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# Determinants of city growth in Colombia

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## Context and broad objectives

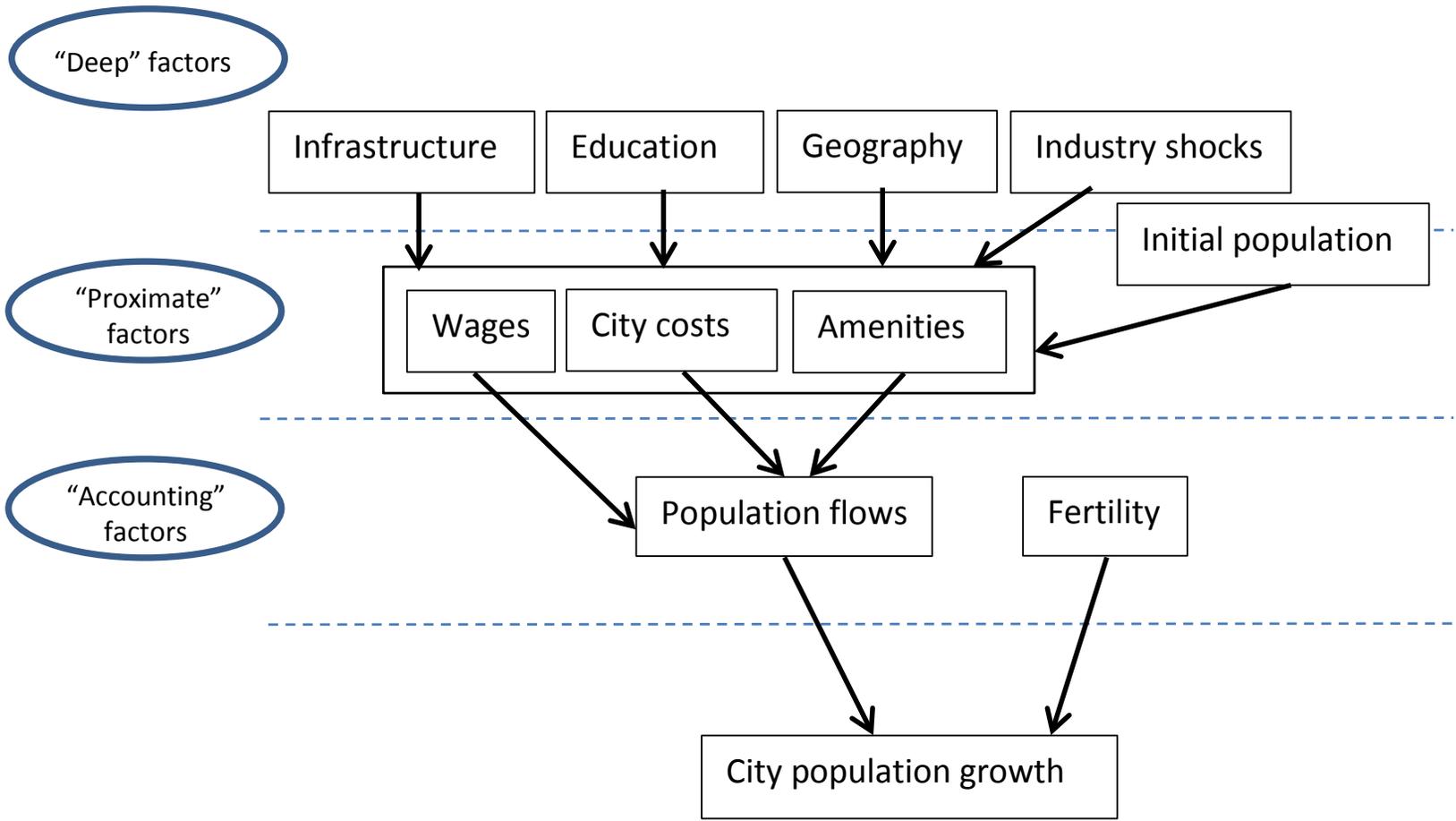
- Two years working for the 'system of cities' mission in Colombia
- Eventually, a monograph (defining metropolitan areas, agglomeration effects, congestion in Bogota, housing and other urban costs, determinants of city growth, local sectoral growth, infrastructure and internal trade)

