Formal Employment is a Consequence of Skill Diversity in Cities

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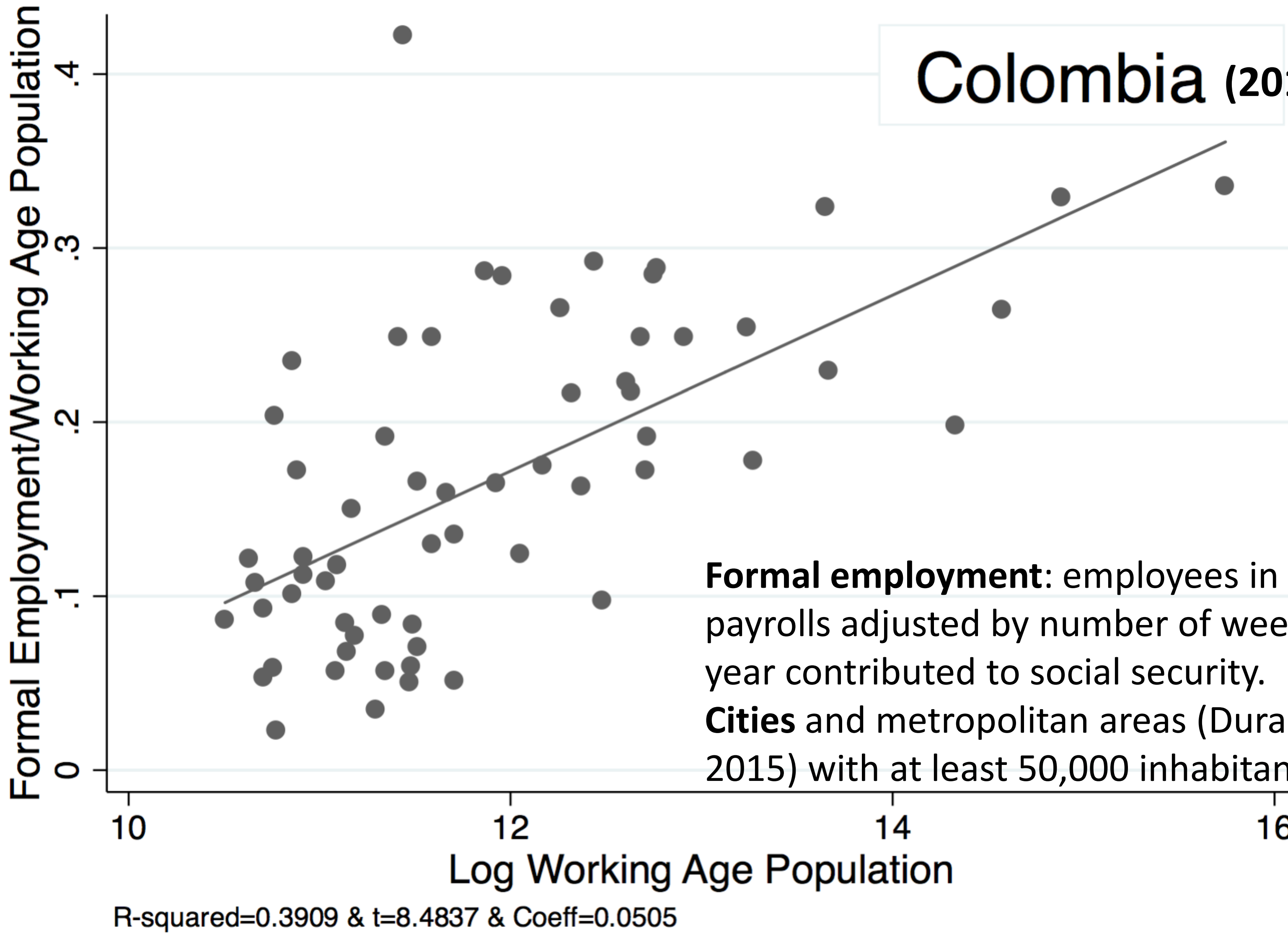
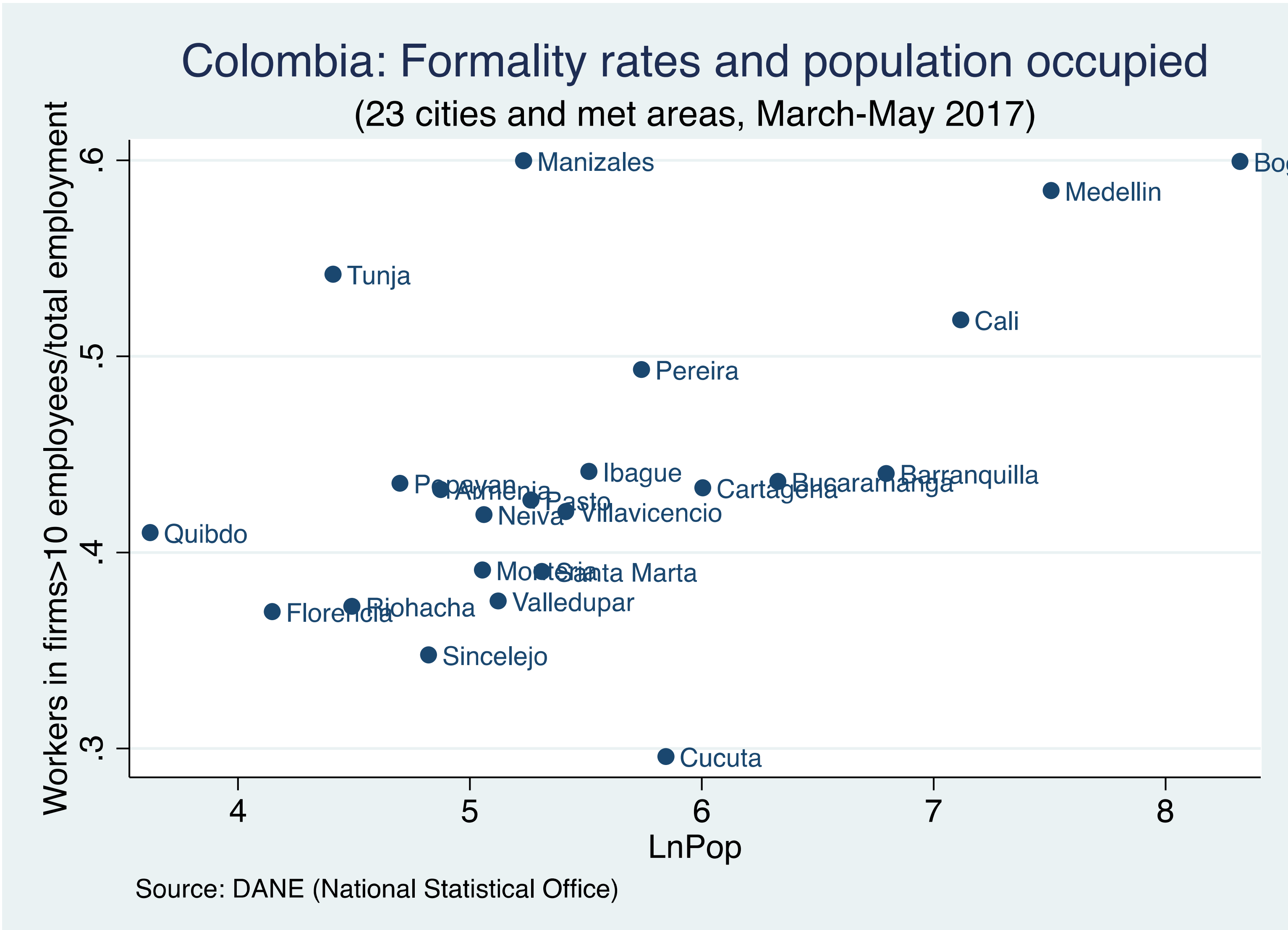
Larger cities have higher formal occupation rates (formal employment/working age population)

