Agglomeration and Network Externalities: Financing Urban Infrastructure in India

A dissertation submitted to the University of Hyderabad in partial fulfilment of the requirements for the degree of

DOCTOR OF PHILOSOPHY
IN
ECONOMICS

BY

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September, 2023

CERTIFICATE

(For Ph.D Dissertation)

This is to certify that the thesis entitled **"Agglomeration and Network Externalities: Financing Urban Infrastructure in India"**, submitted by **Ms. Prerna Panda (16SEPH29)** in partial fulfilment of the requirements for the award of Doctor of Philosophy in the School of Economics, is a bonafide work carried out by her under my supervision and guidance.

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1. Prerna Panda, Alok Kumar Mishra, and Shibani Mishra (2020). Externalities and Urban Infrastructure Financing: A New Theoretical Model and Lessons for Smart Cities in India, International Journal of Transport Economics, April 2020, 30(1), 1-30, http://dx.doi.org/10.19272/202006701004.

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has made presentations at the following conferences:

2. 54th Annual Conference of The Indian Econometric Society (TIES) on March 7-9, 2018, organised by the School of Economics, Shri Mata Vaishno Devi University, Katra, Jammu & Kashmir. (National).
3. 11th Doctoral Thesis Conference organised by IBS Hyderabad on 19-20 April 2018 (National).

Further, the student has passed the following courses towards fulfilling the coursework required for a Ph.D. degree.

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DECLARATION

I, ***Prerna Panda*** *hereby declare that the research embodied in the present dissertation titled* ***"Agglomeration and Network Externalities: Financing Urban Infrastructure in India"*** *carried out by me under the supervision of* ***Prof. Alok Kumar Mishra and Prof. Prasanna Kumar Mohanty,*** *School of Economics for the award of Doctor of Philosophy from University of Hyderabad, is an original research work and free from plagiarism. I also declare to the best of my knowledge that no part of this dissertation is submitted for the award of any research degree or diploma in part or full to this university or any other university or institution for the award of any degree or diploma. I hereby agree that my thesis can be deposited in Shodhganga/ INFLIBNET.*

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To

My Research Supervisor(s)

Prof. Prasanna Kumar Mohanty

&

Prof. Alok Kumar Mishra

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Prerna Panda

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Abbreviations

ABS	Asset Back Securities
ADB	Asian Development Bank
ADBI	Asian Development Bank Institute
ALS	Area Licence System
AMC	Ahmedabad Municipal Corporation
AMRUT	Atal Mission for Rejuvenation and Urban Transformation
ASCI	Administrative Staff College of India
BART	Bay Area Rapid Transit
BCR	Benefit Cost Ratio
BRTS	Bus Rapid Transit System
BSUP	Basic Services to the Urban Poor
CBA	Cost Benefit Analysis
CBD	Central Business District
CCI	Cabinet Committee on Investment
CDPs	City Development Plans
CE	Credit Enhancements
CPI	Consumer Price Index
CSR	Corporate Social Responsibility
CSR	Corporate Social Responsibility
DB	Design Build
DBFOM	Design-Build-Finance-Operate-Maintain
DBOM	Design-Build-Operate-Maintain
DBOO	Design-Build-Own-Operate
DBOT	Design-Build-Operate-Transfer
DF	Degrees of Freedom
ECBs	External Commercial Borrowings
ECM	Error Component Model
EGCIP	Economic Growth Community Improvement Plan
EIB	European Investment Bank
ERP	Electronic Road Pricing
ETFs	Exchange Traded Funds
EU	European Union
EWS	Economically Weaker Sections
FC	Finance Commission
FDI	Foreign Direct Investment
FGT	First Generation Theory
FICCI	Federation of Indian Chambers of Commerce & Industry
FIIs	Foreign Institutional Investors
FMOLS	Fully Modified Ordinary Least Square

FSI	Floor Space Index
GARVEE	Grant Application Revenue Vehicle
GBEs	Government Business Enterprises
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GHMC	Greater Municipal Corporation
GIC	General Insurance Corporation of India
GLS	Generalized Least Square
GO	General Obligations
GoI	Government of India
GP	General Partnerships
GSDP	Gross State Domestic Product
GSDPPC	Gross State Domestic Per Capita
GST	Goods and Services Tax
HAM	Hybrid Annuity Model
HDI	Human Development Indicator
HPEC	High Powered Expert Committee
HRIDAY	National Heritage City Development and Augmentation Yojana
HRIDAY	National Heritage City Development and Augmentation Yojana
HUDCO	Housing and Urban Development Corporation Ltd
ICICI	Industrial Credit and Investment Corporation of India
ICT	Information and Communication Technology
IDAs	International Development Agencies
IDB	Inter-American Development Bank
IDBI	Industrial Development Bank of India
IDF	Infrastructure Debt Funds
IDFC	Infrastructure Development Finance Company
IFCI	Industrial Finance Corporation of India
IHSDP	Integrated Housing and Slum Development Programme
IIFCL	India Infrastructure Finance Company Limited
IIFs	Infrastructure Investment Funds
IITs	Infrastructure Investment Trusts
IL&FS	Infrastructure Leasing & Financial Services Limited
IMF	International Monetary Fund
IOM	International Organisation for Migration
IPOs	Initial Public Offerings
IQ	Intelligent Quotient
ISOs	Initial Superannuation Offerings
JBIC	Japan Bank for International Cooperation
JNNURM	Jawaharlal Nehru National Urban Renewal Mission
KPMG	Klynveld Peat Marwick Goerdeler

LIC	Life Insurance Corporation of India
LIGs	Lower Income Groups
LLC	Levin Lin Chu
LM	Lagrange Multiplier
LMC	Lucknow Municipal Corporation
LOFT	Local Option Fuel Tax
LOIT	Local Option Income Tax
LOST	Local Option Sales Tax
LOVT	Local Option Vehicle Tax
LPs	Limited Partners
MBUF	Mileage-Based User Fee
MDBs	Multilateral Development Banks
MHT	Mohring-Harwitz Theorem
MLPs	Master Limited Partnerships
MoHUPA	Ministry of Housing & Urban Poverty Alleviation
MOU	Memorandum of Understanding
MoUD	Ministry of Urban Development
MRT	Mass Rapid Transit
MSE	Mean Square Error
MTR	Mass Transit Railway
NBFCs	Non-Bank Financial Company
NEG	New Economic Geography
NGE	New Growth Economics
NIIF	National Investment and Infrastructure Fund
NMT	Non-Motorized Transport
NOK	Norwegian Krone
NSW	New South Wales
NUTP	National Urban Transport Policy
O&M	Operations and Maintenance
ODA	Overseas Development Assistance
ODF	Open-Defecation Free
OECD	Organization for Economic Cooperation and Development
OLS	Ordinary Least Square
PAB	Private Activity Bonds
PMAY	Pradhan Mantri Aawas Yojana
PMC	Pune Municipal Corporation
PPI	Private Participation in Infrastructure
PPP	Purchasing Power Parity
PPPs	Public Private Partnerships
PRC	People's Republic of China
PSUs	Public Sector Undertaking

PTC	Private Trip Costs
QFIs	Qualified Foreign Investors
RBI	Reserve Bank of India
REITs	Real Estate Investment Trusts
RUC	Road Usage Charge
SBM	Swachh Bharat Mission
SCGE	Spatial Computable General Equilibrium Model
SDG	Sustainable Development Goals
SDPPC	Net State Domestic Product per capita
SEBI	Securities and Exchange Board of India
SGT	Second Generation Theory
SPVs	Special Purpose Vehicles
SS	Sum of Squares
STC	Social Trip Costs
SWFs	Sovereign Wealth Funds
TDD	Transportation Development District
TDR	Transferable Development Rights
TIF	Tax Increment Financing
TODs	Transport- Oriented Developments
TPF	Total Factor Productivity
U.S. DOT	United States Department of Transportation
UIDSSMT	Urban Infrastructure Development Scheme for Small and Medium Towns
UIG	Urban Infrastructure and Governance
UK	United Kingdom
ULBs	Urban Local Bodies
UN	United Nations
UN DESA	United Nations Department of Economic and Social Affairs
UR	Urbanisation Rate
US	United States
USA	United States of America
USD	US Dollars
VGF	Viability Gap Funding

AGGLOMERATION AND NETWORK EXTERNALITIES: FINANCING URBAN INFRASTRUCTURE IN INDIA

"You and I Come By Road Or Rail, But Economists Travel By Infrastructure" – Margaret Thatcher

Chapter 1
Economic Growth, Infrastructure and Cities

1.1. Economic Growth and Cities

Growth matters, as it reflects the might of an economy. Growth stands as the necessary condition towards broad-based development. It amasses resources to alleviate poverty and drudgery, cater for education and healthcare and uplift individuals and societies (The Growth Report 2008). When the economy grows, so do the technology, capital and human capital follow suit. Therefore, economic growth is important and it is thus the primate objective of policies. India is steadily advancing towards becoming the world's second-largest economy by 2050 (IMF Report 2020).

Growing by a sustained manner, the Indian economy saw structural changes through the passage of time. There is gradual shift from agriculture to the dominance of service sector in Gross Domestic Product (GDP). The contribution of industrial sector to GDP is growing. Service sector contribution to GDP has an impressively upward trend. Despite contributing a lower share to GDP, agriculture still employs a major chunk of the Indian population. India definitely needs to diversify agriculture to feed it’s millions. Even much of the labour force needs to ease out of agricultural sector. This substantially benefits agriculture and the overall economy. Easing out such labour would require appropriately handing them to enter into industrial and service sector. An adequately planned policy is substantial not only for ejecting the labour force from agriculture but also getting them absorbed in the rest two sectors, formally.

The economic growth of India is strong and fast. Further, growth will occur from secondary and tertiary sectors- led by knowledge based services. With the decline in employment in the agricultural sector, urbanization will accelerate. (Michaels, Rauch and Redding 2012). The growing patterns shall localise in cities due to scale and agglomeration economies that cities brim with. Cities being the reservoirs of capital, new technology, innovation, skilled labour pool and infrastructure have the potential to drive that growth. There is a strong and positive correlation of 0.85 between the pace of urbanization and

income per capita, as observed in a cross-section analysis of selected developing countries (Henderson 2010). In the case of Indian states, Bhagat (2003) discovered an association with a correlation coefficient of 0.51 exists between urbanization and per capita income.

No country has grown to middle income without industrialising and urbanising. None has grown to high income without vibrant cities. The rush to cities in developing countries seems chaotic, but it is necessary (World Bank 2009). The global urban population increases by approximately 60 million individuals annually, which is thrice greater than the growth rate of the population in rural areas. Currently, almost half of the global population lives in urban regions. (Economic and Political Weekly 2005). But, the Indian urbanisation is unplanned and relatively slow (Ahluwalia, Kanbur and Mohanty 2014). Despite a low urbanisation rate, India's extensive mega-cities indicate a scope of growing urban population in future. However, in order to harness the potential of cities for job creation, productivity improvements, and enhancing quality of life, there is a need for better urban infrastructure (OECD Economic Survey India 2017). Unfortunately, cities in India have been overlooked. By the year 2025, India is projected to have 69 cities with populations exceeding one million each. Economic growth will be concentrated in these cities, resulting in significant infrastructure development. By 2030, for instance, the economy of Mumbai alone, with a colossal $245 billion consumption market, will surpass the size of present-day Malaysia's economy (as stated by the McKinsey Global Institute in 2013). Similarly, fast-growing cities such as Bangalore, Pune, and Hyderabad demonstrate that job opportunities gravitate towards cities, suggesting that the expansion of human capital propels the growth of urban areas (as highlighted by Sridhar in 2007b).

Analysing the theories of economic growth and economic development, a clearer picture of the importance of cities could be envisioned. Nurkse (1955) stated that growth needed a push in the form of social overhead capital also called lumpy infrastructure investment. Provision of superstructures that breeds entrepreneurial ideas and educated labour force establishes the pre-condition for take-offs (Rostow 1960). Hirschman (1958) stated that strategic investment on productive industries along with infrastructure provisioning shall unbalance the economy towards higher growth. On similar lines, Rosenstein-Rodan (1943) stressed the importance of building basic industries and public utilities to achieve sustained higher growth. Capital accumulation as a driver of economic development was highlighted by Todaro (1981) and then Joan Robinson (1956) gave a capital

accumulation model of growth. Solow (1956) believed in technical progress leading to higher growth. Romer (1986) emphasized on accumulation of knowledge and Lucas (1988) on human capital accumulation leading to economic growth. For Lewis (1954) growth occurs by productively employing surplus labour. Schumpeter (1934) talked about entrepreneurial innovation as a necessity for economic development. Cities contain all these pre-conditions for growth such as capital, infrastructure, surplus and skilled labour pool called human capital, innovation, technology. Paradoxically, cities have not found their place in development strategy.

Recently, there has been an effort to plan cities in India. The political influence of cities in India is growing with effect of 74th Constitutional Amendment Act, 1992. There have been a lot of projects focusing on urban development and renewal such as JNNURM, AMRUT, Smart Cities Mission, HRIDAY etc. A lot of recent research has focused on studying the impact of urban India in its growth trajectory. However, there has been no research focusing on cities, infrastructure, externalities and growth linkage for India. This thesis is an attempt to study the same and draw implications on policies for urban infrastructure financing.

