) + \upsilon_m,$$

- Then, the agglomeration elasticity is estimated with bias

Agglomeration Economies with Labor Market Power

- Calling $\hat{\delta}^{\text{HHI}}$ the agglomeration elasticity when we control for HHI and $\hat{\delta}$ the elasticity when we do not, the extent of the bias is

$$\frac{\hat{\delta} - \hat{\delta}^{\text{HHI}}}{\hat{\delta}} \longrightarrow \frac{\gamma\lambda}{\delta + \gamma\lambda}$$

- This is the part of the CSWP that can be explained by HHI differences across cities, and not by agglomeration economies

Agglomeration Economies with Amenities

- With DRS, $\log(\text{AMRPL}_{mt})$ also depends on city amenities $\log(\beta_c)$
  - Positive shock to amenities $\rightarrow$ workers accept lower wages $\rightarrow$ firms employ more workers, marginally less productive (w/ DRS)
- If amenities correlate w/ density, we have further (ambiguous) bias

$$\log(\beta_c) = \log(\beta) + \underbrace{\rho}_{\lesseqgtr 0} \log(\text{density}_c) + \epsilon_c^b$$

- If $\hat{\delta}^b$ and $\hat{\delta}^{b,\text{HHI}}$ are the agglomeration elasticities when we control for amenities and both HHI and amenities, the bias is now (ω is a function of γ and θ)

$$\frac{\hat{\delta} - \hat{\delta}^{\text{HHI},b}}{\hat{\delta}} \longrightarrow \frac{(1-\omega)\rho + \gamma\lambda}{\omega\delta + (1-\omega)\rho + \gamma\lambda}$$

$$\frac{\hat{\delta}^b - \hat{\delta}^{\text{HHI},b}}{\hat{\delta}^b} \longrightarrow \frac{\gamma\lambda}{\omega\delta + \gamma\lambda}$$

Agglomeration Economies with Amenities - Temporary Slide

- With DRS, $\log(\text{AMRPL}_{mt})$ further depends on the supply intercept (i.e. on amenities, $\log(\beta_c) = b - b_c$) and on HHI_{mt}. Then, if

$$\log(\beta_{mt}) = \log(\beta_c) + \log(\beta_k) + \log(\beta_t) + \log(\beta_c \cdot \beta_k) + \log(\beta_m \cdot \beta_t) + \epsilon^{\beta}_{mt}$$

$$\log(\beta_c) = \log(\beta) + \underbrace{\rho}_{\lesseqgtr 0} \log(\text{density}_c) + \epsilon^{b}_{c}$$

we estimate the first step

$$\log W_{mt} = \underbrace{(\omega - 1)\gamma\psi_1 + \omega \log\theta + \omega \log A_m + (1-\omega)\log\beta_m}_{\alpha_m} +$$

$$\alpha_t + \alpha_m \cdot \alpha_t - \gamma(1 + \underbrace{(1-\omega)\psi_2}_{>0})\text{HHI}_{mt} + \alpha X_{mt} + \varepsilon_{mt}$$

Agglomeration Economies with Amenities - Temporary Slide

- Second step controlling and not controlling for amenities

$$\hat{\alpha}_m = \alpha_k + \underbrace{(\omega\delta + (1-\omega)\rho)}_{\delta^{\text{HHI}}} \log(\text{density}_c) + \upsilon_m$$

$$\hat{\alpha}_m = \alpha_k - (1-\omega)b_c + \underbrace{\omega\delta}_{\delta^{\text{HHI},b}} \log(\text{density}_c) + \upsilon_m$$

- If $\hat{\delta}^b$ and $\hat{\delta}^{b,\text{HHI}}$ are the agglomeration elasticities when we control for amenities and both HHI and amenities, the bias is now (ω is a function of γ and θ)

$$\frac{\hat{\delta} - \hat{\delta}^{\text{HHI},b}}{\hat{\delta}} \longrightarrow \frac{(1-\omega)\rho + \gamma\lambda}{\omega\delta + (1-\omega)\rho + \gamma\lambda}$$

$$\frac{\hat{\delta}^b - \hat{\delta}^{\text{HHI},b}}{\hat{\delta}^b} \longrightarrow \frac{\gamma\lambda}{\omega\delta + \gamma\lambda}$$