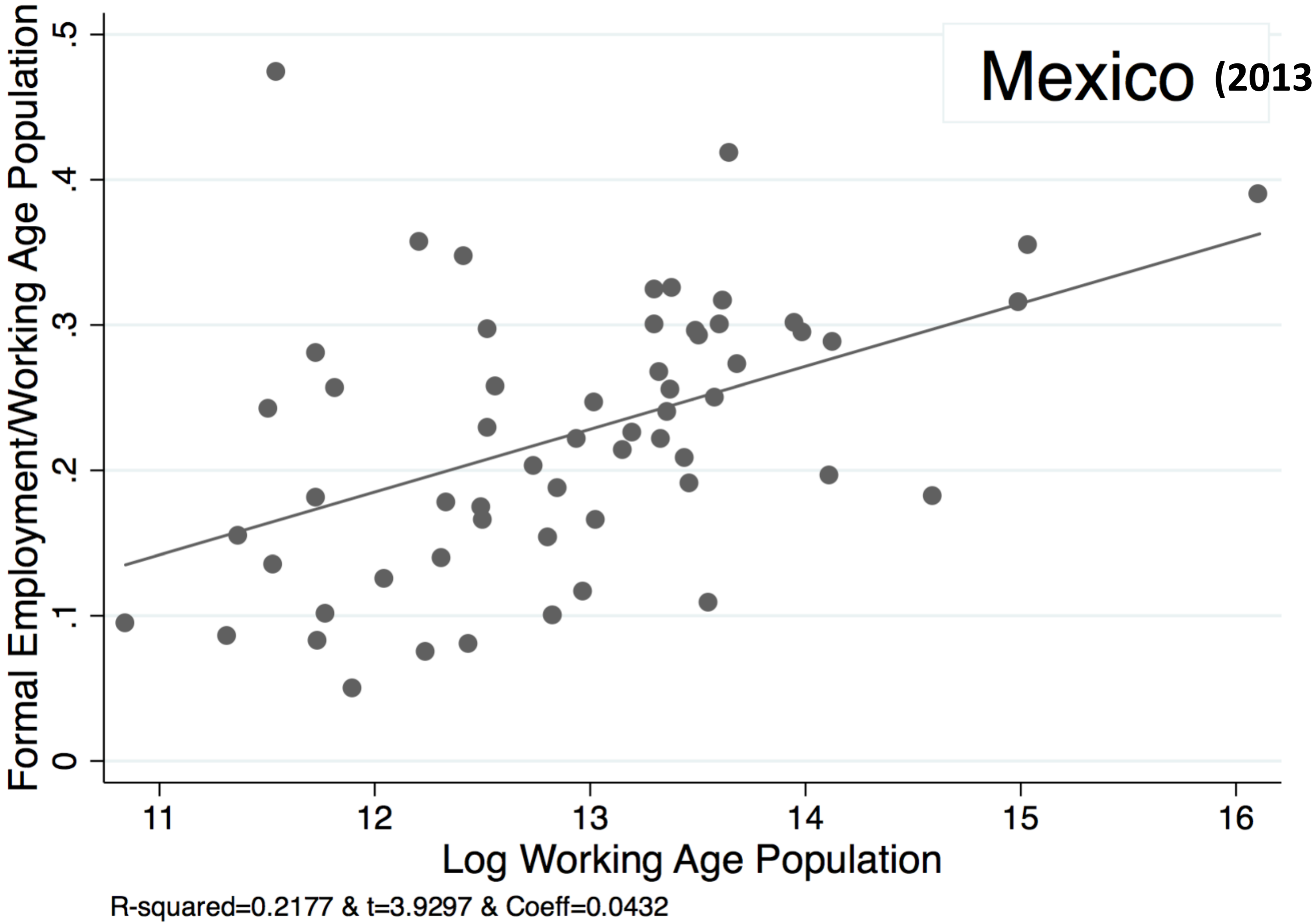


Formal employment: employees in firms' payrolls adjusted by number of weeks in year contributed to social security.
Cities and metropolitan areas (Duranton, 2015) with at least 50,000 inhabitants.