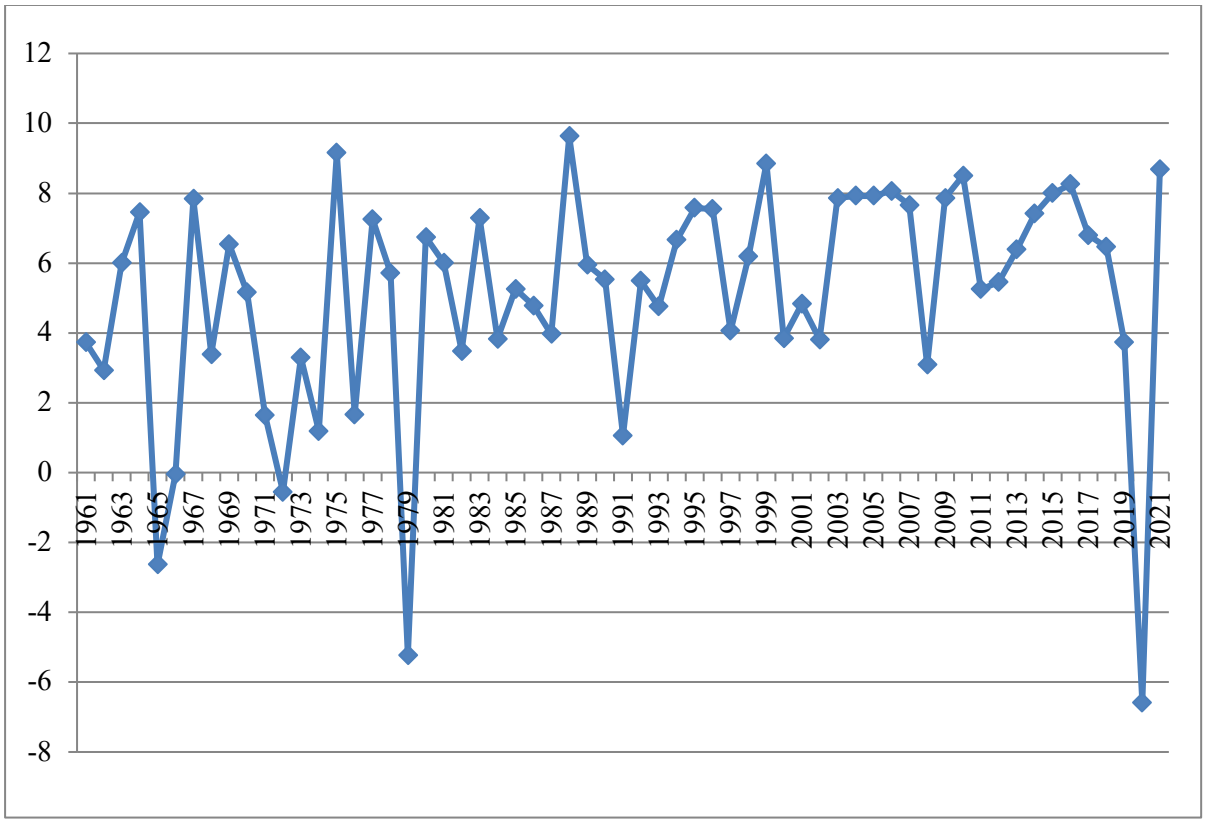
Chapter 1 is organised in eleven distinctive sections to give a broad idea on the topic of the thesis. Section 1 above analysed the cities and economic growth linkage. Section 1.2 will delve into the origins of India's economic growth, aiming to emphasize the structural changes within the economy. Section 1.3 will address the interconnection between infrastructure development and economic growth. Finally, Section 1.4 will explore the nexus between cities, infrastructure, and growth. On similar lines, Section 1.5 continues with cities, infrastructure and externalities. Section 1.6 gives a picture of India’s urban infrastructure crisis. The urban infrastructure financing strategy is discussed in Section 1.7. The gap in research and motivation of the thesis is ordered in Section 1.8. Section 1.9 contains the objective of the study and Section 1.10 the data and methodology followed. This chapter ends with the organisation of the thesis in Section 1.11.

1.2. Genesis of Economic Growth in India

It has been 25 years since the initiation of liberalization, during which India has made significant progress, surpassing the initial challenges and obstacles of that time. The growth dynamics of Indian economy has been altered since then. The growth rate exhibited a gradual acceleration, starting from a mere 1 per cent in 1991 and reaching 4 per cent by 2001. Notably, the economic growth rate soared to as high as 8 per cent in 2004-05. Later, the economic growth rate lowered may be due to global financial crisis, high interest rates, contraction in industrial production, high inflation rates etc. Figure 1.1 shows trends of India's growth trajectory since 1991.

Figure 1.1

Growth rate of Gross Domestic Product

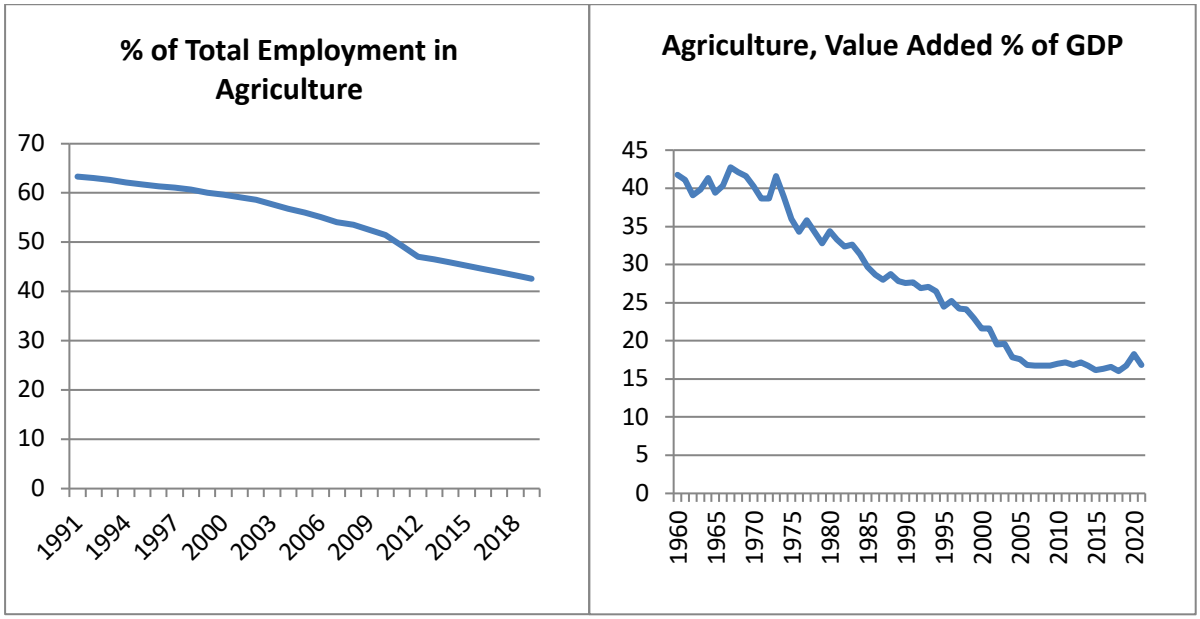


Source: World Bank

The economy saw structural changes through the passage of time, a shift from agriculture to the dominance of service sector in GDP. Share of industrial sector even saw a growing trend. In 1991, the agricultural sector contained 62.7 per cent of total employment in the Indian economy and contributed 30.47 per cent to the GDP. However, by 2019, despite employing 43 per cent of the population, its contribution to GDP had declined to 16.72 per cent. In contrast, the industrial sector employed 15.39 per cent of the total workforce in 1991, which increased to 25.12 per cent in 2019. The share of the industrial sector in GDP stood at 30.33 per cent in 1991, but decreased to 24.59 per cent in 2019. The industrial sector saw a gradual growth and also peaked in 2007, after which it started declining as a share of GDP. The service sector has an impressive trend. The employment share of it was 21.79 per cent in 1991 and rose to 32.28 per cent in 2019. But the value-added of service sector in 2019 was 50.10 per cent and in 1991 it was 39.19 per cent of GDP. Service sector contribution to GDP has an impressively upward trend. All these are graphed in Figures 1.2, 1.3 and 1.4.

Figure 1.2

Employment Shares and Value-Added as a percentage of Indian GDP: Agriculture

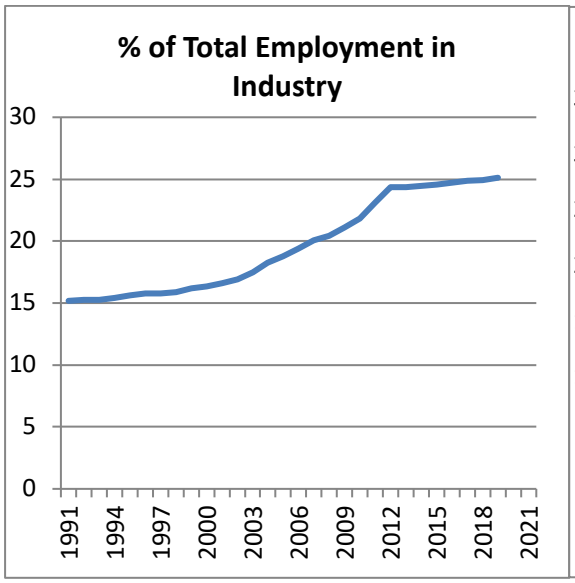


Source: World Bank

Source: World Bank

Figure 1.3

Employment Shares and Value-Added as a percentage of Indian GDP: Industry



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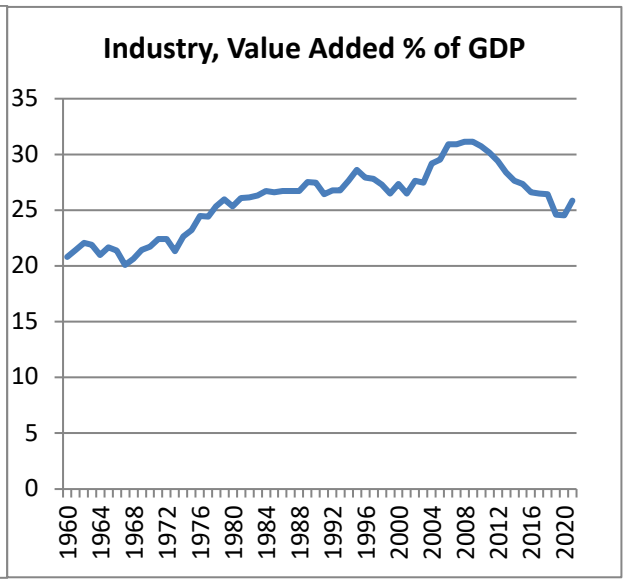
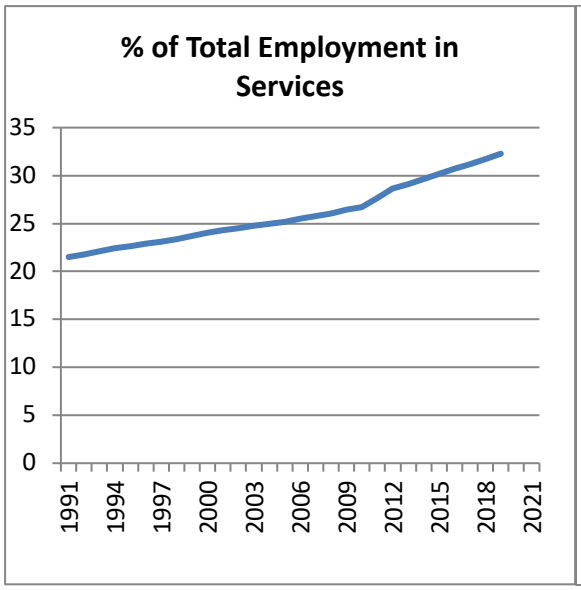


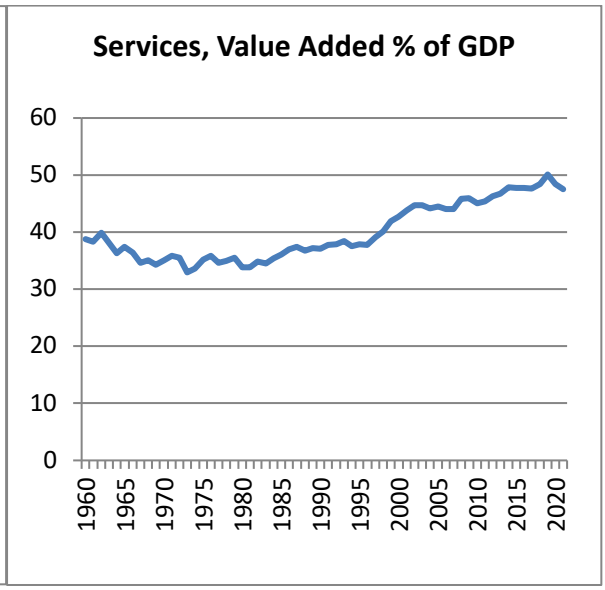
Source: World Bank

Figure 1.4

Employment Shares and Value-Added as a percentage of Indian GDP: Service Sector



Source: World Bank

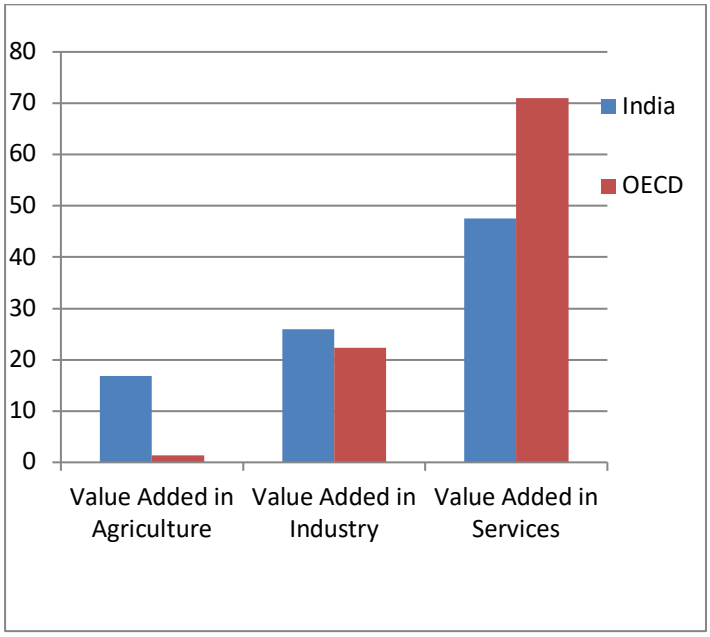


Source: World Bank

With the decreasing employment in the agricultural sector, there will be a momentum towards urbanization, as seen in figure 1.6. The economic growth of India is strong and fast. Further, growth will occur from secondary and tertiary sectors-led by knowledge based services. Both scale and location matter for growth, so it shall localise in cities. To serve an example for this, data for OCED- value added by activity is taken from World Development Indicators. The share of agricultural sector is sure to dwindle as seen from the OCED (Figure 1.5) case where the share of agriculture is merely 1 per cent. Simultaneously, the urban population constitutes 81 per cent of the total population, indicating a notable structural and spatial transformation within the OECD economy.

Figure 1.5

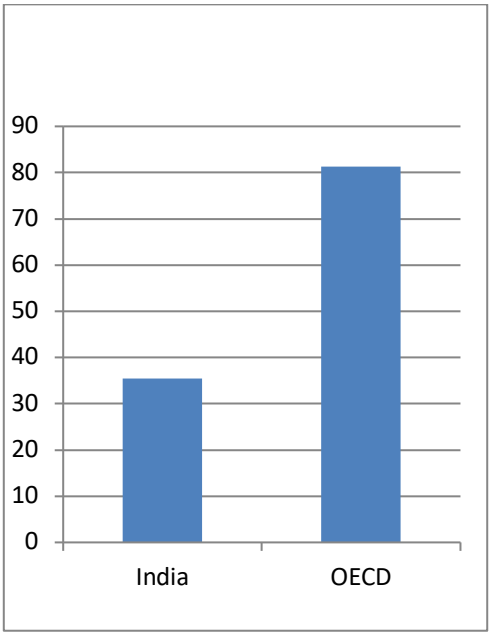
Value-Added by activity (2021)



Source: World Bank

Figure 1.6

Urban Population (2021)



Source: World Bank

Where growth occurs, scale economies, agglomeration economies and network externalities matter. Cities being the reservoirs of capital, new technology, innovation, skilled labour pool and infrastructure have the potential to drive that growth. Yet, fully capitalizing on the potential of cities for job creation, productivity enhancements, and the improvement of quality of life necessitates the presence of enhanced urban infrastructural development (as emphasized in the OECD Economic Survey India 2017).