Without Financial Crisis

When excluding recession years (2008-2012), results are similar

	log W				
	(1)	(2)	(3)	(4)	(5)
HHI	-0.0738***	-0.0715***	-0.0557***	-0.0813***	-0.0664***
	(0.0140)	(0.0150)	(0.0170)	(0.0098)	(0.0140)
Sales HHI	-0.0101	-0.0128	0.0093	-0.0140	-0.0097
	(0.0072)	(0.0089)	(0.0094)	(0.0070)	(0.0086)
Labor Market Controls	✓	✓	✓	✓	✓
Interactive FE				✓	✓
Market FE	✓	✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓
R^2	0.85	0.87	0.86	0.95	0.92
Observations	64,246	42,738	30,889	48,270	22,526
Sample Years	All (2005-2019)	2005-2007 & 2013-2019	2013-2019	All (2005-2019)	2013-2019

Note: Standard errors are clustered at the market level in (1), (2) and (3). $^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$.

Controlling for Firms' Revenue

Accounting for measured productivity does not affect estimates in the interactive fixed-effects model

	log W					
	(1)	(2)	(3)	(4)	(5)	(6)
Log Productivity (AMRPL)		0.0251***	0.0000	0.0030	-0.0001	0.0080**
		(0.0056)	(0.0031)	(0.0034)	(0.0031)	(0.0028)
HHI	-0.1047***	-0.0982***	-0.0738***	-0.0469**	-0.0613***	-0.0816***
	(0.0176)	(0.0171)	(0.0140)	(0.0200)	(0.0141)	(0.0098)
Sales HHI	0.0299***	0.0192*	-0.0100	-0.0133	-0.0049	-0.0218**
	(0.0109)	(0.0110)	(0.0076)	(0.0086)	(0.0079)	(0.0075)
Labor Market Controls	✓	✓	✓	✓	✓	✓
Interactive FE						✓
City-Year, Industry-Year FE					✓	Absorbed
Market FE			✓	✓	✓	✓
Year FE	✓	✓	✓	✓	✓	✓
City FE	✓	✓	Absorbed	Absorbed	Absorbed	Absorbed
Industry FE	✓	✓	Absorbed	Absorbed	Absorbed	Absorbed
R^2	0.71	0.71	0.85	0.89	0.86	0.89
Observations	64,246	64,246	64,246	48,270	64,246	48,270
Panel	Unbalanced	Unbalanced	Unbalanced	Balanced	Unbalanced	Balanced

Note: Standard errors are clustered at the city-industry level in (1) and (2) and the market level in (3), (4) and (5).

Controlling for Unemployment

Accounting for the local unemployment rate does not affect estimates

	$\log W_{priv}$	
	(1)	(2)
HHI	-0.0738***	-0.0756***
	(0.0140)	(0.0160)
Sales HHI	-0.0101	-0.0056
	(0.0072)	(0.0076)
Log Productivity (AMRPL)		0.0016
		(0.0033)
Unemployment Rate		0.0224
		(0.0684)
Labor Market Controls	✓	✓
Market FE	✓	✓
Year FE	✓	✓
R^2	0.85	0.86
Observations	64,246	59,540

Note: Clustered standard errors at the market level.
$^{*}p<0.1$, $^{**}p<0.05$, $^{***}p<0.01$.

- Unemployment rate computed with administrative data on unemp. benefits
- Unemployment rate at the market level:
  - City of residence of recipients
  - Industries where recipients have been employed at some point of their working life (fraction)

Controlling for City Amenities

After accounting for amenities, unchanged role of labor market power in explaining CSWP

Step 2: $\hat{\alpha}_m = \alpha_j + \delta \text{logCitySize}_c + \alpha \text{Amenities}_c + v_m$

	$\hat{\alpha}_m$			
	(1)	(2)	(3)	(4)
Log City Size	0.0929***	0.0952***	0.0765***	0.0790***
	(0.0059)	(0.0063)	(0.0056)	(0.0058)
Log Precipitations		0.0154**		0.0111
		(0.0070)		(0.0069)
Log Distance from Coast		0.0069**		0.0042
		(0.0033)		(0.0033)
Log Mean Temperature		-0.0408*		-0.0487**
		(0.0240)		(0.0234)
Water Within 25km (%)		0.0001		-0.0000
		(0.0002)		(0.0002)
Industry FE	✓	✓	✓	✓
R^2	0.38	0.39	0.38	0.39
Observations	5,027	5,027	5,027	5,027
Step 1 with HHI			✓	✓

Note: Clustered standard errors at the industry level.