Larger cities have higher "formality rates" (employees in firms > 10 employees/total employment)



Larger cities have higher formal occupation rates

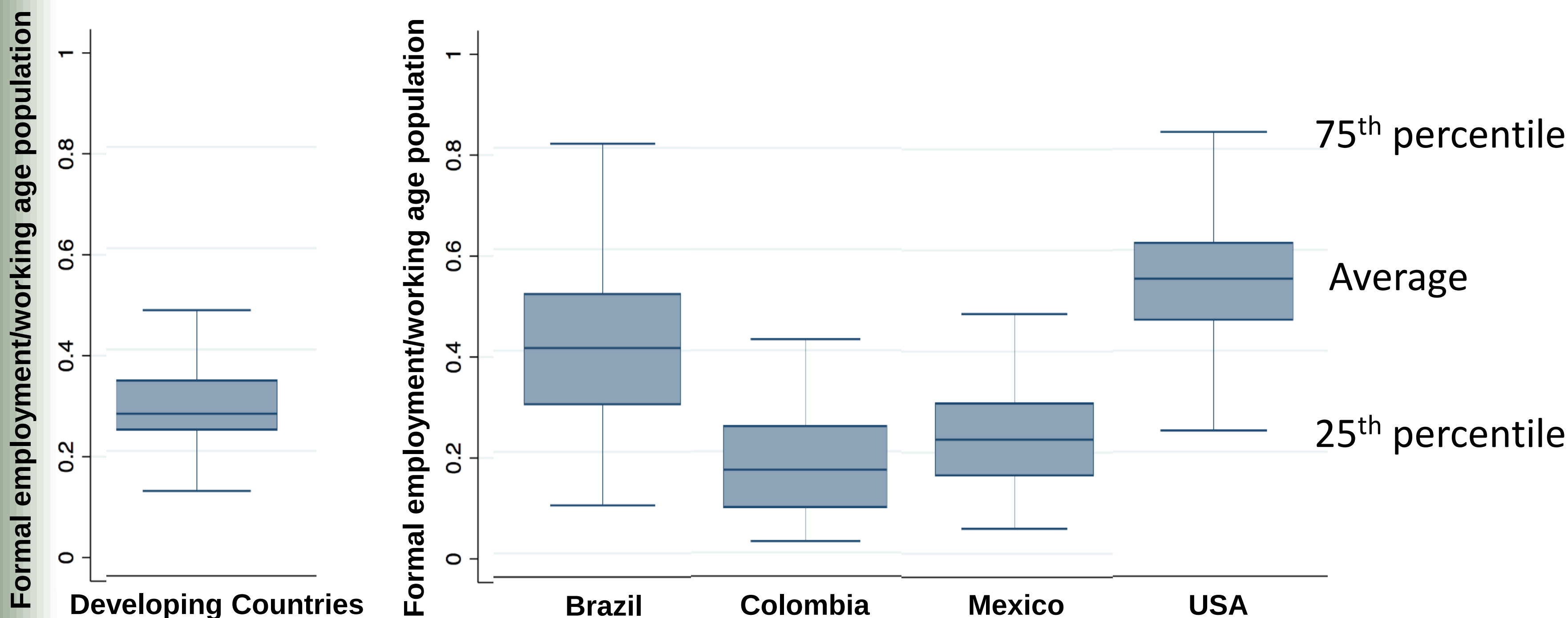


Larger cities have higher formal occupation rates

Larger cities have higher formal occupation rates

Cities have a lot to tell us on (in)formality

Formal occupation rates: formal employment/working age population



This talk

- Motivation
- Main ideas in our theory of (in)formality
- Theoretical model
- Measuring complexity when skills are unobservable
- Testing model predictions
- Further evidence
- Concluding remarks.

Main ideas in our theory of labor (in)formality

- Focus on **cities**, rather than countries:
  - Cities are the actual places where labor markets operate. Cities exist because they give firms access to pools of workers, and give workers access to alternative employment sources (Glaeser, 2011)

What is “new” in our theory of labor (in)formality

- Focus on **cities**, rather than countries
- Emphasis in **skill diversity** (in cities), rather than skill or education attainment:
  - Agglomeration economies result (in part) from the interaction between individuals with different skills (Marshall 1890; Lucas 1978; Duranton and Puga 2004, 2010; Glaeser 1999; Glaeser & Resseger 2010)

What is “new” in our theory of labor (in)formality

- Focus on **cities**, rather than countries
- Emphasis in **skill diversity** (in cities)
- Firms exist because of **tacit knowledge**:

  Firms exist to solve incomplete contracting problems (Coase 1937). Firms solve the incomplete contracting problem that results from the inability of markets to contract over tacit knowledge (Grant 1996)

What is “new” in our theory of labor (in)formality

- Focus on **cities**, rather than countries
- Emphasis in **skill diversity** (in cities)
- Firms exist because of **tacit knowledge**
- **Informal labor** (i.e not in organized firms) exists because some goods can be produced with few (non-specialized) skills
  - Not denying that labor taxes, minimum wages and other interventions may curtail formal employment creation (Levy 2008, 2010; Kugler & Kugler, 2009; Kugler, Kugler & Prada, 2017).

What is “new” in our theory of labor (in)formality

- Focus on **cities**, rather than countries
- Emphasis in **skill diversity** (in cities)
- Firms exist because of **tacit knowledge**
- **Informal labor** in productions with few skills
- **Firms evolve** by tinkering with skills:
  - The set of feasible technologies (products) is not known in advance, but discovered by recombining skills (Beinhoker 2006, Ch. 11)

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Theoretical Model (1)

Workers: $i \in \{1, \dots, N_t\}$ Skills: $\mathrm{Z} = \{0,1, \dots, S\}$

Skill Complexity: $\delta(S) > \delta(S-1) \dots \delta(1) > \delta(0)$

Some skills are harder to learn than others

Worker's skill endowment: $K(i) \in Z$

Supply of workers with skill *k*: $S_t(k)$ $\sum_{k=0}^{S} S_t(k) = N_t$

Output of informal work: $y_t^i = h\left(A_t^i, K(i)\right)$

Theoretical Model (2)

Industries: J

the set of all possible and meaningful subsets of Z

Skills: $\mathrm{Z} = \{0, 1, \ldots, S\}$

A firm's industry: $j_t(r) \in J$ *An industry is a subset of skills.*

$$y_t^r = A_t^r \left[\sum_{k \epsilon j_t(r)} l_t^r(k)^\rho \right]^{\frac{1}{\rho}}$$

Firms combine skills to produce output, but the relevant set of skills depends on the firm's industry.

Elasticity of substitution between skills:

$$1/(1 - \rho)$$

Theoretical Model (3)

Minimum Wage

Labor costs: $$\sum_{k \in j_t(r)} \theta_t(k) \; * \; \overline{w}_t \; * \; l_t^r(k)$$

$\theta_t(k)$ proportional to skill complexity, $\delta(k)$.

Labor demand

Industry complexity: $$C_t^j = \sum_{k \,\epsilon\, j} \theta_t(k)^{\frac{\rho}{\rho - 1}}$$

It measures the portfolio of skills which must be combined in order to produce output.