1.3. Infrastructure and Economic Growth

The term "Infrastructure" originated in the 19th century, in France. Its origin can be traced back to the Latin language- "infra" means "below". Hence, infrastructure can be regarded as a manifestation of the foundation of any economy. Moreover, it was used as a military jargon implying permanent installations of the military such as barracks. In economic literature, infrastructure as a concept of Social Overhead Capital owes its first usage to H.W. Singer (Singer 1958). Singer described various investments which foster the development process, without being directly productive. Ragner Nurkse (Problems of Capital formation in Underdeveloped Countries 1955) and Gunnar Myrdal (1956) also have upheld the significance of infrastructure. Their Social Overhead Capital concept encompasses transport, railways, power plants, public utilities and water works. According to W.W. Rostw's Stages of Economic Growth: A Communist Manifesto (1960), the expansion and enhancement of infrastructure are deemed essential prerequisites for the process of capital formation and the advancement of production and productivity.

Tinbergen (1962:33) introduces a differentiation between infrastructure (such as roads and education) and superstructure (including manufacturing, agriculture, and mining). Nijkamp (2000:88) discusses infrastructure as tangible public capital, encompassing elements like roads and railways, while superstructure refers to intangible public capital, which includes education and communication. The first comprehensive definition of infrastructure in a market economy was provided by Jochimsen (1966:100). Infrastructure is defined as the sum of material, institutional & personal facilities and data which are available to the economic agents which contribute to realizing the equalization of the remuneration of comparable inputs in the case of a suitable allocation of resources that is complete integration and maximum level of economic activities. Diewert (1986) classified specific investments into four general categories: utilities (including water and electricity supplies, sewage disposal, etc.), communication (telephone, postal, and cable services), transport (such as railways, roads, airports, etc.), and land development (drainage improvement, land preparation projects, etc.). These categories encompass not only infrastructure capital that directly contributes services to the private production process but also services primarily intended for private consumers that indirectly affect the production process through the

human capital of the workforce. Therefore, to expand Diewert's categorization, it becomes necessary to include educational institutions, hospitals, recreational facilities, and others. The lack of a common definition of infrastructure poses challenges in formulating consistent policies in this domain (Infrastructure Canada 2007). In essence, infrastructure can be defined as the operational framework of an institution, organization, or nation. Public investment, as defined by the IMF, supports the provision of essential public services like education, healthcare, sanitation, public housing, and various other social infrastructures. Furthermore, it establishes connections between economic agents and firms, facilitating access to economic opportunities through transportation, telecommunication, energy, and other economic infrastructure networks and hubs. The concept of infrastructure as outlined by the Dr. C Rangarajan Commission (2001) emphasized the following distinguishing features of infrastructure:

a. Exclusive National Control or monopoly
b. Significant irreversible expenses or sunk costs
c. Non-tradability
d. Non-competitive consumption (until congestion thresholds are reached)
e. Potential for price discrimination or exclusion

The reasons for which any country requires a strong infrastructural base is as follows:

a. To deaden growth bottlenecks
b. Respond to the pressures of urbanization
c. Role in international trade
d. Fortifying environmental sustainability
e. Supporting developing and emerging markets

Infrastructure is the product of prudent public investment. A characteristic peculiar to infrastructure is that, it activates and also mobilizes the potentials of economic agents'. Individuals benefit from infrastructure, without directly using it. Direct users experience benefits such as cost reduction in providing goods/services or an increase in demand for their outputs. The impact on direct users is mediated to non-users when higher profits of direct users are ploughed back to the economy. With higher profits, the direct users of infrastructure tend to demand more, so the income of infrastructure non-users increases. Such direct and indirect user interaction impacts the local economy as a whole on local output, income and employment. These effects are often reflected in increased land values, benefiting both users

and non-users of infrastructure. As a result, the provision of infrastructure typically influences the competitive landscape of a region. Regional infrastructure development can serve as a catalyst for generating local agglomeration economies, considering infrastructure as a locally utilized non-traded input (Marshall 1920).

The existing literature has classified infrastructure into various types:

A. Economic and Social Infrastructure:

Economic infrastructure pertains to the fundamental facilities necessary for supporting the processes of production and distribution within an economy, such as power and irrigation, communication, and transportation. Social infrastructures cater social objectives and also help in different economic objectives. Such as health, education, sanitation, housing and water supply. Such an infrastructure improves labour productivity and with it there's greater concentration of human resources in a region.

B. Hard and Soft Infrastructure:

Hard infrastructure encompasses the physical networks that play a significant role in maintaining the functionality of an industrialised nation. They are energy, transport, communication, water management, waste management. Soft infrastructure is the framework necessary for maintaining different institutions. It may include physical as well as non-physical assets.

C. Institutional, Personal and Material Infrastructure:

Institutional infrastructure consists of the established rules and procedures within a community that are enforced and implemented by the state. These public goods, which include legislation and judicature, administration of national security, protection of fundamental research, maintenance of currency value, defence, and production of military goods, are essential for the functioning of society. While the state bears the responsibility of guaranteeing the availability of these services, it may not be essential for the state to directly administer them. Personal infrastructure encompasses the diverse human capital within an economy, varying in quality and quantity. And material infrastructure encompasses all the capital goods that facilitate the economic potential of individuals and organizations. This includes transportation, healthcare, education, energy and water supply, sewerage, garbage disposal, housing, and the preservation of natural resources.

D. Core and Not-core infrastructure:

Core infrastructure comprises essential components such as highways and roads, airports and

public transport, energy networks, water distribution, and sewerage systems. On the other hand, non-core infrastructures are residual elements within the overall infrastructure framework (Aschauer, 1989).

E. Basic and Complementary Infrastructure:

Basic infrastructure encompasses critical elements such as major railways, highways, canals, harbors, drainage systems, dikes, and land reclamation.

Complementary infrastructure includes lighter forms of transportation such as light railways, bus rapid transit, tramways, as well as utilities like electricity, water supply, gas networks, and local telephone networks.

F. Network, Nucleus and Territory infrastructures.

Biehl (1991) introduces a differentiation between network infrastructures and nucleus infrastructures, highlighting their distinct characteristics. Network infrastructures encompass roads, railways, waterways, communication networks, energy provision, and water supply. On the other hand, nucleus infrastructures refer to immobile, indivisible, non-interchangeable, and multi-purpose facilities such as hospitals, schools, and museums. Territorial infrastructure plays a vital role in augmenting the attractiveness of a region, irrespective of whether it is provided by the private sector.

The examination of infrastructure cannot be undertaken in isolation from its impact on economic growth. The connection between infrastructure and economic growth is complex and entails an assessment of the direction of their correlation. Economists puzzle over, if infrastructure leads to economic growth or growth leads to infrastructure investment. It can be correctly stated that economic growth justifies such lumpy, capital investments. It rightly provides the resources and also the need for various types of infrastructure.

Investments in infrastructure can have variety of effects. It may boost productivity and stimulate growth or it may bid up rates of interest and crowd out private investment. The public capital hypothesis assumes the former. It states a q-complementarity between public and private capital. There is a commonly held assumption that public capital has a positive effect on the output, productivity, and capital formation within the private sector. Stated differently, public investment crowds-in private investment by having an incremental effect on the returns of private capital and hence invigorating economic growth. It has a debatable impact on employment as well. Infrastructure investment may either substitute labour requirements or may require labour as a complementary input.

The influence of infrastructure on overall output growth can be summarized as follows:

- Infrastructure contributes to enhancing the Gross Domestic Product (GDP) and functions as an additional input in the production processes of various sectors.
- Ensures efficient use of the existing productive inputs. Hence, increasing the Total Factor Productivity (TFP).
- Facilitates trade between and across boundaries by lowering the cost of transaction.
- The economic actors can respond to new demands across time and space.
- Opens up employment opportunities, including public works (works as a counter-cyclical policy at a recessionary phase).
- Boosts up human capital of an economy.
- Improves the environmental condition.

Apart from the conventional channels by which public infrastructure capital may affect economic growth, there are many indirect channels - the positive externality on education and health, diffusion of technologies, innovation, and women's time allocation also magnify the growth-enhancing effects of public infrastructure investment.

Studies relating infrastructure and growth have been done by various economists, starting from Adam Smith (1776). The literature follows from Hirschman (1958) as he advocated unbalancing the economy via investments in Social Overhead Capital (SOC)[1] as it channels investment in Directly Productive Activities (DPA)[2]. Works of Aschauer (1989a, 1989b, 1989c) triggered huge debates among economists and political leaders, when he stated that fall in US productivity in 1970s was attributable to falling rates of public capital investment. Subsequently, various studies followed in this chain such as Munnell (1990), Lynde (1992). Studies conducted by Lau and Sin (1997) and others have identified a substantial and direct relationship between infrastructure investment and productivity growth in the economy. Negative effect of infrastructure was also reported by few studies such as Tantom (1991), Holtz-Eakin (1994) etc. Most of the literature suggests that infrastructure

[1] SOC includes investments on education, public health, communications, transportation and conventional public utilities like light, water, power, irrigation and drainage schemes etc. It comprises of those basic services without which primary, secondary and tertiary productive activities cannot function.

[2] Directly productive activities include those investments which lead to direct increase in the supply of goods and services. Investment in DPA means investment in private sector which is done with a view to maximize profit. In those projects, investment is made first where high profits are expected. In this way, DPA are always induced by profits.

exerts a positive influence on output, employment, and thus, long-term economic growth. The complete review of literature will be done in the next chapter of the thesis.

1.4. Cities, Infrastructure and Economic Growth

As development proceeds, the process of urbanisation comes natural for economies. There occurs structural as well as spatial transformation. There is a change in the composition of gross output, with labour-saving technical change in agriculture release that labour. Economic activity spreads out in cities due to local external economies of scale in the production process. Moreover, cities are also the breeding grounds of rich human capital accumulation creating large social networks. This making cities productive, also erupts substantial demands for urban infrastructure investments. Urbanization and economic development are intricately linked. While urbanization itself may not be the direct cause of development, sustained economic development is unlikely to occur without urbanization (Henderson 2010). The productivity of a country is significantly influenced by the productivity of its cities, and larger cities tend to exhibit higher levels of productivity (OECD 2015).

The economic activity in a city and its spatial configuration depends on the availability of public infrastructure. The investment choices made by businesses and individuals heavily rely on the networks facilitated by urban infrastructure. Various types of investments, including residential, commercial, private, and public, exhibit complementarities that can either foster positive feedback loops or lead to being stuck in a low-level trap. In this context, infrastructure plays a pivotal role in breaking free from such a trap, as emphasized by Collier and Venables (2016). The trade-off between urban costs and urban productivity can only be managed by policies emphasising on proper infrastructure planning. Urban development is possible only under these conditions: innovation, social cohesion, sustainability and connectivity (Barrionuevo et al 2012).

Urban infrastructure is its own distinguished kind due to the intensity of its use. In an urban area, infrastructure has the potential to coordinate investor's expectations, and hence investment flows. This leads to agglomeration and network spillovers which not only raises productivity but also brings down urban costs and in turn raises income and land values;

thereby promoting high-density development. Therefore, for strategic development, there must be a balance between urban development and infrastructure provisioning. In cases where infrastructure systems are underdeveloped and capital markets are restricted, there exist potential efficiency benefits in concentrating production locally. By centralizing economic activities in certain regions, the economy can reduce expenditures on “economic infrastructure”, which encompasses physical infrastructure and managerial resources. This spatial concentration also facilitates information spillovers, especially in cases where the economy lacks sufficient information. Such spillovers enable the cost-effective generation, transmission, and diffusion of knowledge, which are essential for facilitating growth. Nevertheless, as a country progresses in its development, the emergence of congestion externalities may lead to a preference for a more dispersed economic geography. A notable research project that employed cross-country data from 105 nations spanning the years 1960 to 2000 offers cohesive findings that validate Williamson's hypothesis. This hypothesis suggests that agglomeration fosters GDP growth up to a specific development threshold. This threshold is estimated to be approximately US$10,000 per capita in 2006 PPP prices. (Brulhart and Sbergami 2009). Given that India's per capita income is currently below this threshold, it is crucial not to overlook the opportunities presented by urbanization.

The challenge posed by rapid urbanization is that it places strain on the current infrastructure. Proper infrastructure planning is essential for managing urban growth effectively. The anticipated requirement for infrastructure investment is projected to surpass output and tax revenues, compelling a rise in the proportion of total infrastructure funding as a fraction of Gross Domestic Product (GDP) from 3 per cent to 5.6 per cent globally by 2020, as stated by the McKinsey Global Institute in 2012. These capital investments possess the capability to amplify the productive capacity of a region, not solely by augmenting resources but also by elevating the efficiency of current resources, as noted by Munnell in 1990. Such investments spiral up the multiplier process of economic growth through job creation, raising wealth of the society and hence prosperity of its citizens. Furthermore, countries that make investments in infrastructure are in a more advantageous position to attract foreign investment, stimulate trade, and bolster local businesses. Japan, China, South Korea and Taiwan owe their success in part to infrastructure investment. But in India, urban infrastructure availability is much lower than the requirement (EGCIP 1996). One of the

reasons why India failed to have an “urban explosion” is due to deficiency of urban infrastructure (Mohan and Dasgupta 2004).

Considering the various ways in which infrastructure is analysed, this thesis will consider the infrastructure typology more in an economic than social categorization. The present research shall deal with those infrastructures that generate “agglomeration and networking” economies. So infrastructure in this thesis is categorised as:

a) Public Good
b) Positional, Public Good
c) Networked, Positional, Public Good
d) Congested, Positional, Networked, Public Good

This thesis portrays infrastructure as a potent force in a city. It is no longer just a public good but rather a congestible local public good with network and agglomeration externalities. Infrastructures which generate significant positive externalities and high degree of cumulative & reinforcing spillover effects to the urban development shall be detailed in further chapters.

1.5. Cities, Infrastructure and Externalities

Cities have received diverse designations such as the 'driving forces of economic progress,' 'catalysts for transformation,' and 'nurturers of ground breaking ideas.' Cities embrace productivity benefits that multiply the economic growth. Such productivity benefits are distinguished in cities due to the presence of positive agglomeration and network externalities, pecuniary benefits in labour market, non-pecuniary benefits due to diversity, larger markets, product and process innovation, localisation economies, scale economies, etc. Urban areas mitigate the expenses associated with transporting goods, individuals, and ideas, resulting in advantages derived from knowledge acquisition, collaboration, and alignment. (Henderson 1974; Fujita and Thisse 1996; Duranton and Puga 2004; Rosenthal and Strange 2004; Puga 2010; Combes, Duranton and Gobillon 2011). Cities generate a harvest of ideas (Glaeser and Kerr 2009). Cities are considered as fertile grounds for opportunities, amenities and hence a better standard of living. The allure of urban areas continues to draw an increasing number of individuals. In fact, the establishment of cities is a collective result influenced by the advantages of productivity, cost dynamics, and decisions regarding labour

supply and migration. Scholars such as Adam Smith (1776) and Marshall (1890) duly acknowledged the productivity benefits offered by cities and urban clusters. Throughout recorded history, cities have been indispensable for attaining prosperity. Cities serve as magnets for attracting new individuals with fresh ideas, as noted by Jacobs (1969). Growth emanates from concentrated regions, commonly referred to as "cities," as it is assumed that the accumulation of human capital predominantly occurs in those areas (Bertinelli and Black 2004).

