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Does Infrastructure Spending Lead to Price Effects in the Property Market? Evidence from Major Cities across India

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Abstract

A recent boost in spending on the public infrastructure across India raises the question: how does the property sector react to massive infrastructure construction? The answer have significant policy relevance. This paper uses panel data across seven major Indian cities, spanning seven years from 2008 to 2014, to ascertain the short-run and long-run impacts of infrastructure attributes on property values and rents. The study finds that increases in the percentage of public infrastructure spending lead to a positive effect on the property capitalisation rate in India, but have a negative impact on the rental market in the short term.

Keywords: Infrastructure Spending, Rental Price, Cap Rate

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1. Introduction

Almost 70% of the world population is going to live in urban areas by 2050, according to a recent UN (2008) report on world population prospects. For the past decade, India's infrastructure industry has experienced steady growth. As reported by the Economist (15/12/2012), between 2007 and 2012, the private sector invested as much as $225 billion in infrastructure in India during 2007-12[4]. This is equivalent to almost 12% of GDP in 2012. According to a Government of India report, urbanisation is expected to intensify with the urban population reaching approximately 600 million by 2031 and 850 million by 2051[5]. This rapid urbanisation in India would bring about huge demand for houses, as well as high-quality public services for the households. A major, fast-growing economy such as India needs to provide ample public infrastructure due to mounting demands from a growing urban population. This has led to massive spending on improving infrastructure networks and creating new ones. Infrastructure spending is also a popular fiscal stimulus. The idea stems from the economic principle of the demand 'multiplier' effect, i.e. economic development can be kick-started or boosted through job creation in the economy. Infrastructure spending creates room for future development and other investments.

One of the key sectors for development and further investment due to an infrastructure boost is the property sector. The land being opened up for development can lead to significant increases in new construction and thus, the supply of properties. Moreover, both residential and non-residential property sector developments may be correlated, as the needs for both of these types of properties are often interlinked due to simultaneity in job and residence location choices. Public capital may also lead to growth in private capital spending, by removing bottlenecks and thus raising economic productivity. Regions and countries do vary in their institutional backgrounds, resulting in a varying receptiveness for public spending. Regional heterogeneity in institutional constraints may influence the channels through which the effect of infrastructure spending leads to economic development. At the regional level, the possibility of leakage effects can substantially dampen potential growth prospects, where a sizeable portion of the benefits of infrastructure improvement can be reaped by the neighbouring regions. This is especially

[4] See https://www.economist.com/finance-and-economics/2012/12/15/rippp

[5] See https://unfccc.int/sites/default/files/resource/INDIA%20SECOND%20BUR%20High%20Res.pdf

true in a country such as India, which has a large number of contiguous and heterogeneous states with a diverse range of institutional factors.

A number of studies have documented the role of infrastructure investments as key drivers for a country's economic growth (see Prud'homme, 2005 for a review). Developing infrastructure enhances a region's comparative advantage through the improvement of productivity efficiency, transportation and the urban amenities (OECD, 2008). Developed countries focus on replacement and upgrading of their aging infrastructures, while developing countries build new infrastructure to fuel economic growth.

As the current Indian government is planning for massive infrastructure investment (e.g. high-speed railways and highways), a pertinent question is: how will the property sector react to massive infrastructure construction? We use panel data across major Indian cities spanning seven years from 2008 to 2014, to ascertain the impact of infrastructure attributes on property values. Local and state fixed effects are included to control for unobserved heterogeneity. We document that increases in the percentage of public infrastructure spending have a positive effect on the capitalisation rate in India, but a negative impact on the rental market. The effect of changes in the public infrastructure is examined over different construction periods to focus on the long-run effect, which is more likely to be capitalised into the cap rate. The better access to the infrastructure tends to increase the supply of real estate relative to demand in the property sector, resulting in higher market cap rates over the long run.

Contributions of this paper are manifold. First, our paper complements a rich body of literature analysing the relationships between infrastructure investment and economic growth in both developing and developed countries. Second, our paper documents that the property sector benefits from better access to infrastructure; the wealth effect of which serves as a channel to overall economic growth. Thirdly, our investigation of the property-sector consequences of city-based investments contributes to recent literature on gentrification due to rapid urbanisation with a multitude of inflationary impacts on prices and rents. The increased labour mobility, along with strong income growth, raises the demand for urban amenities, contributing to land rent differentials. As infrastructure investment is of considerable relevance in improving urban amenities, it is also likely to explain the current land rent differentials and real estate price dynamics in the property sector. However, there are only a few studies that directly examine the wealth effect of infrastructure investment on the property sector. Our research fills the gap. The findings also have significant policy relevance in terms of curbing property market fluctuation; identifying pockets of development and local urban planning; issues and mechanisms of land value capture; and the formation of an agglomeration economy etc.

The paper is organised as follows: Section 2 reviews the literature on infrastructure investment. Section 3 develops our hypotheses. Section 4 describes the empirical design and data sources. Section 5 presents the main findings and robustness checks. Section 6 concludes the paper with a brief discussion on policy implications.