Optimal labor demand: $$l_t^r(k)^* = \left(\frac{y_t^r}{A_t^r}\right) \left(\theta_t(k)\right)^{\frac{1}{\rho - 1}} \left(C_t^{j_t(r)}\right)^{\frac{-1}{\rho}}$$

Theoretical Model (4)

The probability that a firm which currently operates in industry j transitions into industry j'

$$E_t\left(C_{t+1}^{j} \mid j_t(r) = j\right) = p\, C_t^{j} + (1-p)\underbrace{\left[\sum_{j' \in J} \beta_t(j, j')\, C_t^{j'}\right]}_{\text{Complexity Potential}}$$

*The industry in which a firm operates follows an **evolutionary process**.*

$$F_{t+1} = \sum_{r} \sum_{k \in j_{t+1}(r)} l_{t+1}^{r}(k)^{*}$$

$$= \sum_{r}\left[\left(\frac{y_{t+1}^{r}}{A_{t+1}^{r}}\right)\left(C_{t+1}^{j}\right)^{\frac{-1}{\rho}} \sum_{k \in j_{t+1}(r)} \left(\theta_{t+1}(k)\right)^{\frac{1}{\rho - 1}}\right]$$

Aggregate formal employment in a city depends on current complexity of all its firms, which in turn depend on past complexity potential

Theoretical Model: Main Predictions

(1) The entry rate of firms is higher among low-complexity industries.

(2) Average wages are higher in more complex industries.

(3) A positive correlation between the size of cities and total formal employment.

- City-wide skill accumulation should follow a "geological layers process".

(4) City-wide formal employment creation at $t + 1$ depends on complexity potential at t

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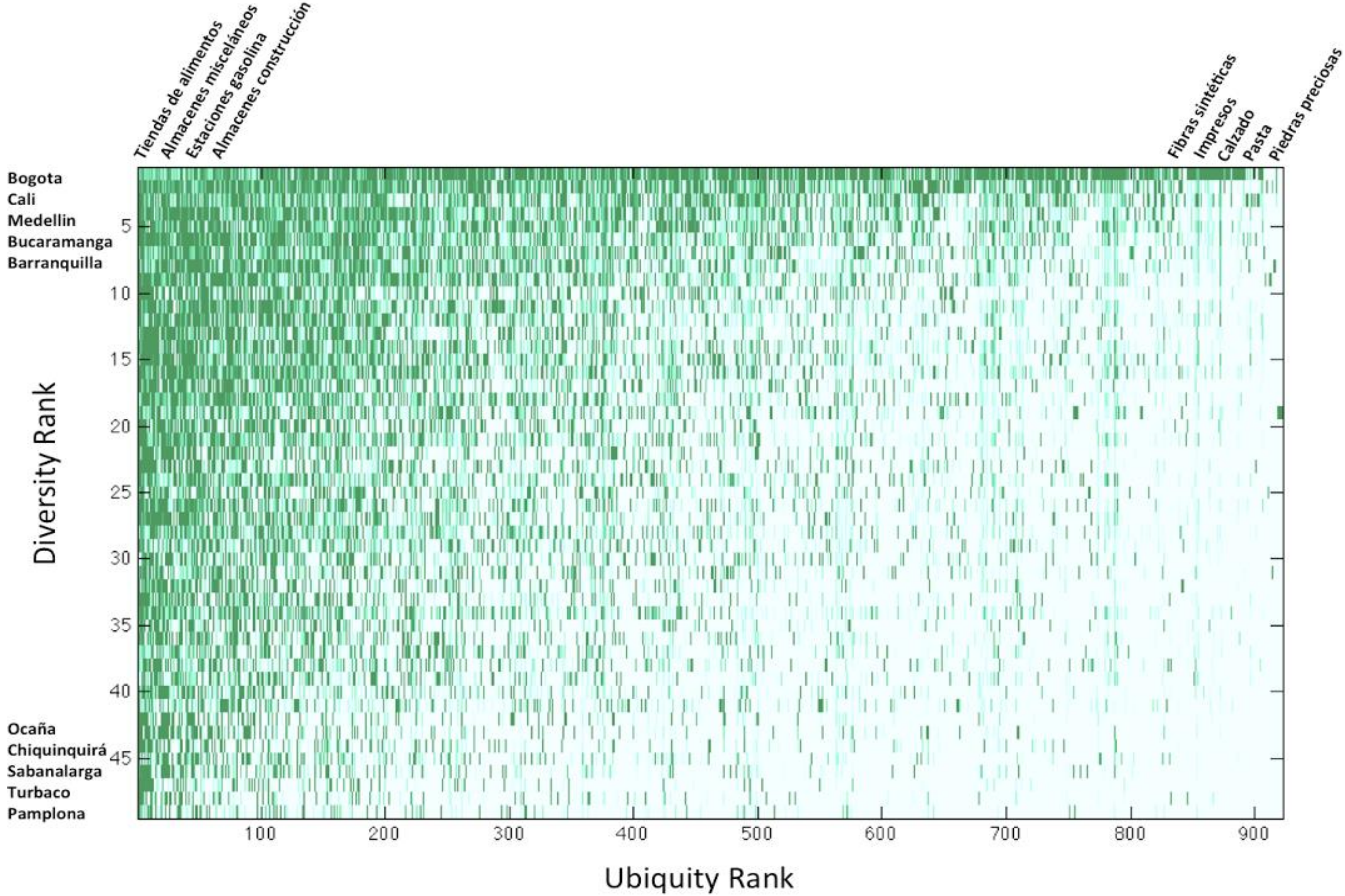
Measuring complexity when skills are unobservable

- Complexity: "A measure of the amount of productive capabilities that an industry requires to operate (…). Industries are complex when they require a sophisticated level of productive knowledge (…) with many individuals with distinct specialized knowledge interacting in a large organization".
- We adapt a method developed by Hidalgo and Hausmann (2009) that employs international trade data to estimate the complexity of products and nations.
- We use employment by city and industry contained in the social security data for Colombia (PILA) to compute a proxy for industry and city complexity.
- First we compute a matrix of city x industry presences (RCA>1), and sort the rows (cities) and columns (industries) by the number of presences.



The complexity of an industry is measured by calculating the average diversity of locations that have the industry, and the average ubiquity of the industries that those locations have.