Cities have the capacity to create, nurture or act as repositories and disseminate knowledge. In endogenous models such as Romer (1986) emphasizing on accumulation of knowledge and Lucas (1988) on human capital accumulation leading to economic growth, have strong implications towards the importance of cities as breeding grounds of ideas, research and development. Lucas, in relation to this matter, remarked that the extent of these effects must be intertwined with the manners in which different groups of individuals engage with each other. In his acclaimed book "Triumph of the City," renowned economist Edward Glaeser (2011) hails cities as "the greatest invention" of our species, enriching our lives and enhancing our intelligence, environmental sustainability, well-being, and happiness. As per Glaeser's perspective, cities yield a wide array of advantages by furnishing environments for residency, employment, production, consumption, leisure, cooperation, education, and communal reflection. They serve as conduits for knowledge dissemination, catalysts for innovation, magnets for attracting talented individuals, and catalysts for honing talent through healthy competition. Furthermore, cities foster entrepreneurial spirit and enable social and economic mobility. The capacity of humanity to learn from one another is greatly amplified by cities, which facilitate the interaction of fertile minds. Through economies of scale, improved market accessibility, and reduced transportation costs, cities enable a more intricate division of labour. They enhance the vitality of human existence, where "consumer cities" draw in inhabitants with diverse commodities, services, plentiful conveniences, and extensive avenues for social engagement. Denser agglomerations curb urban sprawl, dependence on car-centric transportation, and carbon emissions.

The existence of infrastructure holds notable influence over economic growth by cultivating agglomeration externalities within urban areas. These externalities lead to heightened productivity and cost efficiencies linked to factors like market dimensions, backward and forward connections, resource and input collaboration, specialization,

amalgamation of labour markets, diverse economic undertakings, knowledge dissemination, and innovation. Empirical data indicates that a 10 per cent upsurge in agglomeration is associated with a 0.7 to 1 per cent elevation in labour productivity within developed countries. Furthermore, the productivity advantages stemming from agglomeration externalities seem to be more pronounced in developing nations in comparison to their developed counterparts. In developing countries, it is often considered that agglomeration benefits begin to diminish once the commuting time to a job location exceeds one hour. The positive effects of agglomeration are further enhanced by well-developed transport infrastructure, which facilitates connectivity between synergistic areas, expands markets, and reduces congestion. Agglomeration economies represent a significant portion of the broader economic benefits (WEB) derived from urban infrastructure projects.

Graham (2007) reveals that the initial assessment of agglomeration externalities commonly supplements the standard user benefits arising from increasing returns to economic scale by 10-20 per cent. Incorporating the broader economic benefits (WEB) raised the Benefit-Cost Ratio (BCR) of the East West Rail project, which establishes a link between East Anglia and central, western, and southern England, by roughly 40 per cent, as noted by Eddington in 2008. Similarly, it elevated the Benefit-Cost Ratio (BCR) for the London Crossrail project, a 73-mile east-west connection featuring 26 miles of tunnel in Central London, from 2.55 to a span ranging between 3.47 and 4.91, according to Jenkins et al. in 2011. Acknowledging the importance of broader economic benefits (WEB), the United Kingdom's Department for Transport has established official guidelines for assessing the supplementary advantages of transportation investments, encompassing those linked to agglomeration economies, as outlined in the Department for Transport's documentation in 2010.

A distinctive feature of urban infrastructure is its capacity for generating network effects through intensive utilization, leading to advantages that significantly surpass the costs. These networked externalities, as emphasized by Metcalf, are in alignment with Metcalfe's law. This principle, credited to Robert Metcalfe, a co-inventor of Ethernet, posits that the influence of a network expands exponentially with the square of the user count. Furthermore, the worth of a network doesn't solely rise with the inclusion of new participants; it can undergo a substantial surge by intertwining or amalgamating with other networks. This phenomenon is a common occurrence in urban regions, which offer not only markets but also

benefits arising from diversity through the convergence of diverse firms, industries, and activities within the same geographical space.

In Venables' study (2007), the monocentric city model from urban economics is employed to analyse the role of transport enhancements in bolstering economic productivity. Employing a spatial computable general equilibrium (SCGE) model, he illustrates that the external advantages resulting from transport investments can be noteworthy and measurable through the correlation of productivity elasticity with employment density. Through the reduction of commuting expenses, enhancements in transportation facilitate the expansion of employment in the Central Business District (CBD), consequently promoting heightened productivity through the benefits of agglomeration economies. Consequently, this results in higher wages for workers, increased rental rates for landowners, and a broader tax foundation for the government. When accounting for the influence of agglomeration on production and incorporating commuting trips, there emerges an additional 85-147 per cent of benefits in comparison to traditional benefit-cost analysis.

Agglomeration economies stemming from infrastructure can elevate the urban production function and generate other benefits. This principle can be applied to infrastructure as a whole, rather than solely focusing on specific transport infrastructure. When contemplating the effects of infrastructure on rural economies, urban and suburban land utilization, environmental conservation, and resource creation, the utilization of value capture financing renders a compelling economic rationale for augmenting investments in urban infrastructure. Indeed, the present condition of India's urban landscape, where substantial urbanization remains, indicates that an approach to urban development driven by infrastructure might be the most prudent strategy to tackle urban issues effectively. The city represents the zenith of human achievement. Through the process of agglomeration, cities hold the power to innovate, amass wealth, improve the quality of life, and accommodate a larger population within a smaller area, while exhibiting reduced per capita resource consumption and emissions compared to any other settlement arrangement (Robinson, Blake, and Swilling 2013).

Cities have all elements of economic growth. In his modern concept of economic growth, Kuznets (1966) underscores the significance of spatial concentration in economic activities, a phenomenon that evolves through various stages of development. The benefits of dynamic agglomeration economies are counterbalanced by the downsides of static congestion

diseconomies. For instance, the potential advantages stemming from the concentration of economic endeavours in urban areas, fostering the accumulation of human capital, could be significant during initial stages of technological advancement. However, as technological advancements increase, the negative impact of congestion diseconomies becomes more significant. Adding on, Williamson's hypothesis states that to overcome the "development trap", efficiency gains are secured by spatial concentration. So, for developing countries that are low in terms of technology and infrastructure, concentrating spatially leads to information spillovers and also knowledge accumulation. A relationship characterized by an inverted-U shape can be observed between economic growth and concentration of people in urban areas, as noted by Williamson (1965).

Cities connect people, firms and places. They present a mass of connected economic activities. The force that enhances connectivity to the economic mass is infrastructure and magnifies the importance of concentration of production. Agglomeration and network externalities emerge both through market dynamics and public policies aimed at fostering economic growth. These factors hold significant importance for India, particularly considering the potential for "leapfrogged" development offered by the emerging knowledge economy in cities. They lead to multipliers for growth. Cities function as hubs of knowledge acquisition, nurturing grounds for novel ideas, and incubators for innovation. Well-planned and well-managed cities attract creative people. They create jobs in both formal and informal sectors, persistently holding out as the most promising avenues for millions of marginalized individuals in the rural and urban regions of developing nations. This presents a pathway to escape from severe poverty. Cities also create tax bases for development. Urban externalities capitalize into 'agglomeration rents'. The interplay of agglomeration, networking, innovation, and growth provides India with a distinctive chance to expedite development and alleviate poverty by revitalizing its cities. India, in its developing phase needs to harness the city growth through proper planning and provisioning to accentuate positive agglomeration externalities. The UN DESA's Population Division in the 2014 update on World Urbanisation Prospects stated that India, China and Nigeria shall face the biggest urban progress.

1.6. India’s Urban Infrastructure Crisis

In line with the worldwide trend, India is undergoing rapid urbanization on an amplified scale. The issue with growing urbanisation is that it puts pressure on the existing infrastructure. The shadow costs of constrained infrastructure capacity are rather high on economic growth (Acharya and Sundaresan 2022). The World Economic Forum places India at the 70th position out of 141 countries in terms of its infrastructure, according to the Global Competitiveness Report 2020. Hence, the infrastructure deficit in India is indisputable. Despite municipal revenues in India, roughly estimated at Rs. 1 lakh crore (where 1 crore equals 10 million and Rs. 70 equals US$1) in the fiscal year 2012-13, facing formidable challenges, the requirement for funds to sustain urban infrastructure and services is immense.

As per McKinsey (2010), it is estimated that India will need a cumulative outlay of Rs.9.74 million crore for its urban centers by 2030, with Rs.5.31 million crore designated for capital expenditure. A significant portion of this capital spending is anticipated to be directed towards affordable housing, constituting nearly one-third of the overall expenditure. Subsequently, mass public transit emerges as the subsequent prominent sector for investment. Excluding affordable housing, the remaining capital expenditure required until 2030 would tally up to Rs.3.54 million crore. According to the McKinsey analysis, the annual per capita expenditure on urban areas in India, covering both capital and operational costs, stands at $50. This amount corresponds to roughly 14 per cent of China's $362, which is less than 10 per cent of South Africa's $508, and less than 3 per cent of the United Kingdom's $1,772. When considering capital expenditure exclusively, India's per capita urban expenditure stands at $17, which contrasts with $116 in China, $127 in South Africa, and $391 in the United Kingdom. The report proposes that India should raise this amount by a factor of eight, from $17 to $134, thereby increasing it from 0.5 per cent of GDP to 2 per cent of GDP annually. Ironically, the per capita revenues and per capita "own" revenues of municipalities in India were notably modest in 2012-13, totalling Rs. 3,123 and Rs. 1,681, respectively. During that same period, per capita municipal spending amounted to Rs. 3,116, comprising per capita revenue expenditure of Rs.1,986 and per capita capital expenditure of Rs.1,130, as indicated by ASCI in 2014. Based on the calculations of the High Powered Expert Committee (HPEC 2011), India would necessitate Rs. 3.92 million crore for urban infrastructure spanning the

period from 2012 to 2031. If operational and maintenance expenses are factored in, this amount would rise to Rs. 5.92 million crore. Table 1.1 illustrates the extent of the urban infrastructure funding challenge in India across crucial sectors, based on the discoveries of the High Powered Expert Committee (HPEC 2011).

Table 1.1

Urban Expenditure Estimates for Core Sectors (Rs crore at 2009-10 prices): 2012-31

Sector	Total Capital Expenditure (Rs. Crore)	Total Operations & Maintenance Expenditure (Rs. Crore)	Average Per Capita Investment Cost (Rs.)	Average Per Capita O&MCost (Annual – Rs.)
Water Supply	320908	546095	5099	501
Sewerage	242688	236964	4704	286
Solid Waste Management	48582	273906	391	155
Urban Roads	1728941	375267	22974	397
Storm Water Drains	191031	34612	3526	53
Urban Transport	449426	304386	5380	371
Traffic Support Infrastructure	97985	36690	945	34
Street Lighting	18580	4717	366	8
Total	3098141	1812637	43385	1806

Source: High Powered Expert Committee on Urban Infrastructure Report (2011)

The operational and maintenance (O&M) standards suggested by HPEC suggest that Indian municipalities allocate around 20 per cent of the necessary funds for effective public service provision, as noted by Mathur in 2013. A study conducted by the Reserve Bank of India, examining data from 35 metropolitan municipal corporations between 1999-2000 and 2003-2004, also identified notable "under-spending" by these corporations when compared to the normative requirements. The under-spending varied from 94.43 per cent for Patna to 30.78 per cent for Pune, with an average under-spending of about 76 per cent. The study highlights that the fiscal challenges faced by urban areas in India stem from various systemic issues that need to be addressed comprehensively, extending beyond reforms solely focused on municipal taxes, such as property tax. Specifically, the study reveals:

i. There is a notable correlation between the under-spending of Municipal Corporations and the “dependency ratio”, which signifies the ratio of grants received by a Corporation in relation to the overall municipal expenditure;
ii. There is a strong inverse relationship between under-spending and "revenue decentralization," which is determined by the proportion of a Municipal Corporation's revenue per capita to the per capita state revenue. This relationship is statistically significant;
iii. The extent of under-spending is considerably inversely correlated with the efficiency of revenue administration, as indicated by the proportion of own municipal revenues to the Gross State Domestic Product (GSDP);
iv. Among the twenty-five Municipal Corporations examined, cost recovery through user charges and fees was below 10 per cent in ten of them. Among six corporations, the cost recovery spanned from 10 to 20 per cent, whereas in six other corporations, it fell between 20 to 50 per cent. Merely two corporations managed to attain a cost recovery rate exceeding 75 per cent;
v. In eleven Municipal Corporations, over 50 per cent of the total municipal expenditure was directed towards establishment and administration. In twelve Corporations, operation and maintenance expenditures constituted less than 10 per cent of the total. Furthermore, nine Corporations had a capital expenditure share of less than 10 per cent, and among them, seven had a share below 3 per cent, as highlighted by Mohanty et al. in 2007.

The state of India's urban infrastructure is intricately linked to the condition of municipal finance, which is often categorized by a non-expanding tax base, inadequate attention to user charges, an ad hoc system of inter-governmental transfers, inefficient tax, charge, and fee collection, weak credit-worthiness of Urban Local Bodies (ULBs), limited borrowing capacity, and a weak service delivery system. Notwithstanding the constraints of limited financial resources, municipalities also struggle to fully exploit the revenue sources they already possess. Particularly, land-based taxes and charges, including property tax, have not been optimally utilized in India. Despite the significant increase in land values in urban areas due to city planning, infrastructure provision, and growth, ULBs have yet to capitalize on the potential of city land as a valuable asset. It is crucial to implement land-based taxes and charges as a means of financing cities in India. Additionally, there is an overdue requirement for reforms in property tax, which stands as the most significant municipal tax in the country. Expanding the municipal revenue base and effectively utilizing the resources already allocated to Urban Local Bodies (ULBs) should be prioritized in urban policy. Without adequately addressing the infrastructure and service requirements of urbanization, cities will be unable to fulfil their role as drivers of spatio-economic transformation.

China’s urbanisation patterns that led to industrialisation and subsequent higher standard of living are exemplary. From just 20 per cent in 1980, China’s populace living in cities rose to 50 per cent in 2011. The greater commitment to urban infrastructure financing, strengthened job growth, productivity and higher household incomes. The Observer (2012) reports that While Indian authorities invest one pound in urban infrastructure, their Chinese counterparts allocate seven pounds.

1.7. Urban Infrastructure Financing Strategy

The need for urban infrastructure financing is way too much than the available sources of traditional arrangements. These traditional sources are further in doldrums due to contraction of fiscal resources and strict international banking regulations. Infrastructure financing must take into account both the initial costs of construction and the continuous expenses associated with operation and maintenance (O&M). Therefore, a proper identification of potential sources of revenue is essential. For any urban infrastructure project the local government

must undertake a Cost-Benefit Analysis to justify a project, and then borrow to finance these high gestations, indivisible services. Along with these, it must tap some local sources of revenue such as user costs to see the O&M needs. This sets the rationale for Subsidiarity Principle of Oates (1972, 1993, and 1999). This principle suggests specific functions to urban governments as they are the best judge to cater to specific demands of citizens at their jurisdiction. On the contrary this method of financing is utopian in real.

