

Can Land Value Capture make PPP's Competitive in Fares?

A Mumbai Case Study

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Abstract

Mumbai Metro is planning to build 152 km of high-speed urban rail lines. The first line of Mumbai Metro was built through a Public-Private Partnership (PPP) and opened in 2014. Financial issues since its opening necessitated a fare increase—among one of the highest in India to maintain the line's commercial viability for the private operator. This paper examines how high dependence on farebox revenue could have been avoided by using Land Value Capture (LVC) to finance Mumbai Metro. A panel data hedonic price model was used to assess the impact of Mumbai Metro's commencement on approximately 66,000 apartments. The model shows a significant uplift of 14% in property prices in the Mumbai Metro catchment area resulting in USD 179 million value capture opportunity under Mumbai's existing legislative framework. This paper suggests that LVC could enable a PPP urban rail projects to achieve financial and social viability if governance systems can enable appropriate mechanisms.

Key Words: Urban rail, Public-Private Participation, Land Value Capture, Mumbai Metro.

1. Introduction

21st century India has opened over new 10 urban rail systems and is planning another 40. Mumbai¹ is the first Indian city to conceptualise a Public-Private Partnership (PPP) model for urban rail. The concept hinged on projected ridership resulting from a traffic demand model. The planning process did not factor the impact of urban rail on land value and prospective Land Value Capture (LVC). The traffic demand model has failed and the existing ridership amounts to only half the anticipated number. This has led the private operator to request an increase of the fare through a Fare Fixation Committee (FFC) (2015) of the Government of India. The FFC noted that non-fare box revenue

¹ The Municipal Corporation of Greater Mumbai area (generally referred to as Greater Mumbai) was considered as the study area for this research. It is referred to as 'Mumbai' in the paper.

options are limited therefore an increase in fares creates the only way to make Mumbai Metro commercially operational. The FFC however did not explore the option of land-based financing. The fare hike has not been implemented yet as Mumbai Metro's government partner has taken legal recourse rebuking the hike and arguing that higher fares would render the system unaffordable for members of society's low-income sections. Such issues of finding how to balance commercially and equity in transit are common around the world (King & Streeting, 2016; Suzuki et. al, 2015; Ubbels et al., 2001)

In this paper, we examine whether the proposal for the Mumbai Metro could have incorporated LVC as a source of finance, and thus the proposed fare hike could have been avoided. The role of LVC in achieving a balance between affordable fares and business viability in PPP's has been an issue in other cities (Sharma, Newman & Matan, 2015; Smith & Gihring, 2006; Suzuki et. al, 2015). To investigate this in Mumbai, a Hedonic Price Model (HPM) was estimated to assess the impact of Mumbai Metro's 11 km Line 1 commencement on the value of land in its catchment area. This research is essential in highlighting this impact, as Mumbai is planning to expand Mumbai Metro to 190 km in the next 6 years (Bloomberg, 2017). This paper further discusses which LVC mechanisms can be applied in Mumbai based on a literature review and existing applicable LVC mechanisms in Mumbai.

2. Conventional funding sources

Public transport systems have historically faced financial deficit when highly dependent on farebox revenue and government funds (Sharma, Newman & Matan, 2015; Ubbels et al., 2001). The cost-revenue gap is considered widest in urban rail as this is one of the most capital-intensive forms of city public transport (Knight & Trygg; 1977; Viton, 1980). Urban rail is supported primarily by public funds as its cost-revenue structure (business model) is burdened by labour-intensive construction, increasing maintenance needs of older systems and increasing travel demand due to urbanisation (Transportation Research Board [TRB], 1998). Public funds are generally in the form of capital loans and operational subsidies.

Subsidy can be defined as a payment not requiring direct exchange of goods or services of equal market value in return. It is aimed at accomplishing a specific objective or effect (Black, 1995, as cited in Ubbels et al., 2001). Subsidy for public transport is justifiable for it being a 'service'. However, subsidies impose one or both of higher taxes and reduced spending on other public services (Smith & Gihring, 2006). Proost et al. (1999, as cited in Ubbels et al. 2001) argue that subsidies work against economic efficiency when they become excessive.

Another form of public funds i.e. loans involve significant risk for the borrower. Flyvberg (2007) provides empirical evidence for this from a study on 44 urban rail projects (including extension projects) completed between 1966 and 1997 in North America (18), Europe (13) and developing nations (13) worth approximately USD 37 billion (2005 prices). The study revealed (Flyvberg, 2007):

1. Average cost escalation for urban rail is 45% in constant prices.
2. For 25% of urban rail projects, cost escalation is at least 60%.
3. Actual ridership is on average 51% lower than forecast.
4. For 25% of urban rail projects, actual ridership is at least 68% lower than forecast (Flyvberg, 2007).