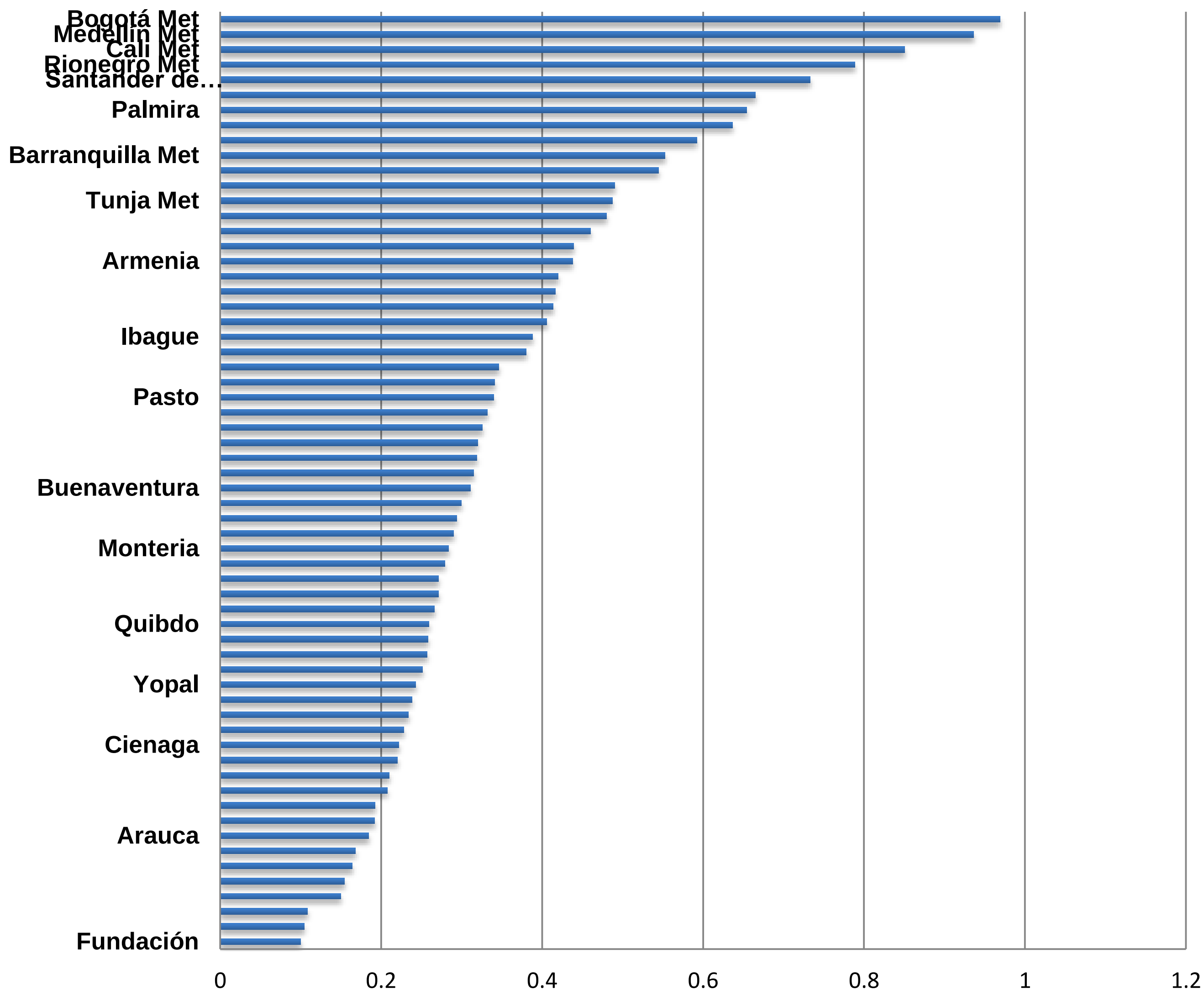
Most and least complex industries

IT and related activities
Automotive vehicles
Clothing and leather products
Office machinery
Textile products
Machinery and electrical appliances
Rubber and plastic products
Paper and paperboard
Chemicals
Machinery and equipment
...
Public administration
Retail
Social services
Hotels and restaurants
Electricity and gas
Coal
Crude oil and natural gas
Associations n.s.e.
Waste disposal
Aquatic transport

10 most complex industries, 2-digit ISIC

10 least complex industries, 2-digit ISIC

City Complexity, 2015



Note: cities with at least 50,000 inhabitants in 2008.

How close is a city to new complex industries?

- We need to define 'close': we compute the skill relatedness between industries (Neffke et al, 2013) using labour transitions**. Industries are proximate if many workers switch jobs between them**.
- $A_{i,j}$ is the skill-proximity between industries i and j
- For each industry i in city c: we compute

$$d_{c,i} = \frac{\sum_{j \in N_c} A_{i,j}}{\sum_j A_{i,j}}.$$

where N_c is the set of industries that is present in city c.

- This can be seen as the likelihood industry i is in city c (given the know-how already embedded in industries N_c).

How close is a city to new complex industries?

- For each missing industry in a city, we compute industry complexity times density

$$CP_c = \frac{1}{|M_c|} \sum_{i \in M_c} d_{c,i} C_i,$$

where M_c denotes the set of 'missing' industries for city c, and the $C_i \in [0, 1]$ is the normalized complexity of industry i.

- Complexity potential is a measure of the aggregate potential of a city to move to new complex industries.

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Prediction 1. Entry of firms is lower in high complexity industries