Financing becomes complex for several reasons. The cost-benefit analysis is an incomplete estimate for multiple objectives that an infrastructure project serves. Benefits can't be accurately measured due to lack of accountability of true public demand. The access of municipal governments to the capital market is restricted so borrowing becomes troublesome. Also the incapability to collect appropriate user fees and along with it uncontrollable high inefficiency costs. In the face of these, infrastructure can either be publicly financed (railways, flood control) or privately (telecommunications). There are inherent differences in their working mechanisms. All infrastructures that are privately financed may not always be privately owned. Government can borrow money to finance specific infrastructure projects from private investors. There can be public-private partnership or privatisation with regulations. The sources of revenue for local governments are basically borrowing, own-sources (taxes) and intergovernmental transfers. There are better described as follows:

i. Issuing bonds or local governments can borrow from private capital markets.
ii. Local governments can borrow from financial intermediaries.
iii. Taxes
iv. User-fees
v. Land-based revenues
vi. Intergovernmental transfers
vii. International institutions

For initial capital investments, the sources of infrastructure financing are municipal borrowing either by issuing bonds or from financial institutions. Intergovernmental transfers aimed to correct vertical and horizontal imbalances and meet the national objectives. A Public-Private Partnership or Private Participation in Infrastructure (PPI) model of financing these long-lived infrastructure costs is also appropriate. They reduce a greater extent of fiscal burden of municipal government. It can be also financed by encouraging market pressures via

competition leading to privatisation. Land-based tools are also good sources to generate urban finances for infrastructure. Infrastructure maintenance and operation entail additional expenses. Utilizing user fees is regarded as an efficient revenue source to address these expenditures, given that they mirror users' readiness to compensate for the provided services. While municipal government taxes are also a source of revenue, they are often insufficient. Intergovernmental transfers, which can be categorized into different forms (as discussed by Bahl and Linn 1992; Shah 2005), provide another potential avenue for funding.

Within India, the Twelfth Plan outlines a goal of dedicating around 8.26 per cent of the GDP, which equates to a sum of $1000 billion, to enhance infrastructure across sectors like transportation, energy, and communication. The challenge lies in mobilizing this substantial amount of funding. Traditionally, infrastructure investment in India has been primarily funded through government budgetary expenditure. Nonetheless, the existing demands for infrastructure are substantial, and over the last ten years, the government has implemented diverse strategies to raise funds. As per the twelfth plan, around 48 per cent of the overall $1000 billion investment is anticipated to originate from the private sector, primarily facilitated by Public-Private Partnerships (PPPs). The remaining 52 per cent is anticipated to be financed by the government through budgetary support and debt finance. The governmental and private sector entities are strategizing to secure funds by borrowing from the banking system, capital markets, and External Commercial Borrowings (ECBs). The government and the RBI have also undertaken endeavours to encourage investment in the infrastructure sector by means of diverse initiatives:

i. The formation of India Infrastructure Finance Company Limited (IIFCL).
ii. The endorsement of the National Investment and Infrastructure Fund (NIIF) to furnish equity assistance to infrastructure-related Non-Bank Financial Companies (NBFCs) is one such step. Additionally, the authorization of tax-free infrastructure bonds for initiatives in railways, roads, and irrigation has also been granted.
iii. Issuance of bonds denominated in rupees in international markets.
iv. Infrastructure bonds to be released by IFCI, LIC, and IDFC, accompanied by tax benefits for individual taxpayers.
v. Encouragement of Foreign Direct Investment (FDI) in the infrastructure domain, permitting 100 per cent FDI via the automatic route in sectors including mining,

power, civil aviation, construction, industrial parks, petroleum and natural gas, telecommunications, railways, and special economic zones.

vi. RBI's fostering bank lending for the infrastructural sector.

vii. Provision of Viability Gap funding.

viii. Relaxed External Commercial Borrowings (ECB) regulations for infrastructure firms, enabling them to obtain up to $750 million for infrastructure ventures.

ix. Deployment of foreign exchange reserves for infrastructure undertakings facilitated by IIFCL.

x. Designation of special category status for infrastructure-focused Non-Bank Financial Companies (NBFCs), enabling them to operate with preferential advantages.

xi. Incremental allocation by the central government in each budget, with the budget for 2016-17 allocating nearly Rs 2 lakh crore, including substantial funds for the road sector.

xii. Permission for Foreign Institutional Investors (FIIs) to invest in infrastructure debt funds. Qualified Foreign Investors (QFIs) are also encouraged to invest in the sector, particularly through bond financing.

xiii. Implementation of take-out financing.

xiv. Introduction of the green bonds.

These measures aim to attract investment and provide financial support for infrastructure development in India.

There are certain key challenges faced by Indian cities. Self-reliance of Indian cities is a distant dream. Cities face the twin problems of feeble credit worthiness and poor financial viability. Therefore, Urban Local Bodies (ULBs) are caught in the dismal low equilibrium cycle. Urban infrastructure, being the driving force requires improved revenue mobilisation for establishment. Further, innovative use of more tools and capturing finances from the positive and negative externalities bestowed by infrastructure is the crux of this thesis.

1.8. Research Gap

The power of infrastructure in conjunction with urban development to drive economic growth is an established fact. A large body of literature talk of agglomeration externalities. Such as Krugman's New Economic Geography depict agglomeration rent to mobile and immobile factors, Henry-George Theorem on land values and Mohring-Harwitz theorem on revenues from congestion tolls. It's a paradox that rents that can be tapped from agglomeration, congestion and land have not been synchronised. The thesis is an attempt to abridge this gap, making a study for India.

1.9. Objectives

The objective of the thesis is to look into theoretical issues of financing urban infrastructure in India. The research will not only combine infrastructure and cities but also the associated agglomeration and network externalities. The study basically tries to highlight that infrastructure is not only a public good but a congested and networked public good, creating externalities. It is infrastructure that generates an 'urban productivity premium' and capturing that premium is a venture of this thesis. In an attempt to do so, the principal objectives are:

a) To explore Indian growth scenario, city scenario, urban infrastructure scenario and urban infrastructure financing scenario.
b) Establish a link between cities and externalities and subsequent implications to growth.
c) Building a theoretical model to tap rents generated from externalities in cities using first best and second best solutions.
d) Analysing the effects of urbanisation and infrastructural development on economic expansion in Indian States by applying econometric tools.
e) Looking at the derived results' implications towards public policy.

Cities are India's future. There is a need for two-pronged strategy- to augment growth and to address the issues of distribution. Cities have the power to drive economic growth through employment generation, innovation, reduction of poverty, inclusive development, and hence can serve the hopes of millions. City development strategy is the need of the hour

as the wealth of cities is the wealth of the nation. Urban infrastructure financing is gaining importance. In 2015, the Securities and Exchange Board of India (SEBI) issued guidelines related to municipal bonds. Additionally, in June 2019, amendments were introduced to the SEBI (Issue and Listing of Debt Securities by Municipalities) Regulations, 2015. This effort aimed to improve the effectiveness and transparency of the municipal bond market in India. Infrastructure is established through borrowing, which ultimately needs to be repaid. No meaningful strategy for infrastructure financing can be worked out if externalities cannot be tapped. To study the same is the objective of this thesis.

1.10. Data and Methodology

The empirical investigation carried out in this thesis seeks to assess the capacity of Indian cities to act as drivers of economic growth and to explore the correlation between infrastructure and growth across various states in India. To achieve this objective, panel data is collected from the Reserve Bank of India-States of India database. An index of "agglomerating and networking" infrastructure is constructed using two approaches, namely multidimensional index and Principal Component Analysis index. A fixed effects regression model is employed to determine whether states with more robust infrastructure and greater urbanization levels demonstrate higher per capita income. Furthermore, the Dumitrescu and Hurlin (2012) Panel Causality Test is utilized to explore the enduring causal connection between infrastructure, urbanization, and economic growth.

1.11. Organisation of the Thesis

The thesis comprises of five chapters. Chapter 1, which is an introduction, explores the interconnection among Economic Growth, Infrastructure, and Urban Centres. Chapter 2 describes the literature on Infrastructure, Externalities and Financing Issues. A new theoretical model along with a tool-box of urban infrastructure financing instruments is described in Chapter 3. Chapter 4 is based on the empirics of the Role of Infrastructure and Urbanization on Economic Growth in Indian States: A Panel Study (2005-19). Finally, in Chapter 5 ends with Summary and Directions for Reforms.

Chapter 2
Financing Urban Infrastructure: A Survey of Literature on Theory and Practice

2.1. Defining Infrastructure

Infrastructure has been equivocally recognized by researchers to determine a country's economic success (World Bank 2009) by expanding catchment areas (Fujita, Krugman and Mori 1999), providing a market for labor (Duranton and Turner 2012), basic services to industry and households (Martini and Lee 1996), reducing inventories (Li and Li 2013) and logistic costs (Holl 2006), improving living conditions of the poor (Straub 2008) and hence accommodating economic and urban growth (Calderon and Serven 2004). Due to these variety of effects, infrastructure has always occupied the centre stage of policy focus. Infrastructure holds significant importance as it provides indispensable basic necessities to households, including water, energy and telecommunications. It is estimated that approximately one-third to half of infrastructural amenities are utilized directly by private households for final consumption (Prud'Homme 2005; World Bank and IDB 2005).

The problem often encountered in the process is robustly defining the concept of 'infrastructure' due to its several intricate impact and incidence. During the Second World War, the military originally employed the term "infrastructure" to refer to the logistics involved in warfare (Jerome 1999). Economic Report of the President (2016) states that infrastructure are permanent capital assets that are collaboratively employed across various production activities, aiding and underpinning economic endeavours (U.S. Council of Economic Advisers 2016). From a more comprehensive viewpoint, infrastructure is commonly defined as an extensive array of physical resources essential for sustaining both private economic ventures and social needs (U.S. Congressional Budget Office 2008; U.S. Congressional Budget Office and Joint Committee on Taxation 2009).

In the World Bank Report (2004), the term "infrastructure" encompasses a wide range of activities. Infrastructure investment, as defined by the IMF, aims to support the delivery of essential public services, including education, healthcare, sanitation, public housing, and

various other social infrastructures. Along with this, it establishes the connection between economic agents and firms to economic opportunities through transport, telecommunication, energy and other economic infrastructure of hubs and networks. Thus, catalyzing the economic growth (Prud'Homme 2005; Sinha, Arya and Singh 2012). Infrastructure encompasses the tangible systems and connections that deliver crucial services to diverse sectors and communities, thereby enabling comprehensive national progress (Singhal, Newell, and Nguyen 2011). Researchers have pinpointed numerous attributes linked to infrastructure, encompassing elevated risk levels, relatively modest returns, gradual development, extended incubation phases, substantial irreversible expenses, less liquid returns, substantial capital outlays, intricacies in assessing due to tax and pricing regulations, and the intricate nature of projects involving various risks (Agrawal, Gupta, and Gupta 2011; Grimsey and Lewis 2002; Huang 2012; Mor and Sehrawat 2006; Sharma and Vohra 2008; Singh, Batra, and Singh 2007).

Hirschman (1958) succinctly defines infrastructure, also known as 'social overhead capital,' as "capital that delivers public services." In essence, infrastructure is composed of two fundamental aspects: 'capitalness' and 'publicness.' The first component sets infrastructure apart as a stock variable, contrasting it with public goods, which are viewed as a flow variable (Rietveld and Bruinsma 1998:18). The second element relates to the inherent qualities of 'non-rivalry' and 'non-excludability.' It is essential to make a clear distinction between infrastructure and public capital because infrastructure encompasses goods with capital traits that may not always be in the public domain. Illustrative instances of these goods might encompass privately owned telecommunications, whereas publicly owned military equipment would be excluded as it does not offer public services. Consequently, a prominent feature of infrastructure seems to be the substantial engagement of the public in its utilization (Rietveld and Bruinsma 1998:19). Economists frequently use the terms "physical infrastructure" or "infrastructure capital" to describe these goods, while urban planners may employ phrases like "transportation modalities" and "utilities" to characterize them.

In India, the Rangarajan Commission (2001) discussed the notion of infrastructure extensively. To the commission, infrastructures are long-lived structures which are not user specific. To identify infrastructure sub-sectors, the Rangarajan Commission outlined six key characteristics, namely:

a) Natural monopoly market: A situation where a single provider efficiently meets the entire demand for a specific product with lower average costs rather than multiple competing firms. Examples of natural monopolies include public utilities such as water supply, electricity distribution, and natural gas pipelines.
b) Output non-tradability: Due to unique nature of the infrastructure goods or services produced, geographical limitations, or regulatory restrictions that prevent transfer or sale in external markets. Examples include public health services, public roads
c) Creating favourable economic conditions that benefit society with significant positive economic spillovers.
d) Substantial sunk costs or asset specialization
e) Non-exclusivity in consumption up to the point of congestion limits, and
f) The potential for implementing price-based exclusion.

The study identified several sub-sectors that exhibited all six characteristics. These included railway networks, signalling infrastructure, and stations, as well as highways and bridges. Additionally, airport runways and their associated facilities met the criteria, along with transmission and distribution systems for electricity. Telephone lines and telecommunication networks were also among the identified sub-sectors. Furthermore, pipelines designed for the transportation of various substances such as water and crude oil, as well as water transport routes and harbour facilities, were found to match all six characteristics. Additionally, irrigation canal networks and sanitation or sewage systems were identified as sub-sectors meeting these criteria. The list was expanded to include more items, taking into account their attributes such as substantial sunk costs, non-rivalry in consumption, and the possibility of price exclusion. These additions encompassed rolling stock utilized in railway operations, various vehicles and aircraft, power generation plants, facilities for crude oil production, and water purification, as well as ships and other types of vessels. In the India Infrastructure Report of 1996, the committee chaired by Dr. Rakesh Mohan categorized the following areas as elements of infrastructure: electrical services, gas supply, water distribution, telecommunications, road networks, industrial zones, railway systems, seaports, air terminals,

urban infrastructure, and storage facilities.

Infrastructure has frequently been delineated within economic literature as an integral component of overall production in the aggregate.

$$Q = A.F(K, L, I(K_I)) \quad (2.1)$$

In the provided equation, the variables are defined as follows: Q represents aggregate output, K represents the total capital stock (excluding infrastructure), K_I stands for the infrastructural stock, L is total labour force hours, and I(K_I) denotes the variable for intermediate inputs. The term A represents a productivity factor, accounting for shifts in the aggregate production function. Within this outline, alterations in K_I lead to a decline in the cost of associated intermediate inputs, which is referred to as the market-mediated effect of infrastructure by Hulten, Bennathan, and Srinavasan (2006). Within this framework, individuals or entities reap returns from their investments in both forms of capital-physical and human; at the culmination of each time period. They then consume the output realized, while maximizing a utility function. Infrastructure is frequently incorporated as a constituent of the comprehensive term for total factor productivity, denoted as A, as it has the potential to impact productivity by reducing costs or enabling economies of scale through market expansion. A general formula that incorporates infrastructure shall be:

$$Q = A(\theta, K_I).F(K, L, I(K_I) \quad (2.2)$$

In this formulation, it is essential to emphasize that improvements in the efficiency factor A can stem from two separate origins: efficiency-boosting externalities linked with the build-up of infrastructure capital, and alternative forms of efficiency-enhancing externalities represented as θ. In summary, the impact channelled through markets with the help of intermediate inputs is often termed as the "direct" effects of infrastructure. Conversely, the efficiency-enhancing externalities resulting from infrastructure are designated as the "indirect" effects.