## **Some general points about second-tier cities**

- In developed countries, second-tier cities are not smaller versions of large cities
- But these differences should not be exaggerated, especially where things can change quickly
- To what extent do our notions of urban systems translate to developing countries?  
(degree of linkage to the broader economy?)
- Second-tier developing cities have not grown as much. Why?
- My starting point: understand who grows and why

## The literature on urban growth

- US-based
- Education
- Amenities
- Roads
- 'Industry'
- My objective: Take a more comprehensive approach to city growth but retain what has been learnt from one factor approaches and fill some gaps. Implement it on one country, Colombia



## The regressions

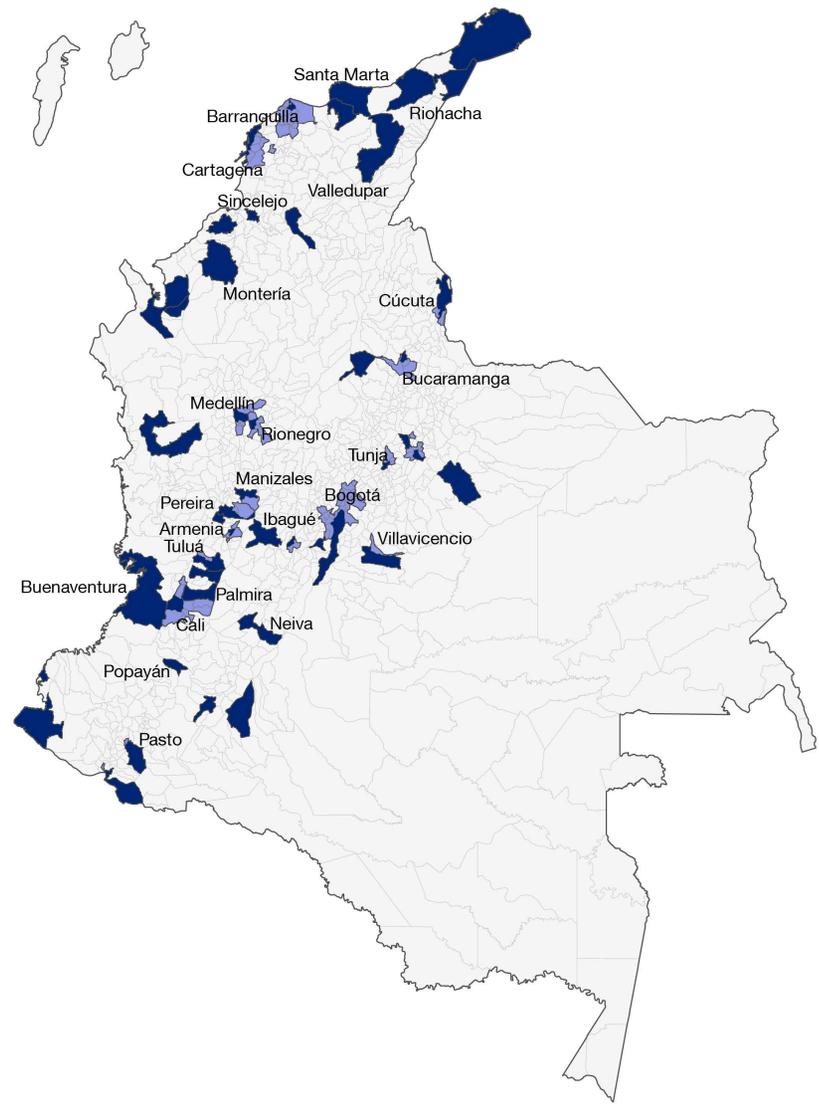
- Can't do the full multi-layered approach
- Typical regression:

$$\Delta_{t,t+1} \log \text{pop}_c = \alpha \log \text{pop}_{ct} + X_{ct} \beta + \epsilon_{ct} \quad (1)$$

- Main issue: simultaneity of  $X$  and population change

## **Colombia and Colombian cities: some basic facts**

- At the Northern tip of South America, area: 1 m sq. km
- Population: 47 million
- GDP per cap: \$ 7,800
- Urbanization rate: about 75%
- A 'balanced' urban system with 50+ metro areas with population above 100,000
- A difficult geography