2. Literature Review

The relationship between infrastructure investment and the property sector revolves around the fact that the 'network' infrastructures, such as roads and airports, open up the land for future development. As Ball and Nanda (2014) note that the property sector perspective is based on the possibility that economic activities across various sectors are accommodated in buildings and transmitted through the property sector. Therefore, expanded local business activity stimulated by infrastructure investment is likely to lead to more commercial building to accommodate it, especially in service-dominated economies. Related to this, the housing sector is also stimulated due to increased labour market activity and changes in travel-to-work patterns. Interestingly, Cohen and Morrison (2007) present evidence of significant positive effects of public infrastructure on US property prices, and the size of the effect depends on distance from the investment, with the effect being less for more distant properties. The results show that rental growth was similar in regeneration locations compared to the prime market. However, they find a major cap rate shift for property in regeneration areas in the short to medium term. In a recent paper, Cohen and Brown (2017) estimate the net capitalisation effect for each individual commercial property price resulting from expected improved urban centre access using a rail rapid transit line announcement in Vancouver, BC, Canada. Haughwout (1997) presents evidence that a 10% increase in central city infrastructure can lead to 0.61% appreciation in suburban house values. Without considering the tax effects, it means, the cost of a 10% increase in infrastructure would be approximately \$1 billion, while the increase in housing value would be approximately \$3 billion. Boarnet (1997) finds a 'leeching' effect of nearby infrastructure, where the most productive resources are drawn away from a region when a nearby region enhances its infrastructure. Kelejian and Robinson (1997) find mixed effects of public infrastructure on productivity; depending on the econometric specifications, the results can vary widely. Holtz-Eakin and Schwartz (1995) report a similar lack of statistically significant evidence. Gibbons and Machin (2008) also argue that it is not possible to draw a clear conclusion on the impact of transport improvements on house prices due to differences in the context and local area dynamics.

A rich body of literature explores the causal relationship between infrastructure development and economic growth (Ahlfeldt, 2011; Atack et al., 2010; Banerjee et al., 2012; Baum-Snow, 2007; Baum-Snow et al., 2012; Datta, 2012; Faber, 2014; Ghani et al., 2012). The wealth effect of access to infrastructure is documented to transfer to the economy via agglomeration. Developing infrastructure enhances a region's comparative advantage (Newell and Peng, 2008) through the improvement of productivity efficiency, transportation and urban amenities.

The question essentially revolves around the size, direction and nature of the impacts resulting from such effects. Using aggregate time series analysis in a couple of seminal studies, Aschauer (1989) concludes that public building investment has a statistically significant impact on economic growth. A number of studies have supported Aschauer's findings (for example, Berndt and Hansson, 1992, using Swedish data; Canning and Fay, 1993, using a panel data analysis of 96 countries; and Lynde and Richmond, 1991, using US data; see also Gramlich, 1994, and Munnell, 1992, for a survey of the literature.).

A number of studies focused on the effect of infrastructure on productivity. Infrastructure investment can reduce (or remove) mobility constraints of factors of production and, thereby, it can result in a positive effect on the productivity of labour and capital. Using Mexican manufacturing industries as the case study, Shah (1992) provides such evidence of the economic significance of public infrastructure investment on private sector profitability. Other studies have also confirmed such effects using data from different countries (Nadiri and Mamuneas, 1994, for US manufacturing industries; Seitz, 1994, and Seitz and Licht, 1995, for the West German manufacturing industries) However, quite a few studies have also found no statistical significance for such relationships (Tatom, 1991; Evans and Karras, 1993). Quite clearly, no consensus appears to have emerged, as yet, in the literature using aggregate national data.

The regional analysis suffers from a range of biases due to the presence of significant unobserved heterogeneity at various geographic levels within an array of effects, such as network and spillover/leakage effects, that are hard to quantify. A group of studies (see Pereira and Andraz, 2008 for a list of the relevant studies) used regional- or state-level panel data to understand these relationships. Using data from 28 US metropolitan areas, Duffy-Deno and Eberts (1991) find positive and statistically significant effects of public infrastructure on regional economic development. The choice of proxy is an important consideration in answering this question, as the problem of endogenous feedback may be significant. Similarly, other studies find comparable evidences (Garcia-Milà and McGuire, 1992; Munnell and Cook, 1990). However, many studies have also presented contradicting or non-supporting evidences of a positive relation (e.g. Pereira and Andraz, 2008; Evans and Karras, 1993; Garcia-Milà et al., 1996; Holtz-Eakin, 1994).

The possibility of spillover effects or leakage from investment in one region to other regions is an important aspect of the regional analysis. Pereira and Andraz (2004, 2006) present the possibility of significant regional spillover effects using US and Portuguese data, respectively. Studying Spanish regions, Pereira and Roca-Sagales (2002) also find considerable spillover effects. Haughwout (1998) provides a model and presents a quantitative example showing that increases in public goods may not always result in higher equilibrium output at the regional level. However, the extent of the effects may crucially depend on the infrastructure endowment of the regions.

Shirley and Winston (2004) show that the rate of return from highway infrastructure spending decreased over time in the US – from about 17–25% in the 1970s to 4.9–7% in the 1980s and to about 1% in the 1990s. As McDonald and McMillen (2010) comment, the reduction could be attributed to the increasing stock of infrastructure, i.e. diminishing marginal returns. Therefore, the positive feedback effect of infrastructure spending may not be guaranteed across regions. However, in a developing country, the positive effect can be achieved relatively easily, as the endowment level is low and incremental impacts are more pronounced.

