Aggregate and Distributional Impacts of Transit Infrastructure: Evidence from Bogotá's TransMilenio

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Measuring the Aggregate and Distributional Effects of Transit

Suppose a new transit system is built in a city:

- *Direct Effects*: Value of travel time saved (VTTS)
- *Indirect Effects*: Firms and workers respond by changing location choices; wages and house prices react
- Total impact will depend on the sum of these forces

Question: How important are indirect vs direct effects? Do they change who wins or loses?

- E.g. in Bogotá, the poor rely on public transit.
- They should gain the most from new transit due to direct effects, but unclear once we consider equilibrium forces...

This Paper

Evaluate impact of TransMilenio, world's most-used Bus Rapid Transit system built in Bogotá in 2000s

Similar speed to subways, but
Faster and **Cheaper** to build

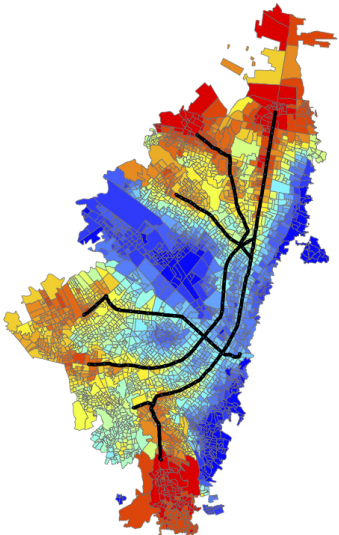
Leverage rich **tract-level data** to:

1. Assess whether quantative spatial model fits the change in city structure to the system
2. Quantify aggregate and distributional effects across the rich and poor, compare with VTTS

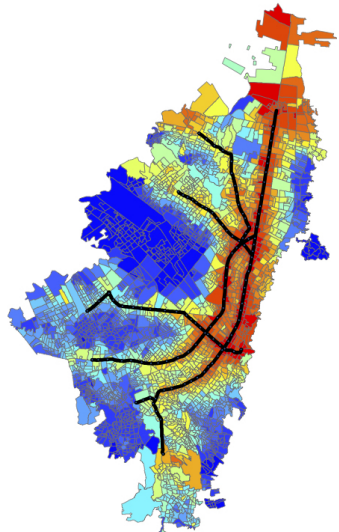
Insight #1: Importance of Data

Impacts of BRT through Accessibility

Change in Resident CMA

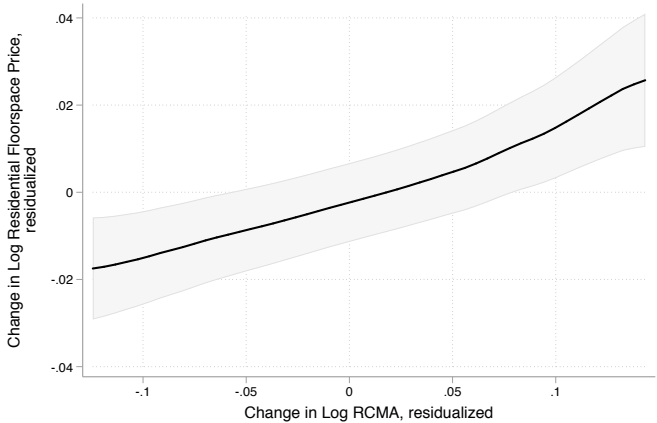


Change in Firm CMA



Model Mechanisms Explain Changes Observed in the Data

- Log-linear relationship between changes in accessibility and residential and commercial floorspace prices, populations and employment borne out in the data



Sensitivity of commute choices to travel times differs by group

- Commute location choices of the low-skilled were 26% more responsive to changes in travel times induced by TransMilenio than the high-skilled

Table 8: Gravity Regression

	(1)	(2)	(3)	(4)	(5)	(6)
HighSkill X Commute Time	-0.0319***	-0.0256**	-0.0283**	-0.0249**	-0.0166***	-0.0165***
	(0.0123)	(0.0121)	(0.0124)	(0.0122)	(0.0025)	(0.0025)
LowSkill X Commute Time	-0.0387***	-0.0281**	-0.0357***	-0.0284**	-0.0298***	-0.0284***
	(0.0131)	(0.0114)	(0.0132)	(0.0117)	(0.0025)	(0.0024)
N	1,778	1,778	1,778	1,778	1,444	1,444
Method	IV	OLS	IV	OLS	PPML	IV-PPML
Years	1995,2015	1995,2015	1995,2015	1995,2015	2015	2015
Orig-Dest-Skill-Car Own FE	X	X	X	X		
Dest-Skill-Year FE	X	X	X	X	X	X
Orig-Skill-Car Own-Year FE	X	X	X	X	X	X
Crime, House Price, Main Road Ctrls			X	X		

Gentrification was uneven across neighborhoods

- Improved accessibility due to TransMilenio led to an increase in the college share **only** in nbhds surrounded by sufficiently high numbers of college workers in the initial period
- Model intuition: rich care about both accessibility + amenities, and WTP for improved accessibility is higher in high amenity neighborhoods
- Implication: Slum unlikely to gentrify from transit since lacks other amenities rich value; middle-income nbhd more likely

Outcome: Change in College Share	(1) OLS	(2) OLS	(3) IV	(4) IV LCP	(5) IV All
Δ lnRCMA	-0.012	-0.040	-0.032	-0.054	-0.052
	(0.026)	(0.025)	(0.025)	(0.042)	(0.040)
Δ lnRCMA X HighColl		0.043*	0.053*	0.091**	0.095**
		(0.023)	(0.028)	(0.043)	(0.040)
N	1,886	1,886	1,886	1,886	1,886
R^2	0.27	0.27			
F-Stat				89.38	122.14
Over-ID p-value					0.54
Locality FE	X	X	X	X	X
HighColl FE		X	X	X	X
Log Dist CBD X Region FE	X	X	X	X	X
Tract Controls	X	X	X	X	X
Historical Controls	X	X	X	X	X

Insight #2: Equilibrium Responses Matter

Equilibrium Responses Matter

- Aggregate gains are ~26% higher accounting for reallocation of activity and equilibrium responses of prices
- Distributional consequencies switch signs, largely driven by the differing elasticities of substitution across commutes (important for incidence)

	Average Welfare	**Inequality**
First Order Approximation (VTTS)	1.308	-0.172
General Equilibrium	1.628	0.085

Insight #3: Interaction of Transport w/Related Policies

Policy Counterfactual: Land Value Capture

- In Bogotá, change in transit w/o complementary change in zoning laws
  - $\Rightarrow$ No significant response in housing supply to TM

- **Land Value Capture (LVC)**: Simulate the impact of one candidate policy in combin. w/TM
  - "Development Air Rights Sale" - Gvt sells permits to build higher densities near stations
  - Successful in Asian cities to (i) finance construction and (ii) increase housing supply

Policy Counterfactual: Land Value Capture

	Avg Welfare	Inequality	Gvt. Rev Closed City	Gvt. Rev Open City
Baseline	1.63%	0.09%		
LVC-Distance	1.71%	0.03%	5.72%	17.82%
LVC-CMA	1.93%	0.01%	10.21%	41.07%

1. Average welfare gain 19% larger under LVC
2. Welfare + Revenue Gain greater under CMA-based scheme
3. Low-skilled benefit the most