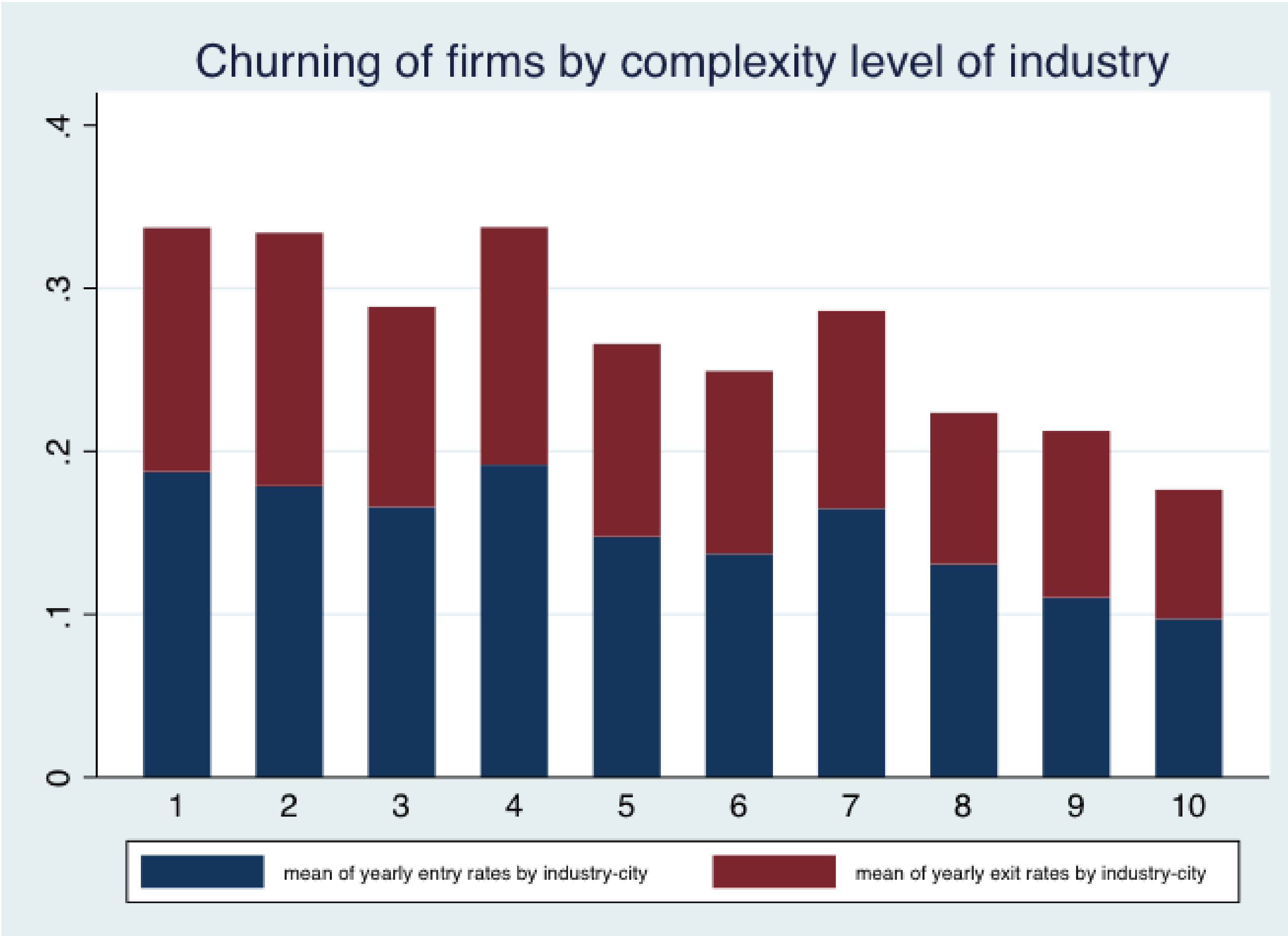


Table 1. Regressions on industry complexity of entry, exit and churning rates of firms

	Entry rate		Exit rate		Churning rate	
Industry complexity	-0.186***	-0.266***	-0.171*	-0.136***	-0.357	-0.402***
	(0.033)	(0.034)	(0.029)	(0.023)	(0.057)	(0.050)
Constant	0.283***	0.084***	0.220***	0.045***	0.503***	0.129***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.002)	(0.002)
City fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Small establishments included	Yes	No	Yes	No	Yes	No
Adjusted R-squared	0.101	0.067	0.104	0.089	0.109	0.089
Number of observations	7882	2825	7882	2825	7882	2825

Each observation is an industry in a city (with at least three establishments in city every year). Small establishments are those with 10 or less employees on average during their years in operation. All rates are averages over 2008-2015 by industry (SIC 4 digits).

