What are the Benefits of a Subway in Mumbai, India?
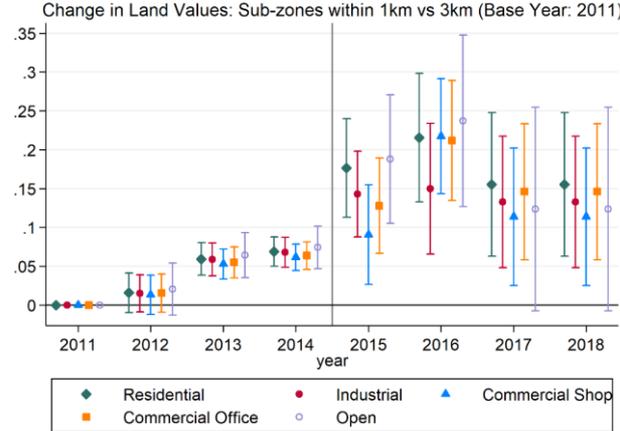
By Maureen L. Cropper* and Palak Suri*

Introduction

- Mumbai is the commercial center of India with 12.5 million people living in an area of 603.4 sqkm. (21,000 people/sqkm.)
- In 2014, the first Metro rail line (Line 1, 11.4 km) started operations in the city, serving as the first east-west rail link.
- How significant was this addition, given Mumbai's extensive (100 km) passenger railway network?
- Suri (2021) measures the value of savings in commute times to households by estimating a joint housing location and commute mode choice model. Expected compensating variation for the reduction in commute times amounts to $1 billion (PPP) annually. 20% of commute time benefits accrue to households living within 1 km of Line 1. We extend Suri's results by estimating the benefits of Line 1 that are capitalized into property values.
- **We estimate the effects of Metro Line 1 on land values within 1 km of the Metro for different land-use types: residential, industrial, commercial office, commercial shop, and open land.**

Data & Empirical Strategy

- We use panel data (2011-2018) on official assessed sale values for residential, commercial, and industrial properties for 725 sub-zones in Mumbai. The map shows Mumbai's historic rail network (blue), Line 1 (red) and the distribution of residential land values in 2011.
- **Difference-in-differences** models compare sub-zones within 1 km of Metro Line 1 with sub-zones within 1 to 3 km from Line 1 before and after 2014 to estimate changes in property values due to Line 1
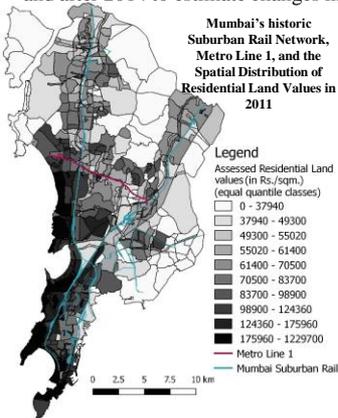

Mumbai's historic Suburban Rail Network, Metro Line 1, and the Spatial Distribution of Residential Land Values in 2011

Legend
Assessed Residential Land values (in Rs./sqm.) (equal quantile classes)
- 0 - 37940
- 37940 - 49300
- 49300 - 55020
- 55020 - 61400
- 61400 - 70500
- 70500 - 83700
- 83700 - 98900
- 98900 - 124360
- 124360 - 175960
- 175960 - 1229700
— Metro Line 1
— Mumbai Suburban Railway

- We test robustness to different control group definitions but sub-zones within 1-3 km from Line 1 are a better comparison group.
- We estimate hedonic regressions for residential property values to suggest mechanisms by which Line 1 may affect property values.
- We conduct heterogeneity analysis to explore the importance of employment accessibility (results not reported here).

- Market reacted in anticipation of opening of Line 1 two years to prior to the opening, leading to 4-6% increase in sale values.
- **Opening of Line 1 led to an increase in property values within 1 km of Line 1 by 13-17%** compared to the increase in values beyond 1 km but within 3 km of Line 1.

Change in Land Values: Sub-zones within 1km vs 3km (Base Year: 2011)

Legend:
- Residential (green diamond)
- Industrial (red circle)
- Commercial Shop (blue triangle)
- Commercial Office (orange square)
- Open (open circle)

DID estimates of the effects of Line 1 on property values

	Residential	Comm. Office	Comm. Shop	Industrial	Open Land
Land within 1km compared to land within 3km					
Anticipatory (2013-14)	0.056***	0.052***	0.051***	0.056***	0.059***
	(0.005)	(0.004)	(0.004)	(0.006)	(0.008)
Opening (2015-18)	0.168***	0.150***	0.127**	0.132***	0.158***
	(0.048)	(0.047)	(0.052)	(0.042)	(0.067)
Observations	1,086	1,088	1,088	1,086	1,092
R2	0.82	0.81	0.81	0.80	0.77
Land within 1km compared to rest of the City					
Anticipatory (2013-14)	0.030***	0.032***	0.036***	0.040***	0.039***
	(0.001)	(0.002)	(0.001)	(0.002)	(0.003)
Opening (2015-18)	0.116**	0.109**	0.064	0.086**	0.089
	(0.04)	(0.038)	(0.042)	(0.034)	(0.05)
Observations	5,733	5,713	5,735	5,719	5,787
R2	0.85	0.89	0.88	0.87	0.87

S.e. clustered at the year and sub-zone level are in parentheses. All specifications have year and sub-zone f.e. Dependent variable is Log(Assessed Land Value) in Rs. Per sqm.

Discussion

- The magnitude of increase in prices goes down as the size of control group is expanded to include regions beyond 3 km, reflecting changes in other parts of the city.
- The increase in residential, commercial office, and open land-use prices was greater than the increase in industrial and commercial shop prices.
- To study the factors affecting residential prices, we estimate hedonic price regressions using data on 3,000 houses in a 2019 World Bank survey. Log price depends on distance from the nearest rail station and on an employment accessibility index, in addition to housing and other neighborhood characteristics.
- Employment accessibility is measured using a commute-time-weighted average of wages obtainable across the city, estimated using a gravity equation. See also Suri (2021)
- A house that is 1 km closer to a rail station sells for 5.6% more than an otherwise identical house. A one standard deviation increase in employment accessibility raises house price by 4%.
- We also compute the employment accessibility index for 2004, using a 2004 World Bank survey to study the changes in sub-zone level employment accessibility.
- The employment accessibility index within 1 km of Line 1 increased faster over this period than in other parts of Mumbai.
- Improvements in employment accessibility and access to rail stations are plausible channels underlying the observed capitalization effects.
- **How large are the increases in property values within 1 km of Line 1 and how do they compare with the aggregate benefits due to commute time savings?**
- Lacking precise data on floor space within 1 km of Line 1, we conservatively approximate the increase in property values after the opening of Line 1 to be $20 billion (PPP). Annualizing this over 30 years using a 10% interest rate yields a value of $2 billion (PPP).
- **This is approximately twice as large as Suri's $1 billion (PPP) estimate of the value of travel time savings, highlighting the need for a more comprehensive framework to study the benefits of infrastructure projects.**

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