A recent strand of literature also focuses on urban gentrification due to the access to infrastructure. Kahn (2007) documents that newly opened 'walk and ride' subway stops for fast new subways contribute to an increase in local home prices in major US cities, such as Boston and Washington DC. Guerrieri et al. (2010) report evidence of spatial spillovers, in which exogenous increases in income in one community lead to an increase in real estate prices in adjacent communities. Cohen and Morrison (2004) test for spatial spillover and apply a cost-function model to 1982–1996 state-level US manufacturing data, in order to untangle the private cost-saving effects of inter- and intrastate public infrastructure investment. Morrison and Schwartz (1996), using a cost-based methodology, find that, in the short run, public capital expenditures provide cost-saving benefits that exceed the associated investment costs due to substitutability between public capital and private inputs. Kahn et al. (2010) also document the gentrification in Los Angeles communities.

3. Hypotheses

The above literature review leads to several testable hypotheses. As mentioned, our focus is on the property sector, which acts as the reflector of economic activities. As evident from the following diagram, a significant extent of the economic benefits from infrastructure investment will be transmitted through the property sector.

[Insert Figure 1]

Two possible transmission channels for the impacts of infrastructure spending on the property market are: (i) sectoral spillover effects caused by stimulating investments in other economic sectors, creating demand for space and (ii) spatial spillover effects, caused by influencing property sub-markets and urban economic geography. Dynamic effects through both channels would be reflected by key property market indicators based on the following hypotheses:

A. **Supply shifter**: Infrastructure spending would open up developable land, leading to various property development activities and, thus, increased supply. An increase in supply, *ceteris paribus*, would exert downward pressure on price variables – the rent and sales value of properties.

B. **Demand shifter**: Infrastructure spending would act as booster for various employment generating sectors. Increased employment opportunities (and recruitment intentions) and business expansion would lead to increased demand for space, leading to upward pressure on price variables – the rent and sales value of properties. Moreover, infrastructure spending may also boost investment sentiment with potential implications for the cap rate.

C. **Net effect**: the above effects may work in tandem and, therefore, the net effect in a local area may depend on infrastructure endowment and current levels of prices.

In a developing country, such as India, the demand shifting effect would probably dominate due to low levels of price variables and rapid business expansions. In the seven Indian major cities in this study have been experiencing rapid business expansions, including the emergence of employment generating sub-sectors.

4. Empirical Design and Data Sources

The dataset used in this paper consists of both data on infrastructure investment and property transactions. We focus on the following Indian cities: Bengaluru, Chennai, Hyderabad, Kolkata, Mumbai, Delhi and Pune. The seven cities are among the 'Big Eight', with populations exceeding 5 million people each and an urgent need for generating agglomeration economies via massive urban infrastructure. The sample used is from 2008 to 2014. We hand-collected the infrastructure data on highway and bridge construction from the Secretariat for India's Planning Commission (see www.infrastructure.gov.in). We then constructed a dataset including property transaction information from the cities with access to infrastructure. Macro data are retrieved from DataStream.

Using a simple theoretical framework around demand multiplier effects, we examined testable hypotheses and used both primary and secondary information in our data analysis. We modelled two key property sector performance indicators: rental growth and cap rate. Nanda and Tiwari (2013) estimate a single-step adjustment model with lagged cap rate, the ratio of real rent index for a given location in a given quarter to its historical average, the real Treasury bond yield, the spread between corporate bond index and Treasury bond yield and the liquidity measure as ratio of total net borrowing and lending to nominal GDP.

We extend the above-mentioned modelling approach, by incorporating fundamental drivers of the local property market and examining various property market indicators including the cap rate. Local area employment is a significant demand shifter for commercial space, as well as residential development. However, as discussed before, the emergence of developable land may be triggered by improved infrastructure. Therefore, infrastructure spending may act as a supply shifter across the property markets. The basic model of interaction of demand and supply shifters can be written as Equation 1:

$$\ln(k_{it}) = \alpha_0 + \beta_1 X_{it} + \beta_2 Z_{it} + \varepsilon_{it} \tag{1}$$

Where, k_{it} is a property market indicator such as rental growth, capital value growth, vacancy rate, net absorption, and cap rate. X_{it} is a vector of local area (i) attributes, such as employment and rent ratio at time *t*. Z_{it} is a vector of macroeconomic variables such as risk spread, liquidity, real GDP growth, stock market performance etc. The literature has also included lagged dependent variable to help identify the robust effects, as shown in Equation 2:

$$\ln(k_{it}) = \alpha_0 + \beta_1 \ln(k_{it-1}) + \beta_2 X_{it} + \beta_3 Z_{it} + \varepsilon_{it} \tag{2}$$

A key variable in our study is infrastructure spending (I_{it}), which can now be incorporated as shown in Equation 3:

$$\ln(k_{it}) = \alpha_0 + \beta_1 \ln(k_{it-1}) + \beta_2 X_{it} + +\beta_3 Z_{it} + \beta_4 I_{it} + \varepsilon_{it} \tag{3}$$