This thesis defines infrastructures as those that generate economies of agglomeration and network. Infrastructure is a potent force in a city. Infrastructure development has crucial

role in fostering economic development and urbanization. It is widely acknowledged that infrastructure creation has been indispensable in facilitating these processes. Infrastructure generates significant spillover effects to urban development. It is no longer just a public good but rather a congestible local public good with network and agglomeration externalities. Specifically, infrastructure is now defined as not just as a public good but a congested, positional, networked public good. Infrastructure projects possess two distinct characteristics that distinguish their financing from the day-to-day operations of governments. Firstly, they necessitate substantial upfront investments for significant capital outlays. Secondly, infrastructure assets have a prolonged economic lifespan. The combination of these factors introduces inherent risks in infrastructure projects. Errors made during the choice, planning, and funding of a capital project can lead to long-lasting effects on a community, as they may be obliged to accept those choices for an extended period. It is crucial to ensure efficient and responsible financing for infrastructure projects. Infrastructure constitutes a considerable part of our communal wealth and extends beyond political borders. Effectively overseeing and enhancing these communal assets is among the paramount challenges facing governments today. This requires actions that extend beyond mere expenditure escalation, as stated in Frankel and Wachs (2017).

This chapter undertakes an extensive literature review. It is organised as follows. The Section 2.1 above outlined the literature on definition of urban infrastructure. Section 2.2 outlines the key characteristics of urban infrastructure. Theory behind infrastructure financing is in Section 2.3. Section 2.4 describes Urban Infrastructure Financing, Theory. Following which the lessons from theory is discussed in Section 2.5. Section 2.6 discusses the international practices of infrastructure financing. In Section 2.7 the chapter portrays the international practices of urban infrastructure financing Approaches to financing Urban Infrastructure in India is discussed in Section 2.8. The lessons from Indian Practice is highlighted in Section 2.9. Section 2.10 concludes with developing urban infrastructure financing strategy in India.

2.2. Urban Infrastructure: Key Characteristics

Cities serve as the focal points of growth and development. Jane Jacob (1984) asserted that throughout the course of civilization, it has become evident that cities, rather than nations, serve as the fundamental building blocks of a dynamic economy. Cities are essentially multidimensional in character. They form the niche for interactions between human and technical capital due to which economic energy is mainly generated in urban areas. Cities are breeding grounds of growth enhancing factors such as an efficient labour pool, technology, market of products, etc. Cities are the potent forces to create economies of collocation whereby people work and live together. They share ideas and inputs, innovate and compete. This is agglomeration externalities. There can be externalities of costs that are captured under the market mechanism or diffusion of economies among markets without the market mechanism called technological externality. Infrastructure is the backbone of a well-functioning city. The organisation of urban infrastructure ensures the transfer of externalities by creating high-density conditions for firms and households to work productively. The characteristics intrinsic to urban infrastructures are the following:

i. Land Matters

Infrastructure planning in an urban area is intertwined with land planning as well. Urban land is crucial for spatial transformation of the economy and location of economic activity. Land is a scarce and an immobile factor. Each plot of city land possesses a distinctive locational feature and development potential; it is impossible to replicate similar land parcels within cities. Urban landmass exhibits both vertical and horizontal dimensions. The worth of urban land is markedly shaped by factors such as the nature, quantity, and standard of services it enjoys, alongside its proximity to public amenities and infrastructure services. These factors play a vital role in determining land value. The location of urban infrastructural services is pivotal in generating its economic impacts. The extent to which the urban infrastructure forms networks decides its concentration of usage. It should be planned to create collocation of economic activity and generating maximum spillovers.

ii. Location Matters

Urban infrastructure networks rationalise and define a city. They shape a city socially, economically, politically and environmentally. Cities must cost effectively build, operate, upgrade, maintain; transportation, power, water and telecommunication to keep up with the growth demands. The existence of urban infrastructure allows the interactions of production and consumption nodes. It enhances and even creates more markets, produces economies of scale and scope. Modern economic growth is linked with the key phenomenon of spatial concentration of economic activities (Kuznets 1966). Localising production can lead to efficiency gains when capital markets are shallow and infrastructure is underdeveloped. This is further important for knowledge spillover for such 'information deficient' economies. By spatially concentrating, the economy conserves on 'economic infrastructure' such as infrastructure.

iii. Externalities

It is the dominant role of externalities in cities that enhance productivity and reduce costs. Cities experience the advantages of learning, sharing, and matching processes (Duranton and Puga 2004). The effectively channelize the flow of goods, capital, labour, services and knowledge. On the supply side agglomeration externalities arise, where households and businesses collocate and share inputs and ideas. Network externalities arise in the demand side that lead to value increments with higher use of networks. The interplay of both the externalities stimulates and sustains growth and productivity in a city. The correlation between urbanisation and economic development has been found to be near perfect in cross-country studies. Agglomeration offers a means to circumvent the "development trap" and mitigate resource constraints commonly faced by developing countries. Countries at lower stages of economic development must harness agglomeration economies as suggested by Williamson's hypothesis (Williamson 1965). Urban infrastructure gives the impetus to externalities in cities.

iv. Value Creation

Urban infrastructure leads to enormous increases in land values. Benefits of accessibility is generated for land and properties located in convenient locations. Accessibility creates a premium by reducing time and cost of travel to workplaces, schools, hospitals, shopping centres, etc., and enhancing face to face interaction, ensuring mobility of people and knowledge. If an infrastructure project passes the basic cost benefit test, then it's expected to create benefits and augment the value of land and properties. Such augmentation in value is a windfall for the landowner, whereby the increment in value is generated to due public expenditure on infrastructure.

v. Wider Economic Benefits

The direct effect or urban infrastructure is to a decline in production costs. The indirect impact of infrastructure is to augment the productivity of inputs utilized in the production process. Furthermore, infrastructure generates monetary advantages by stimulating additional employment opportunities through both forward and backward linkages. Thus, urban infrastructure has the potential to boost city competitiveness, trade, tourism and foreign investments. Taken together, all these characteristics of urban infrastructure refer to the scope of Wider Economic Benefits (WEB).

vi. Rents

Infrastructure provision enhances a city's the accessibility and serviceability. Land being serviced by public goods experiences a rise in demand for housing, industries, institutions and also recreation and hence augmenting its value. Thus, infrastructure creates 'location rents' for properties at the proximity of such developments. When an area is appropriately fabricated by infrastructure facilities, economic activity of that region is spurred leading to a rise in density and hence reinforcing agglomeration economies and network externalities. Rents in cities are also generated due to such economies. Apart from land rent, cities also create agglomeration rent, monopoly rent, congestion rents. Congestion charges can be collected from cities when diseconomies arise due to excessive density and traffic of people.

Sustaining the growth momentum of an economy necessitates the facilitation of urbanization. Urban infrastructure, when inadequately provided translates into significant loses to the economy. Financing urban infrastructure is challenge of intergovernmental transfers. Large amount of money needs to be diverted to construct infrastructure and also for their operation and maintenance. This requires having a dedicated revenue stream to systematically and adequately fund such economic overheads that no country can ignore. Municipalities need to refurbish their own sources gradually. This requires understanding the sounds principles of public finance literature.

2.3. Infrastructure Financing: Theory

Infrastructure is a quasi-public good. Paul Samuelson (1954) introduced two concepts to differentiate between private goods and pure public goods: absence of exclusion and absence of competition. Samuelson's traditional interpretation posits that goods are considered public when they are collectively shared, meaning that the consumption of such goods by one person does not diminish the availability for others to consume them. Considering this perspective, infrastructure can be categorized as a non-pure public good, incorporating certain aspects of "excludability" through the imposition of user charges, as well as "rivalry" stemming from congestion-related inefficiencies. Infrastructure, as public goods requires lumpy finances over long gestation period and exhibiting large economies of scale. After the production of a public good, the marginal cost of consuming an additional unit becomes zero. Public goods are often linked to market failure, as true preferences are not easily revealed, making pricing, a challenging task. Moreover, the extent of externalities is large where social benefits exceed the private benefit. All these characteristics are exhibited by infrastructure. In Table 2.1 the matrix of goods classification is outlined.

Table 2.1

Classification of Goods

Characteristics	Excludable	Non-excludable
Rival	Pure private goods Eg: Furniture, etc.	Mixed goods Eg: Common Property resources
Non-rival	Club Goods Eg: Healthcare	Pure public goods Eg; National Defence

Source: Author

Goods can be categorized into two distinct poles: pure public goods and pure private goods. Allocation of goods can occur efficiently if there are mechanisms to:

- Prevent free ridership
- Identifying transaction costs without reducing demand to zero by thereby revealing preferences

In reality pure private or pure public goods rarely exist. The concept of rivalry is highly relative for the same infrastructure. Roads as an example may be congested during a particular hour in a day. Exclusion depends on transaction costs which at are either 'natural' or 'created' to reveal preferences. The quantity and quality of public goods are influenced by their specific locations. Infrastructure has long been considered a typical example of public goods, and due to their nature, private markets often fail to adequately provide sufficient infrastructure. Another notable feature of infrastructure is the existence of external benefits or positive externalities. For example, it is commonly recognized that convenient access to highway infrastructure generates positive external effects for businesses engaged in shipping. In situations where externalities are present, the private market fails to produce an optimal level of output, making public intervention necessary and justified. Furthermore, government involvement in infrastructure is justified by the concept of natural monopoly. Natural monopolies can emerge as a result of significant fixed costs or economies of scale, establishing formidable impediments for new competitors attempting to enter the market. Such a scenario can result in a shortage of goods and elevated prices enforced by the monopolistic entity. Apart from addressing market failure, governments also frequently make substantial infrastructure investments to generate employment opportunities and boosting the economy, particularly during periods of economic crisis.

Infrastructure projects possess distinctive characteristics that differentiate their financing from other forms of government spending. Firstly, they typically involve significant up-front investments necessitating substantial capital outlay. Secondly, infrastructure assets generally have a long economic lifespan. Thirdly, these endeavours frequently exhibit intricacy, encompassing a range of participants like design and building companies, operators, governmental agencies, financiers, private backers, insurers, and the wider populace. Fourthly, sizeable infrastructure initiatives frequently yield advantages that extend to a broad spectrum of individuals, complicating the precise assessment and distribution of costs. Overall, the combination of large capital requirements, extended timeframes, complexity, and significant externalities introduces higher levels of risk, underscoring the importance of efficient and prudent infrastructure financing. Errors in the planning or financing of infrastructure projects can impose a long-lasting burden on communities, leading to what is often termed as a "white elephant." As Adam Smith (1776) observed, private entities are unlikely to undertake public infrastructure projects as the profits generated would not sufficiently cover the expenses, even though the benefits to society would be substantial. As a result, the responsibility for providing infrastructure typically falls under the purview of the government. Numerous theoretical approaches are available to address the provision of public goods, which will be explored in the subsequent discussions.

Fiscal Federalism

The fiscal federalism theory, as outlined by Rao and Singh (2006), provides a comprehensive normative framework for assigning expenditure and revenue responsibilities to different tiers of government in a federation. It suggests a method of distributing revenue to tackle fiscal disparities. The fiscal federalism's first generation theory (FGT) aims to decentralize expenditure responsibilities while centralizing revenue responsibilities to attain efficiency and fairness within the federation, it underscores the significance of transfers in mitigating both vertical and horizontal imbalances. This theory operates on the assumption that both federal and sub-national decision-makers act with benevolence, prioritizing the well-being of society. While the second generation theory (SGT), specifically the theory of market-preserving federalism, acknowledges that public officials' goals are influenced by political

institutions, which may not always align with maximizing citizens' welfare. Unlike the FGT, the SGT places greater importance on sub-national tax collection as a means of incentivizing economic prosperity. The SGT acknowledges the importance of the incentives created by sub-national tax collection and advocates for the decentralization of both expenditure and revenue responsibilities. It diminishes the reliance on revenue-sharing and intergovernmental transfers. Furthermore, it proposes that inter-jurisdictional competition, the establishment of a unified market, and the imposition of stringent budget constraints can safeguard market operations. In summary, the SGT advocates for the decentralization of expenditure and revenue responsibilities, places less emphasis on revenue-sharing and transfers, and highlights the importance of competition and market-oriented mechanisms to foster thriving sub-national economies while still maintaining equalization goals.

Decentralisation

Infrastructure investments are location specific and therefore assigned in the form of decentralised governments. In other words, it is devolution of authority, responsibility and expenditure of activity to specific units of governments. According to the decentralization theorem proposed by Oates (1972), the efficient approach to assigning expenditure responsibilities is through the devolution of each function to the lowest level of government. This theorem suggests that decentralizing decision-making and allocating expenditure responsibilities to sub-national governments can lead to more efficient outcomes. By bringing decision-making closer to the local level, governments can better tailor policies to the specific needs and preferences of their constituents. This decentralized approach is believed to enhance efficiency by promoting better resource allocation and improving accountability. Tastes and costs vary among all local units therefore assigning public-sector activity responsibilities to the lowest level of government garners potential productivity gains. Decentralisation may not lead to welfare gains due to the presence of scale economies and externalities. Scale economies occur when the cost of providing a service reduces with large units. Externalities are present when the effect of infrastructure service delivery falls outside the jurisdiction. In both these cases, local governments will have a tendency to either under spend or overspend. One way to overcome these is unbundling. The function is broken down

into subcomponents such as by sectors, activities or services and then decentralising the expenditure assignments to local governments. The conditions which must be satisfied for effective decentralisation are:

- Disaggregating of public sector functions and allocating them to the correct tiers of government.
- Accountability at two levels - local governments have a dual obligation to be answerable to both their residents and the higher government authorities, encompassing financial, administrative, and political dimensions.
- Proper system of intergovernmental finance whereby revenue raising powers of local governments are defined, well designed transfers and access to private sources of funding.

Decentralising public good provision and finances offers a number of benefits. First, with regional preferences being highly diverse, it is sensitive to individual preferences. Second, mobility of households reveals their preference. Third, it also caters to the interest of future generations. And finally, decentralisation restricts the power to tax of governments, unconcerned with the welfare maximisation of residents.

Tiebout Model of Infrastructure Financing

According to Tiebout (1956) decentralisation rather than centralisation is better model of providing public goods and services, especially infrastructure. Tiebout argues that an increased number of local governments fosters competition among them to attract individuals and businesses through the efficient provision of public goods and effective tax policies. Consequently, this competition can generate welfare improvements by enhancing the efficiency of resource utilization. In the Tiebout model, individuals express their preferences for certain publicly provided goods by selecting the jurisdiction in which they reside. This means that individuals who highly value quality primary education, for example, will choose to live in a city that invests significantly in this area. This concept is often referred to as "voting with your feet," where individuals express their preferences through their mobility choices. The essential aspects of Tiebout's model revolve around the assumptions that individuals have varying preferences for publicly provided goods and that they have mobility.