Flyvberg (2007) concluded that urban rail reflects a risk profile when cost and revenue risk are combined. Borrowings on projects with high economic risk are most likely to push the nation into a series of debt and significant fiscal deficit. These studies were mostly from 20th century projects and since then significantly better patronage has happened in urban rail (Newman, Kenworthy & Glazebrook, 2013). However, the stark problem of urban rail requiring capital loans and operational subsidies continues.

In emerging Indian cities, the loan borrowing scenario discussed above impacts public and private players differently. The cities have raised soft loans from international donors at about 1%-2% interest rate against a sovereign guarantee to develop urban rail. The funds have been used to construct publicly-owned urban rail systems. The sovereign guarantee option was not available to privately built and operated projects (such as Mumbai Metro) leading them to borrow at a high interest rate (market rate of over 11%) (FFC, 2015).

Urban rail projects in India both public and private are running into losses. The privately-operated systems i.e. Mumbai Metro and Gurgaon Metro have raised fares to compensate for losses but the public systems rely on government subsidies. Neither of these financing models is economically progressive as fare hikes can exclude sections of society from urban rail.

The universal issue of finding a more viable and progressive way of financing the building and operations of urban rail is pushed in this paper by examining how governments can tap the quantitative value created by public investments in urban rail through land value increase. This will be done by examining the case study of Mumbai and how the potential of Indian metro projects can be improved in general through land value capture (Banister & Thurstain-Goodwin, 2011; Lohia, as recorded in Blagg, 2015).

3. Literature review

3.1. Impact of urban rail on land value

Urban rail impact on land value is well established. There is a wealth of empirical studies demonstrating increase in land value due to urban rail in both developed and emerging cities (see Anantsuksomsri & Tontisirin, 2015; Armstrong & Rodriguez, 2006; Cervero, 2003; Du & Mulley, 2007; Garrett, 2004; Laakso, 1992; Medda & Modelewska, 2010; McIntosh, Trubka & Newman, 2014; Mulley, 2014; Sharma & Newman, 2017; Yankaya, 2004). Governments are recognizing this can be used as a significant source of public finance, for example in India and Australia they have instructed their state and city authorities to act on LVC implementation (Commonwealth of Australia, 2016; Ministry of Urban Development, 2017). City deals in Australia now require partnership with all levels of government and the private sector in order to create LVC mechanisms to pay back infrastructure (Smart Cities Plan, 2017).

3.1.1. Impact assessment using hedonic price model

In theory, urban rail transit systems catalyse development opportunities and enhance accessibility of adjacent properties, increasing their desirability, locational value and land value (McIntosh, Trubka & Newman, 2011; Newman & Kenworthy, 2015). This increase can be calculated using econometric price models specifically hedonic price models which have been used extensively to calculate this increase.

HPM is based on the notion that land/property value is a sum of different attributes affecting land value. Thus, the land price can be divided into the component (or 'hedonic') prices of each attribute. The HPM involves the application of ordinary least squares (OLS) regression analysis which requires a linear relationship between the dependent variable (e.g. property value) and independent (explanatory) variables (e.g. characteristics of property). The HPM functional forms include linear, linear-log, log-linear and log-log. It is one of the most applied methods to identify the effects on house prices associated with factors such as proximity to transportation facilities, the subject for this study. Over 30 studies have used HPM to calculate the impact of transit on land values (McIntosh, Trubka & Newman, 2011; Sharma & Newman, 2017).

A basic meta-analysis equation can be:

$$Y = f(P, X, R, T, L) + \epsilon$$

Where,

Y = Independent variable under examination

P = Set of causes of the outcome Y

X = Characteristics of the set of objects under examination affected by P, to determine outcome Y

R = Characteristics of the research method

T = Time period covered by the study

L = Location of each study conducted

ϵ = Error term

Estimation of the windfall gains using HPM depends to a large extent on the nature of data and attributes selected for the model. The attributes include factors influencing land value like distance accessibility to work centres, transit, neighbourhood characteristics and others. Zhao and Larson (2011) highlight the limitation of econometric models as it is difficult to separate the value uplift due to improved transport accessibility from the uplift due to general increase. However, size and nature of data can ensure efficiency in assessments through availability of updated registries and detailed data sets.

HPM cases from developed and emerging cities show significant increase in land values due to urban rail, few cases are marked below:

In developed cities:

1. An HPM study on Perth by McIntosh, Trubka & Newman (2014) showed 40% increase due to commencement of an urban rail line.
2. In Lisbon, this value was found to be 6%, calculated by Martinez & Viegas (2009) through HPM.
3. A study on the San Francisco Bay Area revealed that for every metre a single-family home was closer to an urban rail station in 1990, its sales price increased by USD 2.29 per meter (Landis, Guhathakurta & Zhang, 1994).
4. An HPM study in 1993 on residential properties adjacent to the 14.5-mile urban rail in Philadelphia concluded that access to rail created an average housing value premium of 6.4% (Voith, 1993).