***: significant with 99% confidence, **: significant with 95% confidence; *: significant with 90% confidence.

Prediction 2. Higher wages in more complex industries

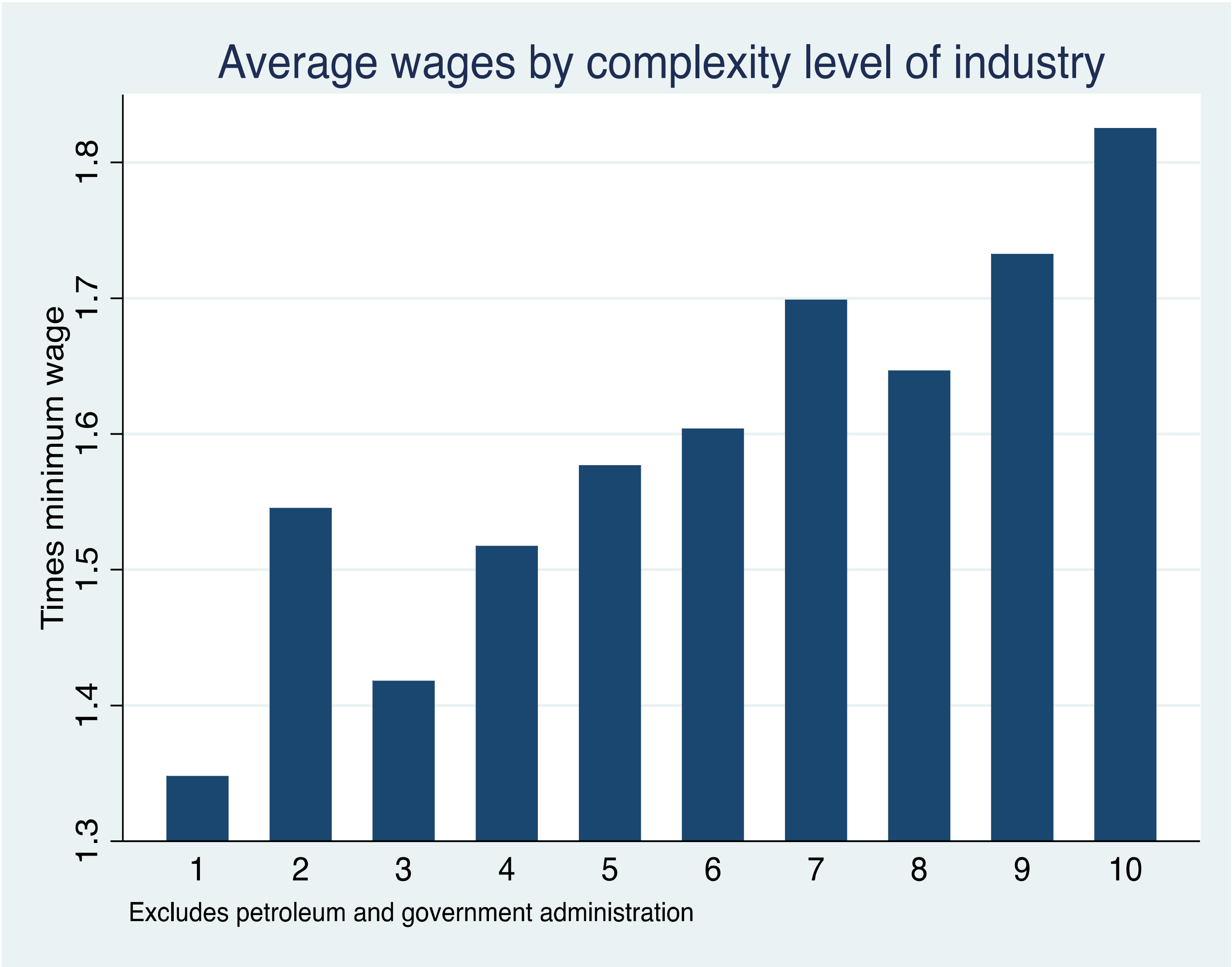


Table 2. Regressions of industry wages on industry complexity

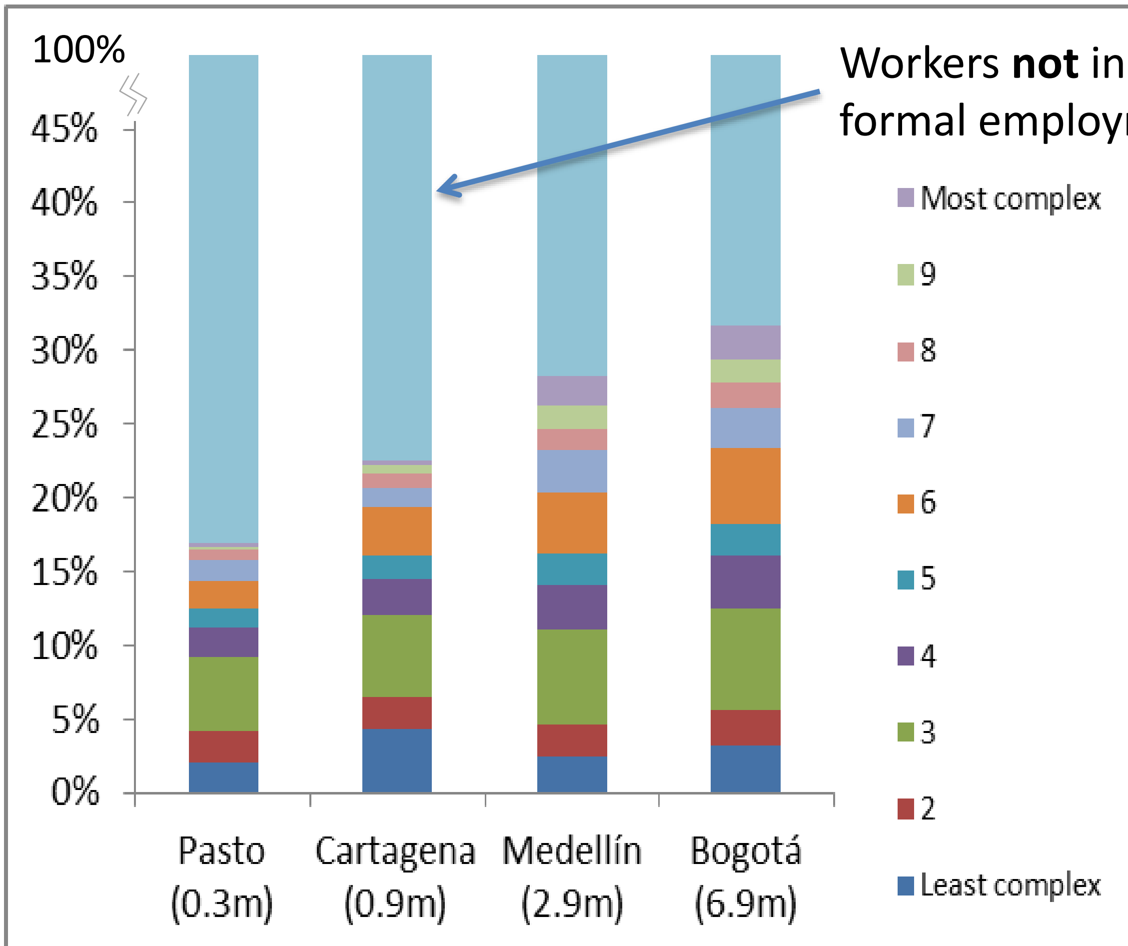
	Dependent variable: log of (average wage in industry/minimum wage)					
Industry complexity	0.445***	0.059	1.347***	0.577***	1.247***	0.643***
	(0.094)	(0.090)	(0.137)	(0.135)	(0.133)	(0.132)
Number of employees per establishment (log)					0.135***	0.098***
					(0.006)	(0.007)
Constant	6.199***	6.205***	6.292***	6.299***	5.819***	5.953***
	(0.004)	(0.004)	(0.005)	(0.005)	(0.022)	(0.024)
City fixed effects	No	Yes	No	Yes	No	Yes
With small establishments	Yes	Yes	No	No	No	No
Adjusted R-squared	0.001	0.109	0.012	0.125	0.069	0.153
Number of observations	15513	15513	8131	8131	8131	8131

Each observation is an industry (four-digit SIC) in a city in 2015. Oil and government sectors are excluded (SIC 11-, and 75- respectively). Small establishments are those with 10 or less employees.