The advantages of local governments providing these goods are rooted in the larger number of towns and cities compared to higher-level jurisdictions such as provinces or countries, as well as the relatively lower costs associated with moving between localities. While Tiebout's theory presents a compelling framework, it is important to acknowledge that the world in real is considerably more complex, and some of its assumptions are unrealistic. Tiebout acknowledged these shortcomings, himself. Critics of the Tiebout model point out various factors, including scale-related efficiencies, clustering effects, cost benefits of localized production, disparities in information among citizen-voters, and tax capitalization, as potential issues.

The Henry George Theorem

Economics underscores the importance of land rent as a funding source for urban development. Adam Smith recognized land rent as an unearned income and characterized landowners in the following manner:

> *"They are the only one of the three orders whose revenue costs them neither labour nor care, but comes to them, as it were, of its own accord, and independent of any plan or project of their own. That indolence, which is the natural effect of the ease and security of their situation, renders them too often, not only ignorant, but incapable of that application of mind which is necessary in order to foresee and understand the consequences of any public regulation. (Smith 1776: Book 1, Chapter 11: 277)"*

John Stuart Mill championed the idea of taxing land rents, outlining the concept of fairness in the following fashion:

> *"Suppose that there is a kind of income which constantly tends to increase, without any exertion or sacrifice on the part of the owners: ... In such a case it would be no violation of the principles on which private property is grounded, if the state should appropriate this increase of wealth, or part of it, as it arises. This would not properly be taking anything from anybody; it would merely be applying an accession of wealth, created by circumstances, to the benefit of society, instead of allowing it to become an unearned appendage to the riches of a particular class. Now this is actually the case with rent. The ordinary progress of a society which increases in wealth, is at all*

times tending to augment the incomes of landlords; to give them both a greater amount and a greater proportion of the wealth of the community, independently of any trouble or outlay incurred by themselves. They grow richer, as it were in their sleep, without working, risking, or economizing. What claim have they, on the general principle of social justice, to this accession of riches? [Mill 1848 (2001, p. 941]"

Henry George, in his 1879 publication "Progress and Poverty," acknowledged land rent as an excess and advocated a compelling case for its taxation to finance public spending. He introduced the concept of a 'single tax' on the value of land, which he deemed non-distorting and capable of generating ample revenue to cover public expenditure needs. According to George, as public investments enhance land value, capturing economic rent from landowners emerges as the most correct form of public revenue and hence financing. The Henry George Theorem (HGT) posits that, under specific criteria, government spending on public utilities can yield significant land rents for effective financing **(**George 1879; Atkinson and Stiglitz 1976; Arnott and Stiglitz 1979; Arnott 2004). Despite criticism for not accounting for the growing financial demands of contemporary economies, the HGT offers valuable insights into financing local government expenses, for developing nations in particular. When public resources for financing are limited, levies imposed on landowners and proprietors of immobile or quasi-immobile assets are seen as the most suitable means of funding urban infrastructure facilities. These facilities often result in considerable unearned increases in land values and rents due to the positive spillovers generated by urban centers. The New Economic Geography (NEG) literature contends that significant agglomeration externalities render production factors relatively immobile, and they can gain from "agglomeration rents" that are taxable without eroding the tax base. "The Price of Inequality," book by Stiglitz (2012) acknowledges the advantages of taxing various forms of rent as a tool for reducing inequalities and distortions in the economy.

"A basic principle of economics holds that it is highly efficient to tax rents because such taxes don't cause any distortions. A tax on land rents does not make the land go away. Indeed, the great nineteenth-century progressive Henry George argued that government should rely solely on such a tax. Today, of course, we realize that rents can take many forms – they can be collected not just on land, but on the value of natural resources like oil, gas, minerals, and coal. There are other sources of rents, such as those derived from the exercise of monopoly power. A

stiff tax on all such rents would not only reduce inequality but also reduce incentives to engage in the kind of rent-seeking activities that distort our economy and our democracy (Stiglitz 2012: 212-213)."

Stiglitz's points offer compelling justifications for contemplating rent taxation as a solution to tackle the infrastructure deficits in urban areas. Curiously, even though these concepts boast strong theoretical advantages, the idea of taxing urban land rent, monopoly rent, and agglomeration rent resulting from external factors has unfortunately not garnered enough focus from Indian policymakers and local authorities.

Mohring Theorem

Known as the "self-financing" or "cost recovery" theorem, the Mohring-Harwitz Theorem (MHT) suggests that, under certain circumstances, the income derived from congestion tolls can effectively offset the capacity expenses of an ideally sized public infrastructure, such as a highway (Mohring and Harwitz 1962; Mohring 1972, 1976). Lindsay (2009) illustrates that this outcome remains valid, even when short-term unpredictability is a factor, given particular supplementary presumptions. This theorem carries significant implications for developing countries such as India, particularly in addressing the often overlooked issue of financing public transportation investments. It underscores that the effective pricing of a congested public resource is in accordance with the "users pay" principle, eliminating the necessity for subsidies. Moreover, users are not burdened with arbitrary or excessive charges, as the pricing strategy ensures that costs are limited to marginal social costs. Significantly, various global cities, including Singapore, Stockholm, and London, have effectively put into practice the "congesters pay" concept through the adoption of electronic pricing and automated payment systems. In situations where congestion pricing is not feasible, options like motor vehicle taxes, fuel levies, and parking charges are contemplated as substitutes. The "congesters pay" approach complements the "beneficiaries pay" principle, emphasizing that those responsible for societal inconveniences should shoulder the expenses associated with alleviating them.

Gravity Model of Infrastructure Financing

Networks and power nodes share a mutually reinforcing relationship. The principles of "connect, connect, and connect" and "location, location, location" bolster one another. Transportation networks play a pivotal role in influencing the geographical placement of economic activities, serving as the linkages that connect resources, individuals, and opportunities. They expand markets for inputs-outputs, provide a wider range of labour market choices, stimulate agglomeration spillovers, enhance the creation of clusters, leverage the power of competition, expedite transfer of knowledge, and create broader economic benefits by improving access to economic mass. The incorporation of Gravity models in regional science, external trade, traffic engineering, and transportation planning, assert that transport networks exert an influence on the potential of various locations by shaping the character and magnitude of activities in linked nodes. Consequently, the ongoing transport revolution in emerging economies like India could be magnifying the importance of their urban centres, and a similar effect might be observed with the ICT revolution. The rationale behind gravity models implies that the impacts of scale and network effects can mutually strengthen each other (see Box 2.1 for reference).

Box 2.1

Gravity Model of Transportation Planning

A gravity model encapsulates network influences by considering significant characteristics of the inter-connected nodes, both at the starting point and the destination. These attributes typically include factors like population, employment, and gross output. The "four-step model" of transport planning, encompassing trip generation, trip distribution, modal split, and route selection, employs the following generic formula for estimating traffic flows between different locations:

$$T_{ij} = A_i A_j T_i T_j f(C_{ij}) \quad (1)$$

T_{ij} = Number of trips between origin i and destination j

T_i = Trips originating from origin i = 1,2,3…...n

T_j = Trips attracted by destination j = 1,2,3……m

C_{ij} = Generalised cost of travel between origin i and destination j (including money and time costs)

$f(C_{ij})$ is the distance-decay function.

A_i, A_j are scale factors solved iteratively to ensure that the trip production and trip attraction constraints are satisfied, i.e. $\Sigma_j T_{ij} = T_i$ and $\Sigma_i T_{ij} = T_j$

Typically, $f(C_{ij})$ is expressed as a negative function of the overall cost of travel between origin i and destination j, which is approximated by distance d_{ij}:

$$f(C_{ij}) = (d_{ij})^{-\lambda} \text{ where } \lambda > 0 \quad (2)$$

T_i and T_j are often depicted as power functions and T_{ij} is specified by the equation:

$$T_{ij} = A_i A_j T_i^{\alpha} T_j^{\beta} (d_{ij})^{-\lambda} \quad (3)$$

Taking logarithms of both sides

$$\log T_{ij} = \log A_i + \log A_j + \alpha \log T_i + \beta \log T_j - \lambda \log (d_{ij}) \quad (4)$$

Taking derivative with respect to d_{ij}yields $\lambda = -(d_{ij}/T_{ij})(\partial T_{ij}/\partial d_{ij})$, which is identical to own-price elasticity of demand of microeconomics. The own-journey time elasticity of travel demand is a measure used to assess the responsiveness of traffic flow to changes in travel time. Empirical studies conducted in developed countries have revealed that this coefficient typically ranges between 1 and 2 for intra-city travel and between 2 and 3 for inter-city travel. These values indicate that an improvement in transportation networks leads to a higher percentage increase in traffic flow between two locations compared to the percentage decrease in journey times. This implies the existence of induced effects or spillovers, wherein reduced travel time or cost not only leads to increased traffic on the same route but also diverts traffic from alternative routes. Theoretical cum empirical investigations carried out in the realm of transportation planning and associated fields have revealed that economies of scale in production and network benefits stemming from enhancements in transportation can lead to multiplier impacts. These consequences hold the potential to greatly enhance the importance of location and clustering within urban areas. The interplay between these factors highlights the potential for cities to experience enhanced economic benefits and growth through the combined influence of production scale and efficient transportation networks."

Sources: Ortuzar and Willumsen (2001), Hensher and Button (2008)

Besides the extensively studied connections involving market accessibility, economies of scale, transportation expenses, and network advantages, the influence of agglomeration and network externalities also holds considerable sway in propelling the expansion and significance of cities. However, there are additional factors that contribute to the power of cities, which have not received as much attention in the research literature. An example of such a factor is the existence of ICT networks within cities. These networks empower companies to embrace new and dynamic business strategies that might be economically unfeasible otherwise. Illustrations of these approaches encompass the "long tail" and the "bottom of the pyramid" methodologies. These strategies leverage the unique capabilities and resources available in cities to reach niche markets and serve low-income populations effectively. Therefore, cities are not only shaped by traditional economic factors but also by their ability to foster innovation and support diverse business strategies.

2.4. Urban Infrastructure Financing: Theory

Musgrave (1959) delineates the key objectives of the public sector, which include stabilization, redistribution, and allocation. These aims are geared towards fostering economic stability, ensuring equitable resource distribution, and efficiently distributing goods and services. Oates (1972), on the other hand, specifically examines the roles and functions of local governments within this framework. He argued that local stabilisation programs would be ineffective as the costs of such program are borne by a jurisdiction but the benefits have a tendency to spillover to neighbouring jurisdictions Similarly, if one jurisdiction undertakes an income redistribution programme in isolation, rich people would out-migrate and poor immigrate leading to the failure of the program. Allocation of public services like telecommunication, roads, sewerage, hospitals, schools, etc., is highly local and therefore should be the responsibility of the local tier of the government. Localities vary with respect to tastes and preferences. The provision of public facilities at the local level would address the specific needs and preferences of the local residents or voters. In this context, Oates (1972) decentralisation theorem gives a better economic point of view. This theorem:

"…..i*ndicates that in the absence of cost-savings from the centralised provision of a [local public] good and of interjurisdictional externalities, the level of welfare will always be at least as high (and typically higher) if Pareto Efficient levels of consumption are provided in each jurisdiction than if any single, uniform level of consumption is maintained across all jurisdictions (Oates, 1972, p. 54)."*

Under such a decentralised setup, where local decision makers act on behalf of the local preference of the voters, 'people get what they want'. The quality and the quantity of the local public goods demand are better adjudged, leading to enhancement of overall public welfare. The 'subsidiarity principle' in the Maastricht Treaty (1992) of European Union is a well cited example. It outlines that only those functions which cannot be rendered effectively by the local governments must be performed by the central authority. At this point, Bahl and Linn (1992) established the fundamental principles for financing local public goods referred as 'golden rules of public finance':

- When the advantages of public facilities are quantifiable and directly received by identifiable individuals within a jurisdiction, the most suitable means of financing is user charges.;
- Local public facilities that serve the general public, like administration, traffic management, street lighting, and services of security, and where it is challenging to identify specific beneficiaries and quantify individual benefits and costs, are best financed through taxes imposed on local residents.;
- Services that generate significant spillover effects into jurisdictions in the neighbourhood, such as healthcare, educational services, and social welfare, should be primarily funded through inter-governmental transfers from the state or national level; and
- Borrowing is a suitable means of financing large-scale capital investments in infrastructure projects, especially those associated with public utilities, roads networks, and transport systems, where the investment requirements are substantial, and the advantages span across multiple generations.

State and local governments typically employ two primary methods to finance infrastructure projects: pay-as-you-go (pay-go) and pay-as-you-use (pay-use) (Marlowe et al. 2009). Pay-go financing entails utilizing available cash reserves or existing assets, rather than seeking loans, to cover the expenses associated with infrastructure projects. It offers

advantages such as simplicity and cost-effectiveness. However, pay-go financing has drawbacks, including the need to accumulate sufficient funds before starting projects and the potential burden on current taxpayers. It is commonly used for smaller projects with shorter lifespans, limited access to debt, or restrictions on borrowing. On the other hand, pay-use financing involves borrowing funds, usually through long-term debt instruments like bonds, to finance infrastructure projects and repaying the borrowed amount over time. This approach is well-suited for extensive projects that yield advantages for both present taxpayers and future generations, thereby promoting intergenerational equity. Debt financing, on the other hand, spreads the expenses across the project's duration. However, pay-use financing has drawbacks, such as time-consuming bond issuance processes, costs associated with involving financial advisors, underwriters, and lawyers, and various legal and tax-related restrictions. The option between pay-go and pay-use financing depends on factors like the project's lifespan, available resources, borrowing rates, and legal limitations. Financing for regional and local infrastructure proposal is typically derived from various sources, including local taxes, user fees, dedicated taxes, intergovernmental grants, bond proceeds, or a combination of these funding streams. Table 2.2 provides further details on the traditional sources of infrastructure financing.