- No strong evidence of bias coming from omitting natural amenities
  - Reduced agglomeration but same role LMP if control for (endogenous) amenities: pollution, commuting time, crime, movie theaters Table
- Labor market power explains ~20% of the city-size wage premium

Controlling for Endogenous City Amenities

	$\hat{\alpha}_m$			
	(1)	(2)	(3)	(4)
Log City Size	0.0929***	0.0795***	0.0765***	0.0636***
	(0.0059)	(0.0081)	(0.0056)	(0.0077)
Log Precipitations		0.0202***		0.0157**
		(0.0069)		(0.0068)
Log Distance from Coast		0.0131***		0.0093**
		(0.0046)		(0.0045)
Log Mean Temperature		-0.0570**		-0.0616**
		(0.0244)		(0.0238)
Water Within 25km (%)		0.0006**		0.0004*
		(0.0003)		(0.0002)
Log Pollution (NO2 Conc.)		0.0379***		0.0311***
		(0.0083)		(0.0081)
Log Mean Commuting Time		-0.0467		-0.0273
		(0.0330)		(0.0323)
Log Crimes per Person		0.0527***		0.0414***
		(0.0077)		(0.0075)
Log Cinemas per Person		0.0308***		0.0344***
		(0.0110)		(0.0108)
Industry FE	✓	✓	✓	✓
R^2	0.38	0.39	0.38	0.39
Observations	5,027	5,027	5,027	5,027
Step 1 with HHI			✓	✓

Note: Clustered standard errors at the industry level.

Instrumenting City Size

Using historical determinants of population as IV, similar role of LMP in explaining CSWP

Step 2: $\hat{\alpha}_m = \alpha_j + \delta \text{logCitySize}_c + \upsilon_m$

	$\hat{\alpha}_m$			
	(1)	(2)	(3)	(4)
Log City Size	0.0929***		0.0765***	
	(0.0059)		(0.0056)	
Log $\widehat{\text{City}}$ Size		0.1018***		0.0835***
		(0.0067)		(0.0063)
Industry FE	✓	✓	✓	✓
R^2	0.38	0.39	0.38	0.39
Observations	5,027	5,027	5,027	5,027
Estimation Method	OLS	IV	OLS	IV
F-test (First Stage)	–	1,591	–	1,591
Step 1 with HHI			✓	✓

Note: Clustered standard errors at the industry level.

▸ First Stage

- Reverse causality: IV based on historical determinants in population, from De la Roca and Puga 2017
  - City size in 1900, roman roads, land fertility, terrain slope, elevation, water bodies
  - Similar results without city size in 1990
- Instrumenting city size does not change estimates much, in line with the literature (Combes et al 2010)
  - Labor market power explains 22% → 18% of the city-size wage premium

Instrumenting City Size, First Stage

	Log City Size
Log City Size in 1900	0.6538***
	(0.0017)
Fertile Land Within 25km (%)	0.0143***
	(0.0002)
Water Within 25km (%)	0.0058***
	(0.0000)
Steep Terrain Within 25km (%)	-0.0134***
	(0.0001)
Log Mean Elevation Within 25km (%)	0.2800***
	(0.0025)
Roman Road Rays Within 25km	0.0694***
	(0.0009)
Industry FE	✓
R^2	0.66
Observations	5,027
F-test	1,591

Note: Clustered standard errors at the industry level.

Measuring Market Productivity

- Market productivity approximated by avg. firm revenue per worker, employm. share weighted:

$$\widetilde{\text{AMRPL}}_{mt} \simeq \sum_i s_{it} \frac{P_{it} Y_{it}}{l_{it}}$$

- If production function Cobb-Douglas, the approximation is exact up to a constant
- Measured with balance sheet data, available for 90% of market-years