I_{it} may be specified in level (depending on availability of data) or as an indicator variable. Unobserved heterogeneity may be modelled as fixed effects, after conducting the Heckman's specification test. However, we envisage that fixed effect modelling may be more appropriate than random effect modelling due to the presence of a small number of large cross-sections. We employ a fixed effect panel data method to estimate the model. The advantage of this method is that it allows us to use both time series and cross-sectional variations in the data, which increases the efficiency of the Ordinary Least Squares (OLS) estimates. A potential bias in estimating equation (3) is the possibility of a correlation between unobserved heterogeneity at the local area level and the observables, which would violate standard assumptions of OLS estimation. Therefore, the disturbance term in equation (3) is specified as a two-way error component model with area-specific fixed effects and time-specific effects. In this fixed effect specification, heterogeneity is assumed to be constant over time and correlated with independent variables.

To analyse the impact of infrastructure investment on the property market, we regress the rental price recorded on each lease transaction on the infrastructure attributes in the panel, as shown in Equation 4:

$$\ln(Rental_{jit}) = \alpha_i + \beta_1 Infras\ Attributes_{it} + \gamma controls_{it-1} + Year_t + City_i + \varepsilon_{it} \tag{4}$$

$Rental_{jit}$ is the rental price recorded on the lease transaction *j* of city *i* in time *t*. α_{i} is region fixed effect. $Infras\ Attributes$ take *Infras_dummy, ln(Infras_length), ln(Infras_spending), ln(Infras_lengthtotal), ln(Infras_spendingtotal)* respectively.

We measure *Infras_dummy*, i.e. the city's access to infrastructure, using the following variables. We denote *Infras_dummy* equal to 1, if the infrastructure investment is observed for the given city at time *t*. *Infras_length* measures the length of highways under construction for the given city at time *t*. *Infras_spending* measures the estimated spending on highways under construction for the given city at time *t*. *Infras_lengthtotal* measures the total length of highways under construction and completed for India at time *t*. *Infras_spendingtotal* measures the total estimated spending on highways under construction and completed for India at time *t*.

Control variables include both property attributes and macro variables. *Area* is the size of property on file. Macro control variables include *GDP, Stock, CPI,* and *Consumption*. *GDP* is the log difference of gross domestic product (GDP), *Interest Rate* is the three-month deposit rate, *CPI* is the quarterly average of monthly Consumer Price Index (CPI), and *Consumption* is the log difference of private consumption. We use the log difference of the stock index as the proxy for growth in the traded stock (*Stock*).

We then analyse the impact of infrastructure investment on the cap rate based on the traditional cap rate model in the property sector, see Equation 6. It is also notable that the body of academic work on the determinants of cap rates is largely silent on the effect of capital flows. Chervachidze and Wheaton (2013) focus on availability of debt (debt flow) as a driver of capitalisation, finding that changes in debt availability at the national level have significant effects on cap rates.

$$\ln(Cap\ Rate_{jit}) = \alpha_i + \beta_1 Infras\ Attributes_{it} + \beta_2 Risk\ Premium + \beta_3 Rentalchange + \gamma controls_{it-1} + Year_t + City_i + \varepsilon_{it} \quad (5)$$

We measure $Cap\ Rate$ for each leased property on file as the rental price over the selling price of the comparable property adjusted by the risk-free rate, measured as the treasury rate. α_i is region fixed effect. $Risk\ Premium$ is the market factor, calculated as the difference of stock market return over risk free rate. *Rentalchange* is calculated as the deviation from the long-run average rental price for each city. $Infras\ Attributes$ are *Infras_dummy, ln(Infras_length), ln(Infras_spending), ln(Infras_lengthtotal),* and *ln(Infras_spendingtotal)*. Control variables include both property attributes and macro variables as described in Table 1.

Finally, our interests on the benefit of infrastructure spending are not just on the impact on rental prices, which tends to be relatively short term, but also in the subsequent change in access to infrastructure. To analyse the long-term impact, we examine the impact of infrastructure investment on both rental prices and cap rate over the subsequent period in the Equation 6:

$$PropertyIndicator_{ji,t+n} = \alpha_i + \beta_1 Infras\ Attributes_{it} + \gamma controls_{it-1} + Year_t + City_i + \varepsilon_{it} \qquad (6)$$

5. Empirical Results

5.1 Main Results

This section reports the empirical evidence on how infrastructure investment affects the property market. Table 1 shows the summary statistics for all the variables used in the empirical analysis. The mean of *Rental Price* is INR 64.99 per sq ft, with the standard deviation 51.56. Massive infrastructure investments are observed in the sample period, with the average *Infras_length* being 57.85 km on highway and bridge constructions at the city level annually. The average spending on infrastructure investments amounts to INR 193.39 crore annually. The standard deviation of the *Risk Premium* is 1.95% with a mean of 3.27, indicating risk premium is significant.