0 50 100 200 400 km

Core municipality  
Satellite municipality

Table 1: Descriptive statistics

	Mean	Standard deviation	Number of municipalities
1993 population ('000)	35.55	194.55	1063
	73.97	324.56	373
2010 population ('000)	41.93	255.44	1073
	90.64	428.59	373
1993-2010 growth	0.060	0.367	1063
	0.065	0.333	373
Fertility	1.570	0.489	373
Wage (municipal fixed effect)	-0.207	0.223	373
Education	0.111	0.076	373
Road index	4.667	3.050	373

Table 2: Change in log population between 1993 and 2010, fertility, OLS specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log 1993 population	0.0027 (0.0096)	0.025 <sup>a</sup> (0.0089)	-0.051 <sup>a</sup> (0.013)	-0.023 <sup>c</sup> (0.014)	-0.0077 (0.020)	-0.026 (0.021)	0.036 (0.037)	0.0017 (0.035)
log birth rate	0.24 <sup>a</sup> (0.025)							
log fertility rate		0.27 <sup>a</sup> (0.028)		0.24 <sup>a</sup> (0.033)	0.23 <sup>a</sup> (0.058)	0.22 <sup>a</sup> (0.058)	0.17 <sup>b</sup> (0.070)	0.27 <sup>a</sup> (0.070)
log out-migrants			-0.042 <sup>a</sup> (0.0083)	-0.062 <sup>a</sup> (0.0088)	-0.071 <sup>a</sup> (0.012)	-0.057 <sup>a</sup> (0.011)	-0.050 <sup>a</sup> (0.013)	-0.047 <sup>a</sup> (0.015)
log in-migrants			0.11 <sup>a</sup> (0.0094)	0.092 <sup>a</sup> (0.0095)	0.099 <sup>a</sup> (0.015)	0.088 <sup>a</sup> (0.015)	0.083 <sup>a</sup> (0.015)	0.071 <sup>a</sup> (0.016)
log wage						0.27 <sup>a</sup> (0.076)	0.27 <sup>a</sup> (0.087)	0.33 <sup>a</sup> (0.096)
Past populations	N	N	N	N	N	N	Y	Y
Location dummies	N	N	N	N	N	N	Reg	Dpt
R <sup>2</sup>	0.13	0.11	0.16	0.22	0.27	0.30	0.32	0.43
Municipalities	1,041	1,041	934	915	344	344	344	344

## Fertility and labour mobility

Colombian cities grow through

- More arrivals
- Fewer exits
- Greater fertility
- Migration and fertility seem equally important to account for city population growth (roughly)
- While there is some mobility, it is far from perfect, even over 17 years

Table 3: Change in log population between 1993 and 2010, wages, OLS specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log 1993 population		0.17 <sup>a</sup> (0.035)	0.12 <sup>a</sup> (0.032)	0.15 <sup>a</sup> (0.036)	0.096 <sup>b</sup> (0.040)	0.12 <sup>a</sup> (0.036)	0.14 <sup>a</sup> (0.036)	0.12 <sup>c</sup> (0.065)
log wage	0.50 <sup>a</sup> (0.070)	0.41 <sup>a</sup> (0.087)	0.48 <sup>a</sup> (0.093)	0.32 <sup>a</sup> (0.065)	0.32 <sup>a</sup> (0.095)	0.28 <sup>a</sup> (0.094)	0.75 <sup>a</sup> (0.15)	0.56 <sup>a</sup> (0.20)
log wage <sup>2</sup>							0.61 <sup>a</sup> (0.21)	
Past populations	N	Y	Y	Y	Y	Y	Y	Y
Location dummies	N	Reg	Dpt	Reg	Reg	Reg	Reg	Reg
R <sup>2</sup>	0.13	0.24	0.36	0.24	0.15	0.15	0.26	0.43
Observations	373	373	373	373	286	373	373	79
Sample	mun.	mun.	mun.	mun.	MSA	urb. core	mun.	big mun.
Wage	FE	FE	FE	mean	FE	FE	FE	FE