In emerging cities:

1. Sharma & Newman's (2017) HPM study on Bengaluru showed a 23% increase in land value in the 1 km catchment area of urban rail and of great significance it appears to have increased land values over the whole city (up to 29 km out) by an average of 4.5%.
2. An HPM study for Izmir reveals a proximity premium of up to 16% for properties within 1 km of the transit station (Yankaya, 2004).
3. Anantsuksomsri & Tontisirin's (2015) HPM study on Bangkok shows windfall gain at

USD 9,210 per km proximity to transit station.

4. Beijing's HPM study showed property premiums of 0.35% per 100 m proximity to urban rail station (Zhang & Wang, 2013).

These examples support the case for assessment of the land value impact using HPM in emerging cities. If the assessment is positive, cities can potentially utilise LVC as a public finance instrument.

3.2. Land value capture

LVC focuses on realizing a portion of the increase in land value originating from urban rail as public revenue through taxes and fees (Medda and Modelewska, 2010). LVC mechanisms can be structured to support cost recovery in the case of urban rail transit projects (Bahl & Linn, 2014). The structuring involves factors such as timing of application (before or after transit development), payment schedule, scale and actors involved (Connolly & Wall, 2016; Medda, 2012; Peterson, 2009; Smolka, 2013; Walters, 2012; Zhao, Iacono & Lari, 2012), and incidence (Chapman, 2017). Various LVC structures can be designed to optimise returns from the potential of land either in sum or on-site land improvements that benefit the community and foster urban development. The following subsections discuss the four broad classifications of LVC that have been used for urban infrastructure and specifically transportation, and which can be applied in urban rail.

3.2.1. Betterment contributions

These are taxes or fees levied on properties to fund capital or operation and maintenance cost for the infrastructure. Landowners pay specific taxes for payment schedules of varied duration. The payment may commence before, during or after the infrastructure is developed and can be charged from local to city scale. Examples of betterment contributions include land value tax, transport utility fee and betterment levy.

Latin American cities have been levying betterment tax to fund infrastructure since the 17th century (Reyes, 1980, as cited in Smolka, 2013). Latin American countries have national legislation that allow the local government to capture the unearned income (*Plusvalías* in Spanish) resulting from a public investment in order to be shared with the public. In Bogotá, the betterment fees (*contribución de valorización*) contributed USD 1.0 billion from 1997-2007, and USD 1.1 billion was planned to be collected for 2008-2015 (Smolka, 2013).

France has established a public transport funding system known as "Versement Transport". It is a specific tax paid by public or private companies when there are more

than nine workers located within a 10,000 habitants urban transport limit (Pascal, 2003, as cited in Milan, 2015). The idea is to tax property owners that benefit from the transport infrastructure. The funds collected are used to cross-finance operational costs and/or new transport infrastructure.

Betterment contribution is considered easy to understand and economically efficient as it is aligned with the benefits of public investment. It is favourable, in terms of benefit distribution equity, as it generates public funds. However, it has some equity considerations as some of the population may not be able to pay but it can be means tested. The levy is viable long-term as a low tax rate remains adequate with its extensive target base even if the economic growth potential is uncertain (Connolly & Wall, 2016). It is easy to implement, however accurate property valuations can be challenging. Overall, it is a progressive tax and is consistent with efficient urban growth.

3.2.2. Regulatory charges & negotiated development

This LVC mechanism imposes a levy on private developers for any development or spatial transformation triggered by the transport project. The rationale is that the private development benefits from the accessibility provided by the infrastructure set-up using public funds. The levy could be in the form of monetary payment (e.g. change in land use and development impact fee), special building permissions (transfer of development rights, air rights and purchasable zoning) and negotiated provisions (execution of public works and forfeiture of a portion of development area). The levy is in addition to the existing charges proportional to the windfall gains by developers due to infrastructure. The revenue from the levy is used to fund public infrastructure. They may be exacted either upfront or ongoing.

Hass-Klau (2006) explains how this mechanism works in Germany. For a license to build in Munich, a land developer must obtain the current land value from a real estate experts' panel, as the land value is bound to increase once construction commences. This increase in value may be claimed (up to as high as 2/3) by government to finance the construction of public infrastructure. The rest of the value accrues to the land developer.

The objective of regulatory charges and negotiated development levies is to realize the opportunity created by the transport infrastructure and boost urban development in its catchment area. The proportional nature of such taxation promotes stability and efficiency in land markets. However, these LVC tools may intrude on the developer's share of the benefit equity and developer's may compensate by choosing to build high-income residences in a desirable market. Thus it may not be a progressive LVC mechanisms.

3.2.3. Taxed local development

This category of LVC mechanisms involves payment of taxes at an elevated rate to fund projects identified for local development. The rate is fixed by earmarking future revenue to finance current expenditures aimed at accessibility improvement. The payers include residents and business-owners from an identified catchment area. A few examples include tax increment financing, business improvement district, benefit assessment district (BAD) and business rate supplement (BRS).