[Insert Table 1 here]

Table 2 reports the results of how infrastructure investment affects rental prices. Column (1) reports the results with the simplest specification of only infrastructure attributes, and they explain about 24.2% of rental prices. The length of highway under construction, as a proxy for the penetration of the infrastructure investment at the city level, is significant and is negatively associated with the rental price. For each 1% expansion in the city's highway, the rental price is further decreased by 0.023%. Column (2) reports the results with control variables. Infrastructure development on the city level decreases the rental prices, while the overall infrastructure on the country level is likely to have a positive impact on the rental prices. In columns (3) and (4), we include the interaction term that is proxy for the total project announced at the time *t* for the given city in the regression, where the interaction terms remain significant and negative. Columns (5) to (8) further report the results on how the infrastructure spending affects the rental prices and the results are broadly similar. Column (5) presents the results with the simplest specification with only infrastructure investment, and they explain about 24% of rental prices. The estimated input on the infrastructure project is significantly and negatively associated with the rental price. For each 1% increase in the infrastructure input, the rental price is decreased by 0.016 %.

[Insert Table 2 here]

Overall, Table 2 shows that infrastructure development on the city level decreases rental prices, while the overall infrastructure on the country level is likely to have a positive impact on rental prices.

Table 3 reports the results of how the infrastructure investment affects the cap rate. In contrast with the results on the rental market, we find a significant and positive relationship between city-level infrastructure investment and the cap rate. Column (1) reports the results of the simplest estimation with only control variables, and they explain about 16.9% of cap rate. Column (2) reports the results with control variables. For each 1% expansion in the city's highway, the cap rate is further increased by 0.104%. In Columns (3) and (4), we include the interaction term that is proxy for the total project announced at time *t* for the given city into the regression, which is still significant and positive. Columns (5) to (8) further document the results of how the infrastructure investment affects the cap rate in the property sector. Column (5) reports the results with the simplest estimation with only infrastructure investment, and they explain about 17.9% of the cap rate. The estimated input on the infrastructure project is significantly and positively associated with the cap rate. For each 1% increase in the infrastructure input, the cap rate is increased by 0.056%, a smaller magnitude compared with the penetration on the infrastructure investment. Column (6) reports the results with control variables, with a significant increase in adjusted r-squared to 49.4%. In Columns (7) and (8), we include the interaction term in the similar vein as we did in rental price analysis.

[Insert Table 3 here]

The positive relationship between infrastructure investment and cap rate indicates an oversupply in the property sector in India. First, the Indian government has launched a massive project on housing for all by the year 2022, which has identified 305 cities and towns in nine states to begin construction of houses for the urban poor, by means of PPP and interest subsidies. Large-scale urban areas are created to attract investment and provide high-quality living standards. Urbanisation in developing countries is gradually associated with oversupply of the property sector. Second, it is a common view that urbanisation implies migrants leaving their rural homes to go to urban areas to work and live, or 'relocating migrants'. However, urbanisation also includes reclassification in developing countries, such as India and China.[6] If a rural area is reclassified as urban, residents living in the area becomes urban residents. They are migrants by reclassification, or 'redefined migrants'. The misclassification may also contribute to the oversupply in the housing market. Third, the Indian government over-regulates the land and real estate market, possibly leading to information inefficiency on the property sector. Fiscal competition among regional governments leads to an inefficient outcome, especially with the overprovision of public infrastructure expenditure (Fuest, 1995). The possibility of the spillover effect and spatial externalities from such regional investment further complicate the dynamics of competition.

Overall, Table 3 shows that infrastructure development on the city level increases the cap rate, while the overall infrastructure at the country level does not appear to exert a positive impact on the property sector. Next, we test for robustness.

5.2 Long-term impact of infrastructure investment

Since we know that the benefits of infrastructure spending are not exclusive to rental prices, which tend to be relatively short term, it is important to examine whether infrastructure spending has a subsequent impact on the property market. We regress both rental price and cap rate in the subsequent periods after the infrastructure project has been announced, the results of which are reported in Table 4. The impact of access to infrastructure is amplified with a larger magnitude over time on rental prices, though a negative relationship is still evident in the short term; however, it reverts to positive after two years. As rental is a payment for property occupation and associated services, there may exist a trade-off between pollution and inconvenience from construction works and commuting benefits that may accrue after the infrastructure project is completed. Moreover, there might also be a lack of ready market take-up along with an initial higher rate of vacancy. Both of these aspects can lead to less favourable effects from infrastructure investment. Over the longer term, both of these adverse influences may dissipate, with the positive effects becoming

[6] The National Bureau of Statistics publishes classification codes for each of the 700,000 neighbourhoods in China from 2009 to 2013. During this period, 3.8% of neighbourhoods were reclassified as urban neighbourhoods.

more prominent and significant. As for the cap rate, the impact of access to infrastructure is positive, with increases in the cap rate over the long run. The better access to infrastructure tends to increase the supply relative to demand in the property sector, resulting in higher market cap rates over the long run.

[Insert Table 4 here]

5.3 Alternative models

As robustness checks, we analyse the impact of infrastructure attributes on the rental price using the vector autoregressive model for each region[7] and estimate the impulse response function of different asset attributes to the rental prices. We further employ a difference-in-differences approach, using the post-crisis period as a quasi-experiment, with an indicator for the global financial crisis period and its interaction with the infrastructure variables, to identify infrastructure effect versus crisis effect. The robustness tests generate similar results to those reported, which are available upon request.