# Wages

Robust association between city wages and population growth

- Preferred elasticity about 0.5
- Growth is possibly convex in wages
- If anything biased downwards
- No result in first differences (sluggish adjustment?)
- No evidence about housing costs
- Hard to compare with the literature

Evidence of divergence in population size (driven by Bogota and Cundinamarca)

Table 4: Change in log population between 1993 and 2010, education, OLS specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log 1993 population		0.0051 (0.018)	0.14 <sup>a</sup> (0.038)	0.099 <sup>a</sup> (0.034)	0.14 <sup>a</sup> (0.038)	0.15 <sup>a</sup> (0.038)	0.14 <sup>a</sup> (0.037)	0.14 <sup>a</sup> (0.038)
log wage		0.43 <sup>a</sup> (0.089)	0.36 <sup>a</sup> (0.090)	0.44 <sup>a</sup> (0.096)	0.36 <sup>a</sup> (0.090)	0.37 <sup>a</sup> (0.098)	0.35 <sup>a</sup> (0.090)	0.37 <sup>a</sup> (0.092)
Share educated	1.43 <sup>a</sup> (0.18)	0.82 <sup>a</sup> (0.27)	0.58 <sup>b</sup> (0.26)	0.49 <sup>c</sup> (0.25)	0.66 <sup>b</sup> (0.31)	0.38 <sup>c</sup> (0.23)	0.019 <sup>a</sup> (0.0070)	-0.060 (0.80)
Share educated <sup>2</sup>								2.45 (2.22)
Past populations	N	N	Y	Y	Y	Y	Y	Y
Location dummies	N	Reg	Reg	Dpt	Reg	Reg	Reg	Reg
R <sup>2</sup>	0.12	0.19	0.25	0.37	0.25	0.30	0.26	0.25
Municipalities	373	373	373	373	373	317	373	373
Education	univ.	univ.	univ.	univ.	log univ.	post- second.	high. ed. enrol.	univ.

Table 5: Change in log population between 1993 and 2010, education, IV specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	TOLS	TOLS	TOLS	TOLS	TOLS	TOLS	LIML	GMM
log 1993 population	0.085 <sup>c</sup> (0.050)	-0.96 <sup>b</sup> (0.43)	-0.00034 (0.058)	0.11 <sup>b</sup> (0.053)	0.031 (0.062)	0.082 (0.051)	0.085 <sup>c</sup> (0.050)	0.085 <sup>c</sup> (0.050)
log wage	0.28 <sup>a</sup> (0.100)	-1.32 <sup>c</sup> (0.78)	0.15 (0.11)		0.19 <sup>c</sup> (0.11)	0.27 <sup>a</sup> (0.10)	0.28 <sup>a</sup> (0.100)	0.28 <sup>a</sup> (0.100)
Share educated	1.61 <sup>b</sup> (0.66)	21.6 <sup>a</sup> (8.28)	3.24 <sup>a</sup> (0.77)	1.80 <sup>a</sup> (0.65)	2.65 <sup>a</sup> (0.95)	1.94 <sup>b</sup> (0.79)	1.61 <sup>b</sup> (0.66)	1.61 <sup>b</sup> (0.66)
Instruments:								
# of establishments	log	N	log	log	level	log	log	log
Sena positions	N	log	log	N	level	N	N	N
First-stage stat.	39.1	6.70	23.8	41.7	13.9	39.6	39.1	39.1
Municipalities	373	373	373	373	373	373	373	373

## Education

Robust association between city share of workers with university education and population growth

- Preferred estimate 0.6-1
- Perhaps higher when instrumented
- Comparable with US evidence
- Lowers the wage coefficient
- Not robust to stated measures of 'quality of life'