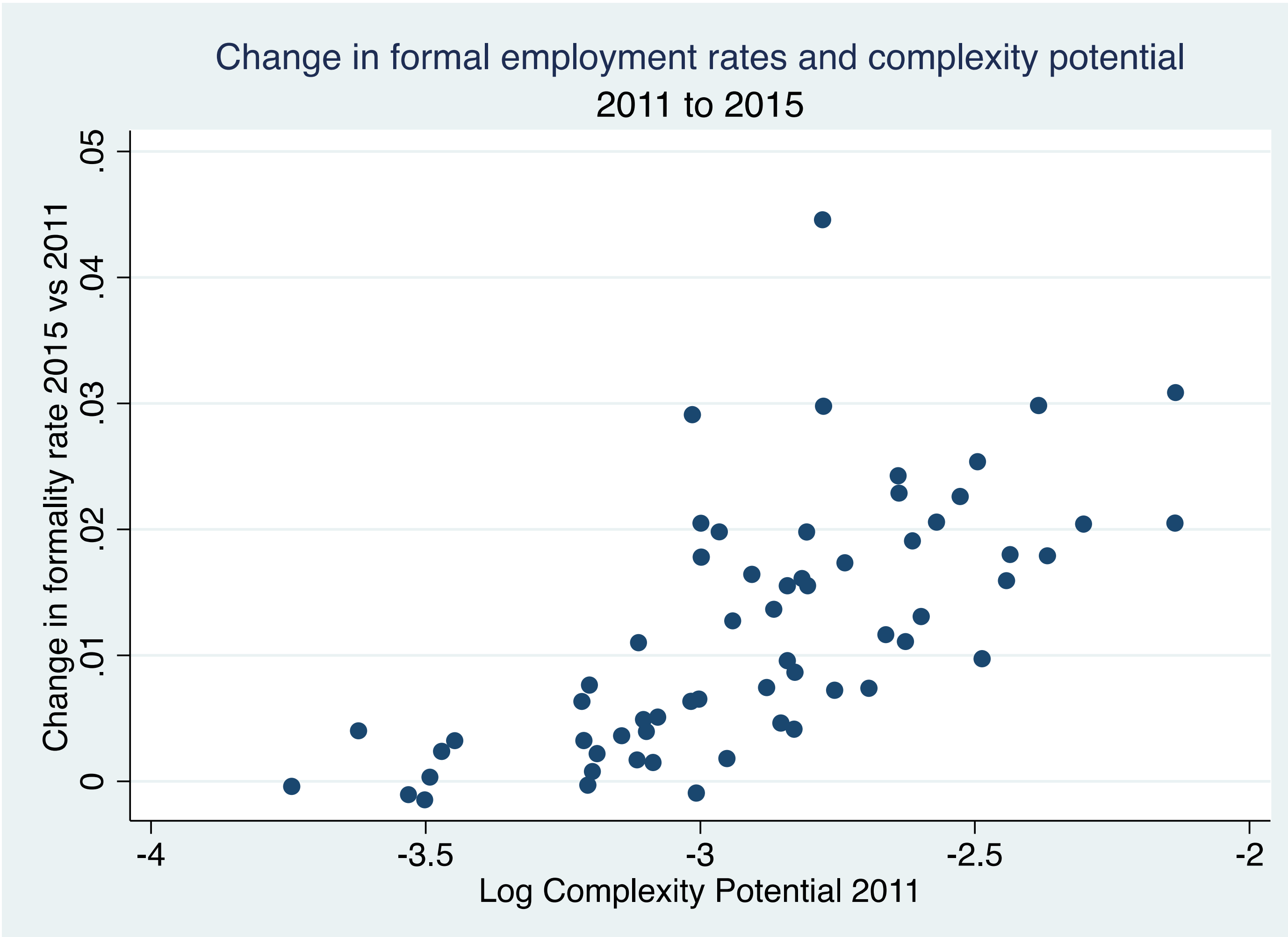
***: significant with 99% confidence, **: significant with 95% confidence; *: significant with 90% confidence.

Prediction 3. Employment creation follows a pattern of “geological layers”

Composition of formal employment by complexity level of industries in cities of different sizes



Prediction 4. Change in formal employment is faster in cities with higher initial complexity potential



Prediction 4. Change in formal employment is faster in cities with higher initial complexity potential

Table 3. Regression results for annual change of formal occupation rates (2008-2015)

	2008-2015			
	All sectors	All sectors	Low complexity sectors	High complexity sectors
Log complexity potential (at t0)	0.007**	0.012***	0.008***	0.003**
	(0.003)	(0.003)	(0.003)	(0.001)
Log working age population (at t0)		-0.002**	-0.001	-0.000
		(0.001)	(0.001)	(0.000)
Dummy for oil producing cities		0.013***	0.009**	0.002**
		(0.004)	(0.004)	(0.001)
Growth government spending per capita		0.002	0.002	0.000
		(0.002)	(0.002)	(0.001)
Sectoral demand shocks (Bartik)		-0.188*	-0.075	0.000
		(0.103)	(0.057)	(0.011)
Formal occupation rate (at t0)	0.036**	0.125**	0.093*	0.016
	(0.018)	(0.052)	(0.054)	(0.014)
Constant	0.029***	0.069***	0.051**	0.008
	(0.011)	(0.018)	(0.021)	(0.006)
Number of cities	62	61	61	61
R squared	0.28	0.638	0.605	0.556

***: significant with 99% confidence, **: significant with 95% confidence; *: significant with 90% confidence.

Results robust to “competitiveness” indicators of infrastructure, institutions, and education

Table 5. Regression results for annual change of formal occupation rates (2011-2015)

	2011-2015	
	All sectors	All sectors
Log complexity potential (at t0)	0.015***	0.0153***
	(0.004)	(0.004)
Infrastructure quality (at t0) [1/]		0.0015
		(0.001)
Quality of institutions (at t0) [1/]		0.0007
		(0.0008)
Higher education quality (at t0) [1/]		-0.0023***
		(0.0007)
Constant	0.054**	0.0558**
	(0.025)	(0.0247)
Number of cities	54	54
R squared	0.654	0.719

Other controls: Log working age population (at t0), dummy for oil producing cities, growth government spending per capita, sectoral demand shocks (Bartik), formal occupation rate (at t0).

1/ Data by department of city from Consejo Privado de Competitividad & Universidad del Rosario (2013), which uses the same methodologies of the *Global Competitiveness Report.*

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Concluding remarks

- Possible extensions
  - Labor market rigidities
  - Labor migration
  - Non-tradable goods
- Relation to endogenous growth models
  - Supply model (externality from skill diversity)
  - Role of knowledge (by-product of evolutionary rule of firm survival)
  - Convergence vs divergence.

The building blocks of a formal employment strategy

- “Intelligent diversification” (instead of spe… …tion):
  - Identify missing industries technologicall… …r to those already successful
  - Identify the barriers facing those in… …s
- Training focused on those indus… (instead of education in general)
- Infrastructure investment… …nimize commuting times within and betw… …unicipalities (instead of reducing freight tran… costs)
- Coordination acr… …ghboring municipalities:
  - Training
  - Zone plan…
  - Transp… …astructure
  - Indu… relocation.

Good urban policies are good active labor policies

Thank you for your time and your comments

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