The development of Crossrail in the Greater London Area is financed partially by BRS. The BRS is expected to fund GBP 4.1 billion of the GBP 14.8 billion project by 2038. It requires non-domestic properties with rateable values above GBP 55,000 to pay higher tax (2 pence for a pound). The tax will be increased by 15% in revaluations to take place every five years. In the first financial year 2010-11, collection surpassed the projected amount (Roukouni & Medda, 2012). Considering the project is on a regional scale, the LVC mechanism does not include specific local development projects and focuses entirely on financing the Crossrail.

The BADs in San Francisco are highly successful. The process begins with constitution of a local committee by the district's residents, business owners, tenants, schools and developers. The committee prepares a local development proposal including financial plan and seeks approval from the local government. The proposal is aimed at uplifting services and infrastructure level in the district to boost business and accelerate local economic growth. The local government scrutinises the proposal and grants BAD eligibility to the district. The district residents are charged with elevated property taxes to fund the development. Involvement of developers in the committee from early stages catalyses investment. Funds from the BADs have been used for various infrastructure projects including the urban rail system. The Los Angeles Red Line sourced 9% of the construction cost (USD 1.4 billion) from BADs (Clark & Mountford, 2007).

The LVC tools of this category encourage deliberation as the local development projects are either initiated by or drafted in consultation with residents. The projects range from developing transit hub, bicycle lanes, social housing, and public amenities, to redeveloping brownfields. The tool enables financing of various improvements in districts with low accessibility levels or low quality services, to induce economic growth. This encourages private investors to further invest in the district as the development is certain and so is their financial gain. However, there may be a few unintended effects like an inflated market and displacement of low-income residents (Medda, 2012).

3.2.4. Joint development on public-private partnership

This tool involves the private sector from the beginning. The public sector enables private sector bids for a joint development of a transport project and the adjacent land. The private sector is involved either directly in the development or through financial support for the same. The development can proceed by privatisation of public land or public acquisition of private land for private leasing. Joint development involves mutual benefit for the public and private partner while the finance and risks are externalised to the private partner. The most suitable examples of joint development are in Hong Kong and Japan.

Hong Kong Mass Transit Railway (MTR) Corporation co-develop land around stations with private developers in order to cover its capital and operational costs. This approach guides the city's urban fabric through high-density development along metro corridors as land market's accessibility attracts people closer to the transit with 41% (in 2002) of Hong Kong's population residing within the catchment area (500m) of a metro station (Tang, Chiang, Baldwin, & Yeung, 2004, 8). MTR turned a net loss in 1980s into profit worth USD 2 billion in 2015 (Cervero & Murakami, 2008, p. 13; Mass Transit Railway, 2016, p. 33) using joint development.

Japan has historically used joint development in order to amalgamate irregularly formed properties that result in smaller but fully serviced urban neighbourhoods and sale of 'extra' land to fund railways. The government, as in-kind support, enables land consolidation and acquisition. This approach is popularly known as land adjustment. Land readjustment helps in efficiently assembling the right of way for a new rail line and land parcels for development. The approach is different to Hong Kong as they go beyond individual buildings. Economic downturn in the last few decades in Japan resulted in additional strategies for value capture such as strategic infill urban development around train stations (Metrolinx, 2013).

Cape Town offers a case to illustrate joint development using a PPP. A sum of USD 1.0 billion was raised through the sale of Victoria and Albert Waterfront property by Transnet (the parastatal transportation agency) in 2006 were used to recapitalize Transnet and support its investment in core transportation infrastructure (Peterson & Kaganova 2010).

The Entrepreneur Rail Model (Newman, Davies-Slate & Jones 2017) emphasizes utilizing private sector resources and skills to co-develop urban rail and adjacent land. This model's concept begins by assessing the amount of land that can be developed and used as the primary fund source, followed by planning the development and finally estimating a transit patronage to suit the development. The government asks for bids to build, own and operate new transit lines based on fare box and land development opportunities created by the consortia. This ensures that the urban rail is constructed

along the right-of-way that promises high ridership and more importantly an on-going way of paying for their infrastructure through land development. This model is happening in Florida (Newman, Beatley and Boyer, 2017).

3.3. Land Value Capture and economic equality

Tax on land value is a progressive tax for several reasons. George (1879) argued that the economic rental generated when the location value of land is improved (non-produced inputs) through public works is the most rational source of public revenue (Ingram & Hong, 2011). It helps counter economic inequality (Plummer, 2010) as it charges the beneficiaries of the project and is applied in proportion to land values and land ownership (which is unequally distributed). It also addresses public concern surrounding imbalanced windfalls—factual or perceived—for owners of specific land units whose values increase following public investment in infrastructure. This tax can not only help the existing urban rail systems become financially viable and expand their network more rapidly but can also enable other cities' self-reliance to implement urban rail.