Table 6: Change in log population between 1993 and 2010, industry composition, OLS specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log 1993 population	0.066 <sup>a</sup> (0.012)	0.14 <sup>a</sup> (0.039)	0.060 <sup>a</sup> (0.022)	0.083 <sup>b</sup> (0.041)	0.029 <sup>c</sup> (0.017)	0.086 <sup>b</sup> (0.041)	0.0043 (0.027)	0.064 (0.041)
log wage		0.32 <sup>a</sup> (0.090)		0.28 <sup>a</sup> (0.099)		0.26 <sup>b</sup> (0.10)		0.21 <sup>b</sup> (0.10)
Share educated		0.74 <sup>b</sup> (0.31)		0.93 <sup>a</sup> (0.31)		0.89 <sup>a</sup> (0.31)		1.03 <sup>a</sup> (0.32)
Bartik 2d	-0.029 (0.034)	0.017 (0.027)					0.038 (0.035)	0.060 <sup>c</sup> (0.033)
Bartik 4d	0.15 <sup>b</sup> (0.068)	0.11 (0.074)					0.084 (0.093)	0.043 (0.10)
Manuf. share					0.57 <sup>a</sup> (0.11)	0.25 <sup>b</sup> (0.11)	0.82 (0.95)	1.71 (1.08)
Service share							0.37 (0.95)	1.49 (1.08)
Bus. serv. share					0.40 (0.59)	0.64 (0.59)	0.72 (1.12)	1.96 (1.20)
SI							0.057 (0.32)	-0.017 (0.28)
RSI			0.0053 <sup>a</sup> (0.0011)	0.0036 <sup>a</sup> (0.00090)			0.0029 <sup>b</sup> (0.0011)	0.0031 <sup>a</sup> (0.0011)
DI							0.018 (0.012)	0.0049 (0.011)
RDI			-0.035 (0.044)	0.037 (0.040)			-0.060 (0.055)	0.019 (0.053)
Past populations	N	Y	N	Y	N	Y	N	Y
Regional dummies	N	Y	N	Y	N	Y	N	Y
R <sup>2</sup>	0.10	0.27	0.09	0.29	0.12	0.28	0.16	0.31
Municipalities	360	360	285	285	285	285	282	282

## Structure of production

Some associations between city population growth and some aspect of the production structure

- Captured through a range of variables
- Which predict employment growth
- Lower the wage coefficient
- Result on specialisation and manufacturing opposite to the US

Table 7: Change in log population between 1993 and 2010, amenities and resources, OLS specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log 1993 population	0.13 <sup>b</sup> (0.060)	0.12 <sup>a</sup> (0.039)	0.13 <sup>a</sup> (0.040)	0.070 (0.087)	0.14 <sup>a</sup> (0.039)	0.081 (0.060)	0.13 <sup>a</sup> (0.040)	0.098 (0.066)
log wage	0.47 <sup>b</sup> (0.19)	0.34 <sup>a</sup> (0.089)	0.38 <sup>a</sup> (0.090)	0.41 <sup>c</sup> (0.21)	0.36 <sup>a</sup> (0.090)	0.42 <sup>b</sup> (0.19)	0.39 <sup>a</sup> (0.089)	0.59 <sup>a</sup> (0.18)
Share educated	-0.35 (0.38)	0.64 <sup>b</sup> (0.31)	0.76 <sup>b</sup> (0.31)	0.12 (0.44)	0.62 <sup>b</sup> (0.31)	-0.43 (0.35)	0.59 <sup>c</sup> (0.31)	0.67 <sup>c</sup> (0.34)
Climate		0.038 (0.043)					0.0097 (0.023)	
Altitude		-0.044 (0.040)						
Water		0.11 (0.11)						
Precipitation		-0.058 <sup>a</sup> (0.020)					-0.044 <sup>a</sup> (0.016)	0.0010 (0.022)
Temperature	-0.012 <sup>a</sup> (0.0044)							-0.0087 <sup>c</sup> (0.0049)
Coal			0.023 (0.043)					
Gold			0.030 (0.043)					
Oil			0.17 <sup>a</sup> (0.050)				0.19 <sup>a</sup> (0.050)	0.061 (0.061)
Libraries pc				-0.044 (0.047)				
Museum pc				-0.023 (0.033)				
Hospitality pc				0.0046 (0.043)				
Tourism					0.0031 (0.0047)			
Homicide pc						-0.077 <sup>c</sup> (0.045)		-0.11 <sup>a</sup> (0.042)
Violence						-0.068 (0.044)		
R <sup>2</sup>	0.36	0.26	0.26	0.35	0.25	0.41	0.27	0.39
Municipalities	99	368	368	89	373	99	368	95