6. Policy Implications and Concluding Remarks

The increased level of labour mobility, along with a rapid urbanisation process, raises the demand for urban amenities, contributing to land rent differentials across cities. Such effects can be especially pronounced in the context of developing countries. As the infrastructure investment is of considerable relevance to improving urban amenities, it is also likely to explain the current land rent differentials and real estate price dynamics in the property sector. In this paper, the empirical evidence shows significant evidence of the infrastructure spending on the property sector. The study finds that an increase in the percentage of public infrastructure spending has a positive effect on the cap rate in India, but it leads to a negative impact on the rental market. The robustness tests clearly indicate that there exists short-run and long-run effects. This could be due to inherent construction inconvenience and initial low take-up, which are likely to dissipate over the longer term.

[7] We also use the spatial lag matrix to capture the spatially weighted externality from the subject city and other cities.

Overall, we document that better access to infrastructure tends to increase the supply for real estate relative to demand in the property sector, resulting in a higher market cap rate over the long run. This is especially true in the Indian context, where the infrastructure endowment is relatively low in many urban areas.

Our results have significant policy implications, in terms of forms of government interventions, strategic urban planning, issues and mechanisms of land value capture, the formation of an agglomeration economy and the nature of urbanisation.

From the government perspective, local areas should be strategically chosen that can promote uniform economic development across regions by unlocking and connecting land for economic activities. The potential positive and negative effects coming from the concentration of economic activities (i.e. the agglomeration effect) induced by the introduction of new infrastructure needs to be weighed and addressed with adequate policies that maximise the former, while keeping the latter under control. While the positive impact on the property values is beneficial from the investors' perspectives, with a likelihood of further increases in premium and density driven by the demand elasticity near new infrastructures, such effects can lead to worsening of affordability. Therefore, policies should be devised to target locations of high appreciation and provide affordable housing for low income groups and commercial space for local businesses. Also, developments closer to key infrastructure points should be required to provide amenities that promote easier access to surrounding areas. This may act as an indirect mechanism for effective land value capture. The increased revenues from the land value capture (due to price premium) can also be utilised for financing current and future infrastructure developments. The increased property tax revenue can be used for supporting social infrastructure needs of the communities, such as public education and a healthcare system. With rising urban populations, the strains on the public education and healthcare systems can be very sizeable, especially in the Indian context. Therefore, channelling the revenues from a higher base for property tax towards social infrastructure can address the typical financing challenges for these two important components of human development.

Moreover, promoting and incentivising public transport, through monetary as well as non-monetary incentive mechanisms, will further boost the impacts on commuting cost-savings and environmental benefits with lower carbon emissions. This can also reduce dependency on private transport, thus accelerating labour mobility across the regions and shaping the regional industrial ecosystem and meeting climate change goals. The employment problem of the affected regions can be effectively addressed. In developing countries with usually higher levels of income inequality, an efficient public transport network can alleviate and potentially eliminate the rich–poor gaps.

The co-ordinated development across large cities and their peripheral areas via an infrastructure boost helps to gather entrepreneurial innovation through agglomeration benefits, optimise supply-chain mechanisms for local businesses and accelerate regional economic upgrading. For a long time, infrastructure investment in the developing countries relied solely on government fiscal allocation or land finance. By expanding the financing channels and effectively using social capital, the PPP model can alleviate project risks as well as reduce a government's financial pressure. In this regard, connecting different regions can help mega cities to achieve functional transfer and serve as growth engines for regional economic development. For the long term, an integration of industrial and land use policies is needed to ensure continuous capital investment from both government and social capital.

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Table 1: Descriptive Statistics

This table describes the key variables used in the empirical analysis.

Variable Name	Definition	Data Sources	Mean	Std	Min	Max
Panel A: Variables of Interests						
Rental	The rental price recorded on the lease transaction *j* of city *i* at time *t (per sq ft)*	Transaction data	64.99	51.56	12	489
CapRate (%)	The rental price recorded on the lease transaction *j* of city *i* over the selling price of a comparable property at time *t*	Transaction data	6.85	24.51	0.76	12.5
Panel B: Infrastructure Spending						
Infras_dummy	Equals to 1, if the infrastructure investment is observed for the given city at time *t*	Hand-collected data	0.202	0.402	0	1
Infras_length	The length of highway projects under construction for the given city at time *t (km)*	Hand-collected data	57.85	164.6	0	1292
Infras_lengthtotal	The total length of highway projects under construction or completed by time *t (km)*	Hand-collected data	16785.99	4427.01	5959.25	19711.67
Infras_spending (in billion)	The estimated spending on the infrastructure investment under constructed for the given city at time *t (INR. crore)*	Hand-collected data	193.39	732.60	0	30000
Infras_spendingtotal (in billion)	The total estimated spending on the infrastructure investment under construction or completed for the given city at time *t (INR. crore)*	Hand-collected data	94150.95	15552.7	54740	104646
Panel C: Control Variables						
Risk Premium (%)	The market factor, the difference of stock market return over risk free rate	DataStream	3.27	1.95	2.24	6.95
Rental Change	The deviation from the long-run average rental price for each city	Transaction data	0.02	0.54	-1.51	2.19
Area (sqft)	The size of property on file	Transaction data	430.2	648.9	1.85	8000
GDP	The log difference of gross domestic product (GDP)	DataStream	9.51	0.12	8.92	9.75
Consumption	The log difference of private consumption	DataStream	8.98	0.13	8.41	9.19
CPI	The log difference of CPI	DataStream	5.24	0.16	4.69	5.48
Stock	The log difference of the stock index	DataStream	8.56	0.17	7.36	8.75
M2	The log difference of M2	DataStream	9.66	0.19	8.67	9.93