Constructing the IV

- Market with 4 competing firms $\overbrace{a, b}^{\text{Public}} + \overbrace{c, d}^{\text{Private}}$ with employment and concentration level:

$$E_t = \underbrace{e^{\text{pub}}_{a,t} + e^{\text{pub}}_{b,t}}_{E^{\text{pub}}_t} + \underbrace{e^{\text{priv}}_{c,t} + e^{\text{priv}}_{d,t}}_{E^{\text{priv}}_t}$$

$$\text{HHI}_t = \frac{\left(e^{\text{pub}}_{a,t}\right)^2 + \left(e^{\text{pub}}_{b,t}\right)^2 + \left(e^{\text{priv}}_{c,t}\right)^2 + \left(e^{\text{priv}}_{d,t}\right)^2}{\left(E_t\right)^2}$$

- Concentration next period is

$$\text{HHI}_{t+1} = \frac{\left(e^{\text{pub}}_{a,t} + \Delta e^{\text{pub}}_{a,t}\right)^2 + \left(e^{\text{pub}}_{b,t} + \Delta e^{\text{pub}}_{b,t}\right)^2 + \left(e^{\text{priv}}_{c,t} + \Delta e^{\text{priv}}_{c,t}\right)^2 + \left(e^{\text{priv}}_{d,t} + \Delta e^{\text{priv}}_{d,t}\right)^2}{\left(E_t + \Delta E^{\text{pub}}_t + \Delta E^{\text{priv}}_t\right)^2}$$

Constructing the IV

$$\text{HHI}_{t+1} = \frac{\left(e_{a,t}^{\text{pub}} + \Delta e_{a,t}^{\text{pub}}\right)^2 + \left(e_{b,t}^{\text{pub}} + \Delta e_{b,t}^{\text{pub}}\right)^2 + \left(e_{c,t}^{\text{priv}} + \Delta e_{c,t}^{\text{priv}}\right)^2 + \left(e_{d,t}^{\text{priv}} + \Delta e_{d,t}^{\text{priv}}\right)^2}{\left(E_t + \Delta E_t^{\text{pub}} + \Delta E_t^{\text{priv}}\right)^2}$$

- Suppose changes in public employment are "exogenous" to local productivity shocks. Then

$$\widehat{\text{HHI}}_{t+1}^{\text{pub}} = \frac{\left(e_{a,t}^{\text{pub}} + \Delta e_{a,t}^{\text{pub}}\right)^2 + \left(e_{b,t}^{\text{pub}} + \Delta e_{b,t}^{\text{pub}}\right)^2}{\left(E_t + \Delta E_t^{\text{pub}}\right)^2}$$

  is a candidate instrument for HHI_{t+1}

Constructing the IV

$$\mathrm{HHI}_{t+1} = \frac{\left(e^{\text{pub}}_{a,t} + \Delta e^{\text{pub}}_{a,t}\right)^2 + \left(e^{\text{pub}}_{b,t} + \Delta e^{\text{pub}}_{b,t}\right)^2 + \left(e^{\text{priv}}_{c,t} + \Delta e^{\text{priv}}_{c,t}\right)^2 + \left(e^{\text{priv}}_{d,t} + \Delta e^{\text{priv}}_{d,t}\right)^2}{\left(E_t + \Delta E^{\text{pub}}_t + \Delta E^{\text{priv}}_t\right)^2}$$

- Similarly, we can define

$$\widehat{\mathrm{HHI}}^{\text{priv}}_{t+1} = \frac{\left(e^{\text{priv}}_{c,t} + \Delta e^{\text{priv}}_{d,t}\right)^2 + \left(e^{\text{priv}}_{b,t} + \Delta e^{\text{priv}}_{b,t}\right)^2}{\left(E_t + \Delta E^{\text{priv}}_t\right)^2}$$

Private and Public Wages

Private and public wages in the same local labor market are similarly affected by changes in HHI

	W_{priv}	W_{pub}	W_{all}
	(1)	(2)	(3)
HHI	-0.0734***	-0.0713*	-0.0733***
	(0.0132)	(0.0415)	(0.0127)
Labor Market Controls	✓	✓	✓
Market FE	✓	✓	✓
Year FE	✓	✓	✓
R^2	0.85	0.87	0.86
Observations	70,569	11,987	71,527
Private Firms	✓		✓
Public Firms		✓	✓

Note: Labor market controls include average worker experience and tenure years, share of workers with high school and university education level, share of jobs by task content (five skill levels), share of workers covered by collective agreements (unions), contract types shares (temporary or permanent), share of spanish native citizens, share of male workers, share of exported revenue. Standard errors are clustered at the market level. *$p<0.1$, **$p<0.05$, ***$p<0.01$.