The financial viability of urban rail allows planners and project managers to implement and package urban rail projects in a manner that promotes amenity and affordable housing by providing incentives to developers to consider elements that address social equity concerns (some percentage of housing reserved for every income class), local community spaces, work centres, shopping areas and community services, where all these would ideally be at walking distance from the mass transit (Chava & Newman, 2016; Matan & Newman, 2016; Pendall, Gainsborough, Lowe & Nguyen, 2012).²

4. Case Study - Mumbai Metro

Mumbai is a mega city and the financial capital of India. It is the centre of commercial, cultural and trade activities. Mumbai developed as a monocentric city initially (19th and early 20th century) with port, industry, government, banking and insurance, stock exchange and wholesale trade being concentrated in its southern neighbourhoods. In the latter half of the 20th century Mumbai grew linearly as a polycentric city with a more diverse economy, attracting a sizeable immigrant population, effecting a four-fold population increase i.e. around 3 million in 1951 to around 12 million in 2011 (BMC, 2015). The linear development occurred due to the geographic boundaries of Mumbai and was enabled by the north-south connectivity provided by the suburban rail network.

² In India, government housing authorities are legislatively bound to include housing for every income group in housing schemes. In some states, like Madhya Pradesh, private developments must also include a percentage of housing for economically weaker sections.

These factors enabled Mumbai to develop as a dense city with high demand for its urban rail system.

The number of public transport users in Mumbai amounts to over 11 million accounting for 75% of total daily trips (BMC, 2016). This high percentage is attributable mostly to the suburban railway (43)% as it is the fastest and most reliable mode to travel in the highly congested corridor than bus or car. This mode-share of public transport remained constant through two decades before shifting slightly in recent years with public transport declining nominally and private modes rising (BMC, 2016). Both private vehicle ownership and road capacity have increased in the last decade but further growth is impossible due to spatial constraints. Expansion of the rail system has been demanded due to heavy overloading, lack of east-west rail connectivity and delay in implementing further rail options (BMC, 2015; 2016). Thus Mumbai is planning to implement a Mumbai Metro (Mumbai Metropolitan Region Development Authority, 2013). The government has estimated that 43% (USD 11 billion) of the total investment in Mumbai's transport sector should be allocated towards investment in Mumbai Metro (BMC, 2016).

4.1. Mumbai Metro

Mumbai Metro was conceptualized on the Build, Own, Operate and Transfer model (a PPP model) with a 35-year concession period (5 years' construction, 30 years' operation). Commercial operations of Line 1 of the Mumbai Metro (about 11 km) were successfully commenced on June 8, 2014. A special purpose vehicle (SPV) was constituted to implement the Mumbai Metro Line 1 with the selected concessionaire and government agency entitled to 74% and 26% equity share capital respectively (Mumbai Metro, 2013). The SPV serves to design, finance, build, operate, maintain and transfer the system to the state government at the end of the concession period.

A key impact of Mumbai Metro is that the reduction in travel time for its 11-km corridor is from 71 minutes to 21 minutes. It provides an essential link between the suburban eastern rail line and the suburban western rail line and areas unserved by the suburban rail system. It is integrated to the suburban rail system through a foot-bridge thus making it an integrated system. Additionally, the rail line's adjacent area has emerged as a business district over the past two decades and the high population density of Mumbai can result in high ridership (Rangwala, Mathews & Sridhar, 2014). These factors were all considered to provide the Mumbai Metro with a significant advantage that should provide sufficient patronage to pay for the system. However, although the daily ridership of 0.3 million on 11 km (11 stations) is high on any global comparison, it is not reaching the anticipated levels of over 0.5 million in 2016 (Mumbai Metropolitan Region Development Authority, 2013; Sharma, 2017).

The ridership shortfall of 60% significantly impact the revenue of Mumbai Metro as the project is depends predominantly on farebox and partially on non-farebox (rent from shops at stations and advertisement). Mumbai Metro has consistently run into substantial financial loss since operations commenced. The 2015-16 losses amounted to USD 44 million (Deloitte Haskins & Sells, 2016). Being a private system on at limited 35-year lease period it is essential for it to overcome the financial loss.

There seem to be three main causes for Mumbai Metro's financial loss. Firstly, construction costs blew out by around 83% following construction delay, which heavily impacted on the repayment of capital loans³. Secondly, the private operator raised capital at standard market interest rates (over 11%) rather than acquiring soft loans like other Indian government metro systems (e.g. Delhi Metro) which raised capital from international donors at a minimal (about 1%) interest rate under the sovereign guarantee of India (FFC, 2015). This rate of interest creates repayment of raised capital substantial and pushes an operator to optimize its revenue. The last factor is the dependence on farebox revenue which we discuss in the next section and is the more fundamental factor.