Table 2: The Impact of Infrastructure Investment on Rental Prices, 2008–2014

This table presents the relationship between the infrastructure attributes and rental prices. The dependent variable is ln(*Rental Price*). All variables are as defined in Table 1. *, ** and *** represent the 10%, 5% and 1% significance levels, respectively. Coefficients for the variables of interest are presented in sequence, and robust standard errors are included in parentheses.

	ln(Rental Price)							
	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
ln(Infras_length)	-0.023***	-0.024***						
	(0.005)	(0.005)						
*Infras_dummy * ln(Infras_lengthtotal)*			-0.012***	-0.012***				
			(0.003)	(0.003)				
ln(Infras_lengthtotal)	-0.031	-0.010	-0.038	-0.032				
	(0.029)	(0.055)	(0.029)	(0.054)				
ln(Infras_spending)					-0.016***	-0.016***		
					(0.004)	(0.004)		
Infras_dummy ln(Infras_spendingtotal)*							-0.010***	-0.010***
							(0.002)	(0.002)
ln(Infras_spendingtotal)					-0.055	-0.038	-0.067	-0.049
					(0.053)	(0.101)	(0.053)	(0.100)
ln(Area)		-0.085***		-0.085***		-0.085***		-0.085***
		(0.009)		(0.009)		(0.009)		(0.009)
GDP		-0.392*		-0.412**		-0.384*		-0.413**
		(0.208)		(0.209)		(0.208)		(0.209)
Consumption		0.014		0.068		0.026		0.065
		(0.273)		(0.274)		(0.273)		(0.274)
CPI		0.107		0.122		0.129		0.104
		(0.466)		(0.467)		(0.464)		(0.464)
Stock		-0.238***		-0.228**		-0.239***		-0.234***
		(0.089)		(0.089)		(0.089)		(0.089)
M2		0.000		0.000		0.000		0.000
		(0.000)		(0.000)		(0.000)		(0.000)
Micromarket Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Obs.	2,675	2,675	2,675	2,675	2675	2,675	2,675	2,675
Adjusted R^2	0.242	0.265	0.240	0.263	0.240	0.263	0.240	0.263

Table 3: The Impact of Infrastructure Investment on Cap Rate, 2008–2014

This table presents the relationship between the infrastructure attributes and the cap rate. The dependent variable is ln(*Cap Rate*). All variables are as defined in Table 1. *, ** and *** represent the 10%, 5% and 1% significance levels, respectively. Coefficients for the variables of interest are presented in sequence, and robust standard errors are included in parentheses.

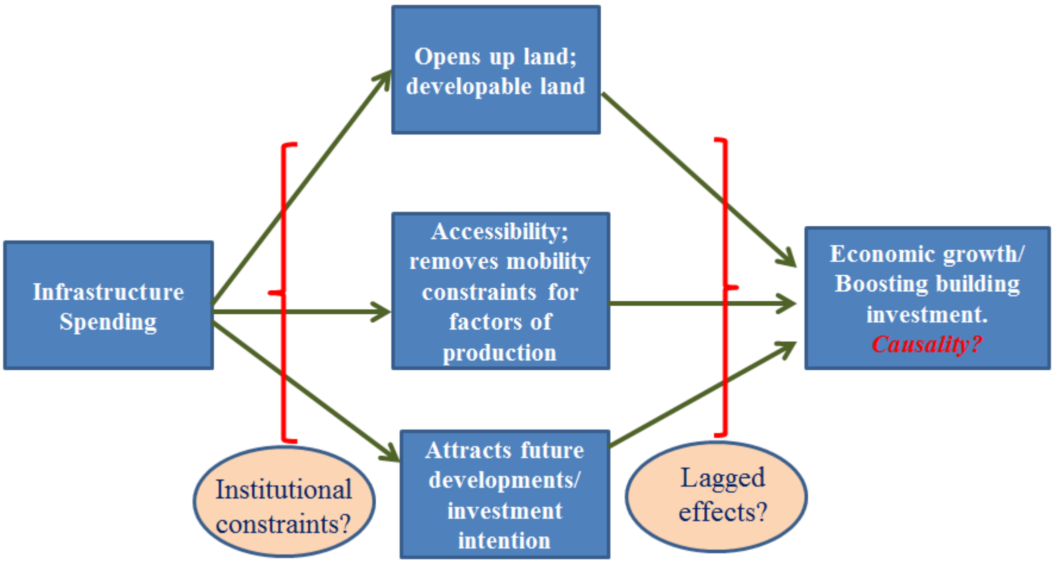
	ln(Cap Rate)							
	Column 1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
ln(Infras_length)	0.067**	0.104***						
	(0.029)	(0.021)						
*Infras_dummy * ln(Infras_lengthtotal)*			0.036**	0.064***				
			(0.017)	(0.012)				
ln(Infras_lengthtotal)	0.378**	-1.365***	0.381**	-1.353***				
	(0.163)	(0.220)	(0.164)	(0.218)				
ln(Infras_spending)					0.056**	0.085***		
					(0.024)	(0.017)		
Infras_dummy ln(Infras_spendingtotal)*							0.030**	0.052***
							(0.014)	(0.010)
ln(Infras_spendingtotal)					0.763**	-2.450***	0.750**	-2.552***
					(0.307)	(0.391)	(0.306)	(0.400)
ln(Risk Premium)	-0.085*	-0.144***	-0.083*	-0.155***	-0.078	-0.149***	-0.077	-0.159***
	(0.049)	(0.045)	(0.050)	(0.046)	(0.049)	(0.045)	(0.049)	(0.046)
Rentalchange	0.951***	0.881***	0.948***	0.881***	0.946***	0.878***	0.947***	0.882***
	(0.077)	(0.063)	(0.077)	(0.063)	(0.077)	(0.063)	(0.077)	(0.063)
ln(Area)		-0.996***		-0.996***		-0.993***		-0.995***
		(0.048)		(0.048)		(0.048)		(0.048)
GDP		10.906***		11.093***		11.110***		11.266***
		(0.731)		(0.740)		(0.742)		(0.748)
Consumption		-5.453***		-5.694***		-5.587***		-5.777***
		(1.346)		(1.349)		(1.338)		(1.347)
CPI		-12.149***		-12.180***		-13.457***		-12.750***
		(2.281)		(2.282)		(2.266)		(2.251)
Stock		1.541***		1.560***		1.516***		1.566***
		(0.446)		(0.449)		(0.447)		(0.450)
M2		0.001***		0.001***		0.001***		0.001***
		(0.000)		(0.000)		(0.000)		(0.000)
Micromarket Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Obs.	1,047	1,047	1,047	1,047	1,047	1,047	1,047	1,047
Adjusted R^2	0.169	0.493	0.169	0.494	0.179	0.494	0.169	0.494