Private-Public Job Switches

(i) Across Health and Education Markets

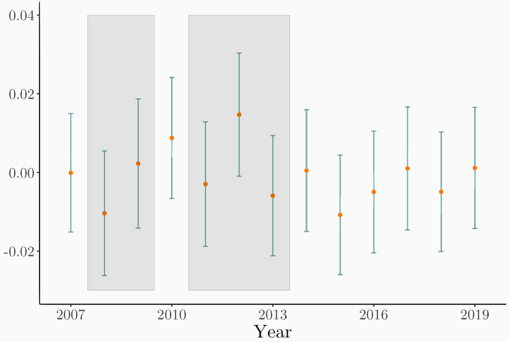
$$\begin{array}{rc} & \begin{array}{cc} \text{Private}_t & \text{Public}_t \end{array} \\ \begin{array}{r} \text{Private}_{t-1} \\ \text{Public}_{t-1} \end{array} & \begin{bmatrix} .81 & .19 \\ .17 & .83 \end{bmatrix} \end{array}$$

(ii) Within Health and Education Markets

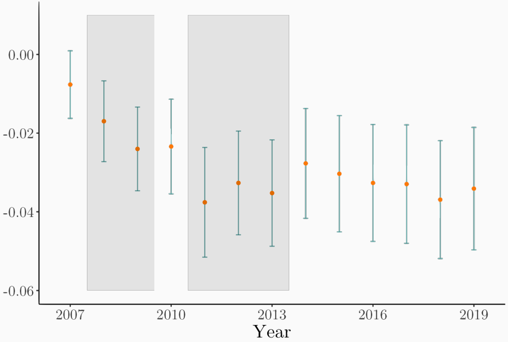
$$\begin{array}{rc} & \begin{array}{cc} \text{Private}_t & \text{Public}_t \end{array} \\ \begin{array}{r} \text{Private}_{t-1} \\ \text{Public}_{t-1} \end{array} & \begin{bmatrix} .88 & .12 \\ .10 & .90 \end{bmatrix} \end{array}$$

Instrument is Weakly Procyclical

(i) $\widehat{\text{HHI}}_{\text{priv}}$: change in HHI coming from private firms



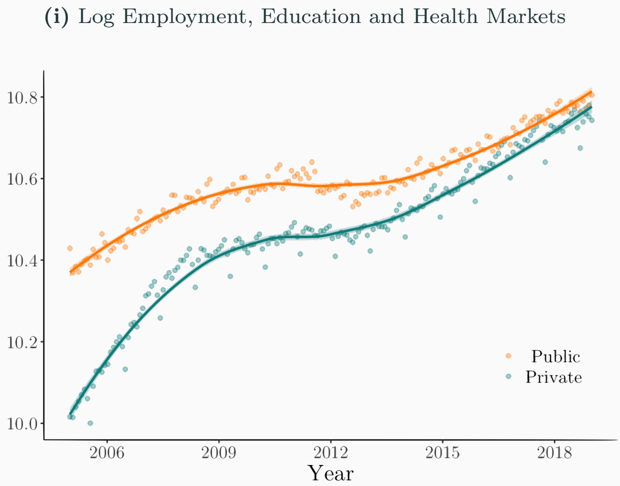
(ii) $\widehat{\text{HHI}}_{\text{pub}}$: change in HHI coming from public firms



Note: Education and health education related local labor markets. Market fixed-effects included. Recession years in gray.