4.2. Mumbai Metro's financial challenge

A detailed discussion on Mumbai Metro's fare structure merits an introduction to the legislative framework governing fare fixation of urban rail projects in India: Railways being a subject of federal jurisdiction in India, Indian urban rail projects are implemented under the federal legislation Metro Railway Act of 2002. The Act allows the operator to fix the initial fare independently, while fare revision is decided upon by a Fare Fixation Committee (FFC) constituted by the federal government.

The financial health of operational Mumbai Metro Line 1 did not reflect the vision of the project's conception, that of high ridership resulting in high farebox revenue enabling a commercially viable PPP project. In order to overcome financial losses the operator demanded to increase the fare and a FFC was set-up to fix the fare in 2015. The FFC report highlights that the Mumbai Metro project had raised capital at market interest rates and relied on farebox revenue to sustain the system commercially⁴.

The FFC recommended a higher fare for Mumbai Metro which could render it one of the most expensive commuter urban rail systems in India. The proposed fare stands at INR 110 (USD 1.7) for 11 km at INR 10 per station, while the existing fare is (sold as

³ The private operator blames the government approval and the private operator has been criticized by a few civil society organizations for artificial escalation of project costs (Kulkarni & Shaikh, 2014)

⁴ The FFC notes that Mumbai Metro should explore options to increase non-fare revenue but are limited with no mention to land value capture, this may be due to their scope of work.

discounted fare) INR 40 (USD 0.6). While Mumbai Metro's revised fare is comparable to that of urban rail systems in developed world cities including Milan, Tokyo and Sydney, it significantly exceeds that of other Indian metro systems - Jaipur Metro (INR 20 for comparable distance), Delhi Metro (INR 18 for comparable distance), entirely privately owned Rapid Metro Gurgaon (INR 20 for 5 km). The FFC notes that the steep fare hike may not even suffice for the operator to recover their cost for the next few years. This reflects the substantial lacunae in the project's planning and risk analysis. A section of the FFC report notes that the private operator is not sharing risks on delay in the project which may contradict the fundamental principle of PPP projects. Rather, the private operator seemingly seeks to pass such costs (risk) on to the people of Mumbai.

The significant fare hike can have social and political impacts for Mumbai as it is an emerging city with the majority of population residing in slums at significantly low income levels. It is apparent that for many Mumbai Metro users cost is not an overriding factor compared to comfort, travel time saving, safety and convenience. However, cost overrides all factors for members of economically weaker sections of society whose transport costs command a significant share of living expenses. Cropper and Bhattacharya (2012) note that Mumbai's economically weaker section spend the highest percent of their income on public transport (16%) among all economic classes. This was noted when the public transport was highly subsidized (in year 2012) by the government.

Despite the burdensome cost (higher fare than Milan's subway), Mumbai commuters might resort to using Mumbai Metro to save 50 minutes on a one-way trip as no other travel option exists.

The concerns discussed in this section can significantly hinder private investment in future PPP urban rail projects in India and emerging cities. Over-reliance on farebox revenue towards sustaining a privately-funded metro project poses a critical issue for emerging countries seeking substantial private investment in the urban rail sector.

The Mumbai Metro case demonstrates how governments may fail to balance urban rail fare affordability, travel time and private investment in emerging cities. Such a scenario demands that the government explore non-farebox revenue sources, specifically LVC that—as discussed in the literature review—are generally economically progressive.

The subsequent sections investigate the application of LVC to Mumbai Metro. The study involved using HPM to calculate the impact of Mumbai Metro's commencement on property values, followed by exploring the LVC options suitable to Mumbai.

5. Hedonic Price Model for Mumbai Metro

The study considered panel data HPM to evaluate the impact of commencement of Mumbai Metro's Line 1 (11 km line operation since June 2014). Thus, panel data HPM consisting of the years 2014 (before rail) and 2015 (after rail) were investigated. The dependent and independent variables used for panel data HPM are discussed in the two succeeding sections.

5.1. Dependent variable

This study uses the average sale price of residential apartment projects (hereafter referred to as property) in Mumbai as a dependent variable for the panel data HPM. Property data were collected from a real estate company for March 2014 and March 2015. The data set comprised 333 property samples (about 66,000 apartments)⁵ for each year.

5.2. Independent variables

Explanatory variables influencing property price were considered based on neighbourhood variables, accessibility variables and city-specific variables. Additionally, property price and metro rail specific time dummy variables were included. A property price dummy variable was included for 2015 prices to estimate the conventional annual increase in property prices. Table 1 lists the variables used for the panel data HPM with their descriptive statistics.

The following Mumbai Metro rail corridor specific dummy variables were included to investigate the impact of the commencement of Mumbai Metro:

1. Properties located within 0 km to 0.5 km from metro station: includes 4% samples of total sample
2. Properties located within 0.5 km to 1 km from metro station: includes 5% samples of total sample
3. Properties located within 1 km to 2 km from metro station: includes 7% samples of total sample

Table 1: Descriptive statistics

Sl. No.	Variables	Mean	Std. Deviation
1.	Property price	22,016.2	13,401.7
2.	Property price 2015 (dummy variable)	0.5	0.5
3.	Distance from local activity centre	0.5	0.30

⁵ A property sample used in the study consists of around 200 apartments of varying size and type, which suggests that individual samples hold a substantial quantum for analysis.