Table 4: The Long-term Impact of Infrastructure Investment

This table presents the relationship between the infrastructure attributes and the property market. All variables are as defined in Table 1. *, ** and *** represent the 10%, 5% and 1% significance levels, respectively. Coefficients for the variables of interest are presented in sequence, and robust standard errors are included in parentheses.

	ln(Rental price)				*ln(Cap rate)*			
	After one year		*After two years*		*Cap rate after one year*		*Cap rate after two years*	
	Column1	Column 2	Column 3	Column 4	Column 5	Column 6	Column 7	Column 8
ln(Infras_length)	0.008*		0.016***		0.094***		0.114***	
	(0.005)		(0.005)		(0.021)		(0.031)	
ln(Infras_lengthtotal)	-0.057		-0.181***		-0.060		0.389***	
	(0.054)		(0.067)		(0.287)		(0.139)	
ln(Infras_Spending)		0.009**		0.010***		0.074***		0.088***
		(0.004)		(0.004)		(0.018)		(0.028)
ln(Infras_Spendingtotal)		-0.109***		-0.082**		0.137		0.794***
		(0.040)		(0.033)		(0.524)		(0.290)
Risk Premium					-0.358***	-0.348***	-0.252***	-0.228***
					(0.045)	(0.042)	(0.047)	(0.047)
Rentalchange					1.018***	1.008***	0.700***	0.712***
					(0.065)	(0.065)	(0.064)	(0.064)
ln(Area)	-0.086***	-0.086***	-0.085***	-0.085***	-1.102***	-1.101***	-0.932***	-0.946***
	(0.009)	(0.009)	(0.009)	(0.009)	(0.046)	(0.046)	(0.052)	(0.051)
GDP	-0.123	-0.160	-0.413*	-0.432**	10.146***	10.077***	12.259***	12.442***
	(0.208)	(0.207)	(0.212)	(0.210)	(0.924)	(0.918)	(0.908)	(0.964)
Consumption	-0.708**	-0.610**	-0.576**	-0.478*	-4.592***	-4.542***	1.009	-0.737
	(0.278)	(0.278)	(0.281)	(0.284)	(1.246)	(1.247)	(1.408)	(1.359)
CPI	0.157	0.052	1.936***	1.471***	-5.473**	-6.687***	2.529	-3.408*
	(0.518)	(0.518)	(0.531)	(0.530)	(2.130)	(2.179)	(1.796)	(1.920)
Stock	0.231***	0.215***	-0.035	-0.059	0.293	0.226	1.496***	1.106***
	(0.056)	(0.056)	(0.047)	(0.049)	(0.313)	(0.307)	(0.223)	(0.216)
M2	0.000	0.000	-0.000	-0.000	0.000	0.000	0.001***	0.001***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Micro market Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
State Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Constant	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
No. of Obs.	2,675	2,675	2,675	2,675	1,076	1,076	895	895
Adjusted R^2	0.265	0.266	0.266	0.265	0.544	0.543	0.618	0.597

Figure 1: Debate on Infrastructure and Economic Growth



Source: Nanda (2012)