## **Amenities and resources**

Mild association between city population growth and amenities / resources

- Oil seems to be the only resource that matters
- Weak effect of climate
- Some association with homicides but not with political violence
- Results in contrast with the us and Europe

Table 8: Change in log population between 1993 and 2010, roads, OLS specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log 1993 population	0.064 <sup>a</sup> (0.013)	0.13 <sup>a</sup> (0.038)	0.16 <sup>a</sup> (0.049)	0.054 <sup>a</sup> (0.013)	0.10 <sup>a</sup> (0.038)	0.053 <sup>a</sup> (0.014)	0.10 <sup>a</sup> (0.038)	0.12 <sup>a</sup> (0.041)
log wage		0.35 <sup>a</sup> (0.090)	0.17 (0.15)		0.36 <sup>a</sup> (0.089)		0.36 <sup>a</sup> (0.088)	0.23 <sup>b</sup> (0.10)
Share educated		0.64 <sup>b</sup> (0.31)	1.35 <sup>a</sup> (0.40)		0.71 <sup>b</sup> (0.30)		0.73 <sup>b</sup> (0.30)	0.89 <sup>a</sup> (0.32)
Road Index	0.0100 <sup>b</sup> (0.0042)	0.0065 (0.0040)	0.0039 (0.016)	0.015 <sup>a</sup> (0.0050)	0.015 <sup>a</sup> (0.0048)	0.021 <sup>a</sup> (0.0075)	0.023 <sup>a</sup> (0.0071)	0.021 (0.013)
Past populations	N	Y	Y	N	Y	N	Y	Y
Regional dummies	N	Y	Y	N	Y	N	Y	Y
R <sup>2</sup>	0.10	0.26	0.33	0.11	0.27	0.10	0.27	0.26
Municipalities	373	373	198	373	373	373	373	279

Table 9: Change in log population between 1993 and 2010, roads, IV specifications

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
log 1993 population	0.039 <sup>c</sup> (0.021)	0.10 <sup>b</sup> (0.040)	0.12 <sup>c</sup> (0.068)	-0.041 (0.064)	-0.031 (0.080)	0.0067 (0.076)	0.0034 (0.066)	-0.049 (0.11)
log wage		0.34 <sup>a</sup> (0.091)	0.17 (0.15)		0.36 <sup>a</sup> (0.10)	0.36 <sup>a</sup> (0.095)	0.36 <sup>a</sup> (0.095)	0.40 <sup>b</sup> (0.18)
Share educated		0.57 <sup>c</sup> (0.32)	1.79 <sup>a</sup> (0.52)		0.90 <sup>b</sup> (0.36)	0.84 <sup>b</sup> (0.34)	0.93 <sup>a</sup> (0.34)	1.70 <sup>a</sup> (0.57)
Road Index	0.026 <sup>b</sup> (0.011)	0.026 <sup>b</sup> (0.012)	0.10 <sup>b</sup> (0.051)	0.073 <sup>b</sup> (0.035)	0.072 <sup>b</sup> (0.028)	0.056 <sup>b</sup> (0.027)	0.086 <sup>a</sup> (0.032)	0.12 <sup>a</sup> (0.045)
Instruments:								
1938 roads	Y	Y	Y	Y	Y	Y	Y	Y
Camino reales	N	N	N	N	N	Y	N	N
First-stage stat.	20.2	16.1	7.83	6.77	6.39	4.10	8.50	4.26
Overid. p-value	0.68	0.20	0.38	0.38	0.75	0.67	0.88	0.72
Municipalities	373	373	198	373	373	373	373	198

## Roads

Solid association between city population growth and roads

- Roads foster trade with other cities and ease travel within cities
- Robust to controlling for market access
- Some differences across measures of roads
- Higher effects with IV
- Results closely match those for the US and other countries
- Strong results for growth since 1938 for 1938 roads

## Other results

- Market access (negative effect)
- Municipal management (positive association with outcomes but not with the measured quality of the process)
- Inequality (no association)

## Conclusions

- Imperfect mobility (role of fertility, sluggish responses)
- Wages a key proximate factor of city growth
- Wages are in part driven by human capital and the production structure
- Important role of human capital and roads
- Mild effects of amenities