Sl. No.	Variables	Mean	Std. Deviation
4.	Distance from airport	9.3	4.6
5.	Distance from central business district	11.1	7.3
6.	Distance from suburban railway station	1.4	1.0
7.	Distance from park	0.5	0.3
8.	Distance from inter-city railway station	4.3	3.1
9.	Distance from coast line	2.7	1.6
10.	Distance from industrial area	2.1	1.3

5.3. Results from panel data HPM

Four functional forms (linear, log-linear, linear-log and log-log) were tested for the panel data HPM. Investigating the different functional forms of HPM was necessary for identifying the form best suited for the study. Statistical software (SPSS 22) was used for estimating the HPM.

Out of the four functional forms, only the log-linear functional form was statistically significant for the desired explanatory variables and not random up to 99.99%. According to the analysis presented in Table 2, the log-linear functional form of the panel data HPM explains 58.4% of the variation in the dependent variable, demonstrating that the model is statistically significant. The variance inflation factor (VIF) test was also conducted, to avoid estimation errors caused by a multicollinearity issue. The test showed that all explanatory variables' VIF values were lower than 3, ruling out serious collinearity concerns in the model.

Table 2: Model summary and ANOVA⁶ for statistically significant variables

Model	Model summary			ANOVA	
	Function	Adjusted R ²	Std. error of the estimate	F	Significance
Panel Data HPM	Log-Linear	0.584	0.315	94.499	0.000

Table 3 displays the panel data HPM results for the impact of statistically significant explanatory variables on Mumbai's property price. The statistical significance of the property price dummy variable for 2015 shows that the model recognizes the panel data for both 2014 and 2015, which is essential for panel data HPM. In the Mumbai Metro

⁶ Analysis of variance

catchment specific time dummy variables only 1 km to 2 km were statistically significant in the calibrated model⁷.

Table 3: OLS log-linear HPM of property price in Mumbai (2014 to 2015)

Sl. no.	Explanatory variables	Coefficients	Std. error	Significance	% increase in mean property price with a unit increase in explanatory variables
1	(Constant)	10.859	0.06	0	-
2	Property price 2015 (dummy variable)	0.049	0.025	0.05	4.9%
3	Price change in properties at 1 km – 2 km from metro stations	0.142	0.072	0.04	14.2%
4	Distance from activity centre	-0.318	0.041	0.00	-31.8%
5	Distance from airport	-0.029	0.003	0.00	-2.9%
6	Distance from central business district	-0.028	0.003	0.00	-2.8%
7	Distance from suburban railway station	0.039	0.014	0.00	3.9%
8	Distance from park	-0.09	0.04	0.02	-9.0%
9	Distance from inter-city railway station	-0.027	0.005	0.00	-2.7%
10	Distance from coast line	-0.11	0.01	0.00	-11.0%
11	Distance from industrial area	0.059	0.012	0.00	5.9%

Note:

⁷ This may be due to the lower sample size at 0 km - 0.5 km and 0.5 km - 1 km and due to the slums and industrial area around the stations.

1. *Dummy variable

The calibrated panel data HPM shows that the commencement of Mumbai Metro resulted in a windfall gain of 14% in the properties located within 1 km to 2 km from metro stations. This property value uplift seems to align with the Knight Frank (2015) report which notes the highest value uplift happened in the micro-markets adjacent to the Mumbai Metro as compared to all real estate micro-markets in Mumbai. This significant increase can be attributed to the travel time saving and new network linkages as discussed in detail in the 'Mumbai Metro' section of this paper. Commuters can get easy access to reach the 1-2 km catchment area through walking⁸ and paratransit modes like auto rickshaw/ taxi/ cycle rickshaw which help explain the 14% increase out to the 1-2 km catchment.

The calibrated panel data HPM results also shows a conventional annual increase of about 5% in the studied properties from 2014 to 2015. This is a direct reflection from the real estate data. The model shows that with each km decrease in distance from the activity centre increases property prices by 32%. This is attributable to the diversified economy of Mumbai, emergence of activity centres and their local economic benefits.

The HPM model shows that a km decrease in distance from suburban railway stations decreases property prices by 3.9%. There are two possible reasons for this, firstly, residents of an emerging city are deterred from residing adjacent to the rail station as it attracts informal commercial setups, hawking activities, traffic congestion, pollution and presence of access/egress modes or paratransit modes like auto rickshaw creating highly crowded conditions in the immediate surroundings of the stations. Secondly, the value of properties located equidistant from station on the west side and the east side vary significantly due to the local planning factors⁹.