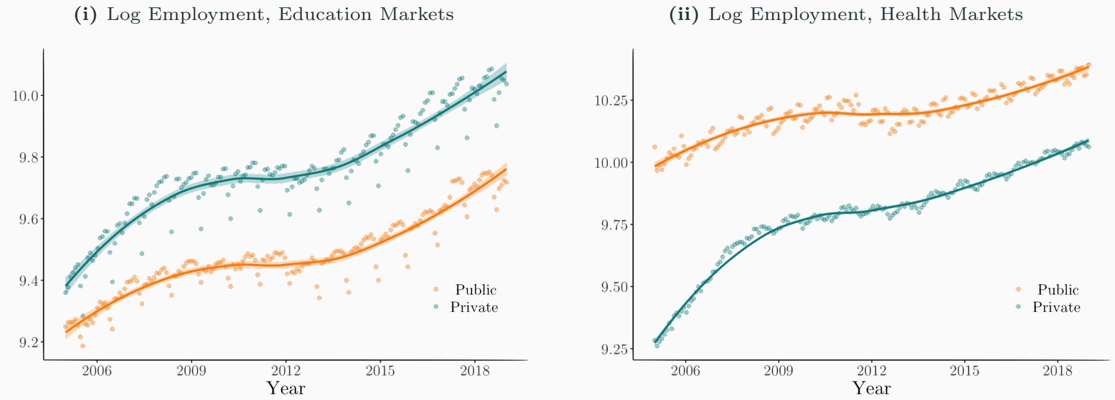
Aggregate Employment

Aggregate Employment in Health and Education



▸ Education and Health Separate

Aggregate Employment in Health and Education



IV Results, First Stage

	HHI	log W_{priv}
	(1)	(2)
$\widehat{HHI}_{pub,\ forest}$	1.290***	-0.1872***
	(0.0253)	(0.0553)
Labor Market Controls	✓	✓
Market FE	✓	✓
Year FE	✓	✓
R^2	0.48	0.13
Observations	13,572	13,572
Regression	First Stage	Reduced Form
F-test	2,561	–
Education and Health Markets	✓	✓

Note: Clustered standard errors at the market level. *$p<0.1$, **$p<0.05$, ***$p<0.01$.

IV Results, First Stage (Logit)

	HHI	log W_{priv}	
	(1)	(2)	(3)
$\widehat{\text{HHI}}_{\text{pub, logit}}$	1.066***	-0.2092*	
	(0.0556)	(0.1135)	
HHI			-0.1964*
			(0.1065)
Labor Market Controls	✓	✓	✓
Market FE	✓	✓	✓
Year FE	✓	✓	✓
R^2	0.82	0.82	0.82
Observations	13,900	13,166	13,166
Regression	First Stage	Reduced Form	IV
F-test (First Stage)	621.5	–	621.5
Education and Health Markets	✓	✓	✓

Note: Clustered standard errors by market. *$p<0.1$, **$p<0.05$, ***$p<0.01$.

IV Results

Controlling for market productivity (firms' revenues)

	$\log W_{priv}$		
	(1)	(2)	(3)
HHI	-0.1670**	-0.2265**	-0.2076***
	(0.0656)	(0.0744)	(0.0305)
AMRPL Control	✓		
Labor Market Controls	✓	✓	✓
Market FE	✓	✓	✓
Year FE	✓	✓	✓
R^2	0.31	0.38	0.31
Observations	12,658	7,084	56,747
F-test (First Stage)	2,080	1,196	14,034
Sample	Health and Education (H&E)	Highest Pub-Priv Flows H&E	All Markets

Note: Clustered standard errors at the market level. *$p<0.1$, **$p<0.05$, ***$p<0.01$.

IV Results

Restricted to health and educ. markets with highest job flows between public and private firms

	log W_{priv}		
	(1)	(2)	(3)
HHI	-0.1670**	-0.2265**	-0.2076***
	(0.0656)	(0.0744)	(0.0305)
AMRPL Control	✓		
Labor Market Controls	✓	✓	✓
Market FE	✓	✓	✓
Year FE	✓	✓	✓
R^2	0.31	0.38	0.31
Observations	12,658	7,084	56,747
F-test (First Stage)	2,080	1,196	14,034
Sample	Health and Education (H&E)	Highest Pub-Priv Flows H&E	All Markets

Note: Clustered standard errors at the market level. *p<0.1, **p<0.05, ***p<0.01.

IV Results

Including all markets (not only health and education industries)

	log W_{priv}		
	(1)	(2)	(3)
HHI	-0.1670**	-0.2265**	-0.2076***
	(0.0656)	(0.0744)	(0.0305)
AMRPL Control	✓		
Labor Market Controls	✓	✓	✓
Market FE	✓	✓	✓
Year FE	✓	✓	✓
R^2	0.31	0.38	0.31
Observations	12,658	7,084	56,747
F-test (First Stage)	2,080	1,196	14,034
Sample	Health and Education (H&E)	Highest Pub-Priv Flows H&E	All Markets

Note: Clustered standard errors at the market level. *p<0.1, **p<0.05, ***p<0.01.