The HPM model predicts that a km decrease in distance from the coast increases property prices by 11%. This was predictable on the global phenomenon of residents willing to pay higher for residing closer to the coast. Whilst, a km decrease in distance from industrial areas decreases property prices by 6%. This was expected due to the polluting characteristics of industrial areas.

5.4. Willingness to pay for Mumbai Metro

⁸ Average walking trip distance of Mumbai commuters is about 1 km (Rastogi & Rao, 2003)

⁹ The suburban railway divides Mumbai longitudinally and western part of the city has significantly higher land price as compared to the eastern part.

Willingness to Pay (WTP) in monetary terms for the Mumbai Metro is calculated by multiplying the windfall gain from HPM with the average property price.

The WTP for properties located within 1 km to 2 km from metro stations is INR 33,651 (USD 524) per square meter due to the impact of the commencement of the Mumbai Metro Line 1. This windfall gain is substantial and results in an aggregate WTP of USD 161 million¹⁰ when applied to the number of properties (22 studied samples) falling in the catchment area of 1 km to 2 km results. The total cost of Line 1 of the Mumbai Metro was about USD 670 million. Thus the value creation is highly significant in relation to the cost of building the metro and warrants an evaluation as to how LVC could have been applied.

6. Discussion on Land Value Capture for Mumbai

Mumbai is one of the few Indian cities with existing legislative provisions for LVC. Maharashtra Regional and Town Planning Act, 1966 entitles Brihanmumbai (Mumbai) Municipal Corporation (BMC) to levy development charges to sell additional floor area/space and on the change of land use. Mumbai Municipal Corporation Act, 1888 entitles BMC to collect property tax upon all land and buildings within the city and levy a betterment charge on the windfall gain due to any public investment (improvement project).

The Mumbai Metropolitan Region Development Authority (MMRDA) is the government authority involved in implementing the Mumbai Metro and is its part owner. MMRDA has approached the court on the fare hike issue. Therefore, we discuss MMRDA's options to generate revenue through the LVC under their existing statutory powers.

The MMRDA Act 1974, entitles them to levy 'betterment charges' on the windfall gains to private land owners due to MMRDA's development project. This levy can't be more than 50% of the windfall gain. The MMRDA is required to notify every land owner about the levy and allow three months to raise any concerns. In case an issue prevails, the individual can approach the court or arbitration panel. As per the MMRDA Act, the betterment charges apply only to land value for properties, not to the value of apartments or buildings. Based on our discussions with the MMRDA, they have considered implementing betterment charges for Mumbai Metro but have not been able to implement it. This is due to the lack of empirical analysis available on the windfall increase in land values and its catchment area due to Mumbai Metro commencement.

¹⁰ Each apartment measured 70 sq m and each apartment project included 200 apartments.

This study fills this knowledge gap to show the impact of Mumbai Metro Line 1 on residential values¹¹.

The estimated 14% windfall gain applied on land value within the 1 km to 2 km residential catchment area¹² from Mumbai Metro results in an estimated revenue of USD 179 million¹³, based on the government land rate of about INR 60,000 (USD 934) square meter (at a very conservative rate)¹⁴. This substantial revenue can sustain Mumbai Metro losses for the next four years (based on their existing USD 44 million loss in 2016) without any substantial hike fares. This study could help government committee's and policy makers in emerging cities to show how LVC can be implemented to finance urban rail.

7. Conclusion

This study has shown significant land value uplift potential due to the commencement of urban rail in Mumbai. The study illustrates that the impact of metro rail is beyond the traditional 500m. The analysis has shown that Mumbai could have used existing legislation to capture this uplift to make the PPP metro project financially viable along with keeping fares competitive. Although it is too late for the Line 1 phase of the Mumbai Metro, other phases could tap the LVC mechanism for funding.

This paper illustrates how LVC for urban rail can be used to avoid a high dependence on farebox revenue with the consequent struggles over fare fixation. Mumbai is one city where the fare box may have been possible to cover all costs but even here it does not. Application of LVC is possibly necessary to enhance fare affordability and mitigate the financial strain imposed by public transport on the community in any city.

The use of LVC will require governance to include financial mechanisms in future PPP arrangements that can enable the value increases around stations to be captured in a reasonable and transparent way. Detailed studies of land use along new lines can provide the basis of projected financial uptake based on the data from this first line.

¹¹ The MMRDA and the state government of Maharashtra had set up a committee to propose non-fare revenue, specifically LVC, options for financing urban rail projects. The committee discussed on key two points, first on how to evaluate the impact of urban rail and second how to implement land value tools.

¹² 25% of the total area is under residential land use as per Draft Development Plan – 2034, Greater Mumbai, 2016.

¹³ This calculation is based on the multiplication of residential area (25% of 22 million sq m), per sq m price (USD 934) and 25% betterment charge levy on windfall gain worth 14%.

¹⁴ Mumbai has the highest real estate capital values as compared to any other Indian city (Knight Frank, 2015). Thus application of land value capture tool can return substantial funds for urban rail.

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