Table 2.2

Conventional Sources of Financing Infrastructure

Pay-as-you-go Financing:	
General Taxes:	Revenues for public projects are garnered through taxation on both individuals and businesses. These levies encompass various forms, including sales taxes, property value taxes, and income or earnings taxes. They are frequently utilized to fund infrastructure endeavours that yield advantages for the entire populace. Illustrations of such initiatives encompass road networks of the state or local area, public transportation systems, streets, parks, and recreational amenities.
Dedicated Taxes:	Specifically targeted taxes, either within general funds or dedicated special funds, are utilized to finance infrastructure projects. These specialized taxes consist of levies such as fuel taxes, local utility taxes, telecommunications taxes, wagering taxes, and taxes on hotel stays and accommodations. These taxes are typically allocated to a dedicated revenue stream fund specifically

	designated for infrastructure purposes.
User Charges/Fees:	User fees are of significant importance in the financing of local infrastructure, especially for services such as road tolls, parking fees, drinking water supply, wastewater management, and solid waste disposal. Residents and businesses are subject to various fees based on their usage of utilities and other public services. These charges encompass a diverse array of fees, spanning tolls, motor vehicle licensing and registration charges, congestion pricing, public transit fares, airport-terminal usage fees, water and sewer fees, franchise fees, parking fees, and various others.
Capital Reserves and Fund Balance:	Local governments employ the strategy of saving and accumulating funds in capital reserve accounts, which are subsequently allocated for recurring expenses and smaller capital projects. Additionally, they establish capital asset replacement funds, also known as sinking funds, to finance the future replacement of government buildings, equipment, facilities, vehicles, and other specified assets. These replacement funds operate as internal service funds, charging government departments and agencies a service fee for their utilization of equipment, facilities, and vehicles.
Intergovernmental Grants and Aid:	Intergovernmental transfers are deemed suitable when public functions entail notable spillover effects and when there is a need to address vertical and horizontal imbalances.
Pay-as-you-use Financing:	
Debt Finance:	Debt finance involves obtaining long-term loans to finance the development and construction of infrastructural assets with a long lifespan. The substantial investment required for infrastructure projects and the aim of achieving intergenerational equity provide justification for utilizing debt funding. By distributing the costs of public infrastructure investments over multiple years, it is possible to derive advantages. Debt financing can be secured through private bank loans or by issuing bonds.
Loan Finance:	Governments have the option to obtain loans directly from commercial banks, industrial banks, or industrial loan companies.
Bond Finance:	Local municipalities frequently choose to issue bonds to attract investments from municipal capital providers (bond purchasers) for the purpose of raising essential funds for new infrastructure undertakings or refinancing existing bonds. The borrower assumes the obligation to reimburse the debt service,

	covering both bond principal and interest repayments. Thanks to the tax exemption on interest income from publicly issued bonds, regional and local governments can secure more favourable interest rates in contrast to corporate bonds, thereby lowering issuance expenses. There exist two primary categories of bond financing: General Obligation Bonds and Revenue Bonds.
General Obligation (GO) Bonds:	General Obligation (GO) are financial commitments made by lower tier of governments, supported by complete trust and creditworthiness of the issuer. This signifies that the governing bodies that issue these bonds are committed to repaying them through their general tax incomes. General Obligation (GO) bonds are frequently employed to finance projects that do not produce substantial revenues, such as government schools, public libraries, public safety equipment, community halls, fire stations, and correctional facilities.
Revenue Bond:	Revenue bonds, also known as non-guaranteed debt, are commonly employed to finance public infrastructure that caters to specific users and generates identifiable revenue streams. Instances of such establishments encompass public utilities, road tolls, bridges, dams, educational institutions, and medical centres. Revenue bonds are backed by the assurance of dedicated revenue streams stemming from the projects financed by these bonds, such as user charges, tolls, and facility rentals.
Private Activity Bond (PAB):	PABs represent a class of civic securities released by regional and provincial administrations in support of corporate enterprises. These bonds are utilized to finance projects that provide advantages to private entities while also serving a public purpose. Examples of such projects include airport enhancements, water facility upgradation, and road tolls. PABs leverage the tax-exempt position of the government, allowing private users to access lower interest rates. They act as a vehicle to encourage private industry investment in projects related to infrastructure, which provide significant advantages to the general public.
Leasing Revenue Bonds:	Lease-purchase arrangements has gained popularity as a method of bond financing for various local infrastructure needs such as police service vehicles, fire station trucks, court-houses, and correctional homes This funding method entails a leasing arrangement between private or not-for-profit owners of equipment and facilities or construction developers (the lessors) and a regional administration (the lessee). Through this lease, the equipment is transferred to the local government for a predetermined and given period, granting them both

	usage and ownership rights. In a lease funding agreement, the lessors receive periodic lease disbursements from the regional administration, which are utilized to settle the debt obligations. One advantage of lease financing is that the interest income earned by the lessors is typically tax-exempt. Additionally, at the conclusion of the lease period, ownership of the property often transfers to the local government. Significantly, lease funding doesn't necessitate a bond vote and isn't constrained by legal debt ceilings, providing it with increased adaptability when contrasted with alternative financing techniques.

Source: Author

The Generalised Benefit Principle

The proper functions of local governments have been vastly discussed in theory but in practice the finances with the local governments fall short of their responsibilities. Especially the city governments operationalise too many function with too little funds. Cities are subject to external economies where firms, households, institutions collocate leading to the benefits of agglomeration. Due to this, funding of public goods, especially infrastructure can garner finance itself or even a generate surplus revenue. Moreover, cities create unearned rents in the form of higher land values or 'agglomeration rents' and therefore value-capture financing methods can be efficient instruments to capture and recycle such rents to finance urban infrastructure. Mobile factors, including skilled labour and capital, contribute to agglomeration rent in a manner similar to immobile factors like land, as indicated by recent studies in the area of NEG (Andersson and Forslid 2003; Baldwin and Krugman 2004; Borck and Pfluger 2006; Ludema and Wooton 2000). Urban infrastructure investments that multiply such unearned rents can be financed by making the beneficiaries pay. This makes the case for the 'generalised benefit principle' of urban infrastructure financing. Using this principle, financing becomes smooth as the urban infrastructure projects that qualify the Cost-Benefit analysis should be value generating. Therefore, debt financing is facilitated with the availability of adequate resources. There is also accountability in service delivery of Urban Local Bodies (ULBs) with expenditures and revenues being closely linked.

The Wicksellian Connection and Lindahl Pricing

Knut Wicksell differed from the mainstream public finance view in his theory of ‘just taxation’. To him, the beneficiaries of public programmes should pay taxes, diverging from the ‘no quid pro quo’ principle of taxation. This concept was further extended in the theory of ‘Lindahl pricing’. The latter principle signifies that the price of a public service should correspond to the marginal benefit it provides. These principles establish a significant connection between expenditure and revenue decisions, playing a crucial role in ensuring the efficient operation of urban local bodies. Breton (1996) termed this connection the 'Wicksellian Connection.' It establishes a relationship between expenditure, resources, taxes, services, revenue capacities, and political accountability, thereby linking areas of benefits with areas of financing (Bird and Slack 2017).

Earmarking Principle

The primary challenge in public economics is to supply public goods in a manner that aligns with people's preferences while also covering costs. Buchanan (1963) proposes the principle of 'earmarking' as the optimal approach to address this normative problem. Earmarking involves dedicating user charges or benefit taxes specifically for financing debt-funded infrastructure projects. Infrastructure plays a crucial role in urban areas, and earmarking ensures a reliable source of funding for such projects. Additionally, earmarking is more feasible in urban areas due to the generation of rent from both mobile and immobile factors. These unearned increments in values can be specifically allocated to generate revenue for infrastructure projects.

Urban Land Taxation

Land based taxes qualify the ‘principles of taxation’ laid by Adam Smith (1776). In terms of efficiency, land taxes do not affect allocation of resources and fall directly on the landowner. Land taxes recoup the unearned increments in value due to infrastructure programs. It only taxes households that own the land, satisfying the equity principle. Land owners that benefit

from public investments should pay for the same according to the benefit principle. Therefore, Smith regarded land as a proper 'subject' of taxation due to these attributes. The idea was further discussed by Henry George (1879). To him, progress of the society along with public expenditures led to increment in land values, which landowners should not appropriate. Hengry George presented a strong case of land based taxation to adequately fund public expenditure.

2.5. Lessons from Theory

Long-term funding is essential for infrastructure financing. The establishment of infrastructure projects typically requires substantial capital investment upfront, accompanied by relatively low ongoing operating costs. These projects often have limited recourse or non-recourse financing structures, meaning that the revenue generated by the projects serves as the primary source for repaying the lenders. As a result, there are increased levels of market and commercial risks associated with infrastructure projects. Apart from these there are certain unique risks due to the "public interest" nature of most infrastructure projects such as tariff determination problems, environmental clearance issues, contracts reneging and non-payment. Infrastructure is a non-tradable output where revenue is generated in domestic currency so it encompasses high foreign exchange risk; therefore domestic financing of such projects is mostly preferable. Moreover, infrastructure projects are subject to market failure due to externalities. Given that private returns are lower than social returns, the government implements various subsidy arrangements to incentivize private sector participation. Consequently, infrastructure financing presents numerous challenges. As a result:

i. Domestic revenues must finance infrastructure and must underwrite the public liabilities.
ii. Urban Local Bodies (ULBs) must be strengthened with clearly defined finances and functions and also autonomy in terms of investment decisions.

Infrastructure is location specific, though its benefits network over jurisdictions. The provision of infrastructure should be undertaken in a decentralised manner. In order for local governments to effectively deliver urban infrastructure, the link between expenditure and revenue decisions is crucial. This is at the core of the decentralization theorem (Bahl et. al.

2002), which emphasizes the importance of aligning finances with functions. Implementing a Wicksellian Connection, which establishes a transparent link between expenditure and revenue decisions, not only promotes government accountability but also reduces taxpayer aversion towards tax payment. Local government bodies (ULBs) have access to various revenue sources, as stated in Table 2.3.

Table 2.3

Typical Sources of Finances for City Government

Taxes	Grants	User Charges	Lease Income
Property Taxes, Licence Fees, Entertainment Tax, Sales Tax	National/provincial/state governments	Water, sewerage & drainage, tolls, fares etc.	Lease rentals from land, markets, projects etc.

Source: KPMG (2010)

Designing an optimal strategy for municipal finances requires a synergy between the kind of public utilities to be delivered, how much of it to be delivered along with the revenue system to incentivize the expenditure package. Revenues comprises of a variety of taxes, grants, user changes and lease income. The costs of infrastructure projects must be allocated with given benefits of the project to groups, businesses, firms, neighbourhoods, individuals, to ensure efficient allocation of scarce investible resources (Bazel and Mintz 2015). Accordingly, there are matching fiscal tools to the type of infrastructure services as given in Table 2.4.

Table 2.4

Matching Fiscal tools for City Infrastructure Financing

User Fees	Taxes	Land Value Capture	Development Charges	Transfers	Borrowing	Public Private Partnership
Identifiable Beneficiaries. Eg: water	Short asset life. Eg: police	Increasing property values. Eg: transit	Growth related costs, new development or redevelopment. Eg: roads	Spillover municipal boundaries. Eg: roads	Large-scale assets with long life. Eg: roads	Large in scale; revenue stream; measurable results. Eg; toll roads

Source: Slack and Tassonyi (2017)

User fees play a vital role in sustaining services that demonstrate characteristics of private goods, including water, sewage, waste collection and disposal, public transportation, and certain recreational activities. These fees serve two primary objectives: generating income for local governments and encouraging economic efficiency. When individuals do not directly pay for services they use, they tend to undervalue the last unit they consume. Consequently, consumption and demand exceed what individuals' willingness to pay if they were fully aware of the actual costs of delivering the service (Bird and Slack 2017). Offering services at under-priced rates or for free leads to excessive consumption and often leads to misguided investments. For instance, when subsidized roads become congested, there is a heightened political pressure to expand them further. Overinvesting in under-priced infrastructure results in inefficient utilization of limited public resources. Implementing appropriate user charges can help prevent such wastage. User-charge financing is beneficial as it helps recover partial or complete costs associated with government services, while also providing price signals to guide consumer choices (Anderson 2012; Fisher 2007). User charges have an important role in promoting efficiency by providing demand information to public service providers and ensuring that the value of services provided by the public sector is recognized by citizens. To achieve efficiency, user charges should be imposed on those who directly benefit from the services. Direct subsidies can be provided to the poor when necessary, rather than relying on

reduced prices that can distort the entire service market. When user fees are not practical or viable, it is reasonable to collect local revenues for financing services and infrastructure primarily from local residents. Ideally, the allocation of these revenues should be based on the perceived benefits individuals derive from local services. This ensures that those who directly benefit from the services contribute to their financing in a fair and proportional manner. Likewise, income generated from other origins, such as local business operations, should correspond to the advantages these enterprises derive from local services. This approach promotes a sense of equity and ensures that the costs of providing services are distributed in a manner that reflects the benefits derived by different stakeholders. By aligning revenue collection with the perceived benefits received from local services, local governments can foster a more equitable and sustainable financing framework for community infrastructure and services.

Services possessing characteristics of public goods, such as firefighting, community green spaces, residential roadways, and street illumination, offer communal advantages to the entirety of the local populace. Determining precise tariffs or payments for individual recipients in these instances proves to be a formidable task. In such scenarios, a viable substitute involves implementing a local tax system based on benefits, such as property taxation. This form of taxation allows community members to collectively indicate their need for services and participate in their financial support. Property taxation is regarded as a broad or non-specific user fee since it is imposed on property proprietors according to the evaluated worth of their real estate holdings. It is particularly well-suited for financing infrastructure with a limited lifespan. Studies by Kneebone and McKenzie (2003) and Tassonyi (1997) have highlighted the suitability of property tax for this purpose. By utilizing the property tax as a local benefit-based taxation system, local governments can ensure that the costs of providing public goods and services are shared by the community as a whole, in proportion to their property ownership and value. This approach helps sustainably finance infrastructure projects and support the provision of essential services to the local community.

Pay-as-you-go methods of financing or property taxes in general, may not be the most suitable approach for funding large infrastructure projects with long lifespans of 30 or 40 years. Implementing such financing methods could result in a significant surge in property taxes during the year of the investment. In such cases, land value capture taxes can serve as a more refined alternative for local taxation, especially when infrastructure projects lead to an

increase in land values. Furthermore, development charges are suitable for offsetting capital expenditures connected to fresh construction or revitalization, especially those associated with growth-induced costs. In cases where services yield spill-over benefits extending beyond municipal borders, yet local delivery is preferred, federal or provincial subsidies may be fitting. Favorable spill-over effects, often referred to as externalities, arise when inhabitants of adjacent areas obtain a service without charge or at a cost below the genuine expense of service provision. This leads to an inefficient allocation of resources for that service. For instance, when one administrative region builds significant roadways used by inhabitants of another jurisdiction without any fee, it generates a circumstance where the expenses of delivering the service are not entirely shouldered by those who enjoy its advantages. This can lead to an ineffectual distribution of resources, as the providing jurisdiction makes spending choices solely based on the advantages within its own geographical confines, neglecting the benefits received by those outside its jurisdiction. To address these spillover effects and promote efficient resource allocation, transfers from higher levels of government, such as federal or provincial governments, can be appropriate. These transfers help compensate the providing jurisdiction for the costs associated with providing services that benefit residents beyond its boundaries. By considering the broader benefits and costs of services, these transfers help ensure a more equitable and efficient provision of services across jurisdictions, taking into account the spillover effects that occur.

Utilizing borrowing for long-term assets and engaging in PPPs, where the private sector participates in various aspects such as design, construction, financing, maintenance, and operation of facilities, are considered financing sources rather than funding mechanisms. Municipalities are still required to generate revenues to repay the borrowed funds or make availability payments to the private sector (in cases where user fees are not applicable). In the realm of local public finance research, several guiding principles, known as golden rules, can aid in identifying appropriate sources of revenue for financing specific types of local expenditures:

- When it's possible to quantify and assign the benefits of public services to particular individuals within a jurisdiction, user charges emerge as the most appropriate means of financing.

- Local public services, which confer general benefits upon the community, such as administration, traffic management, street lighting, and security, and prove challenging to associate with specific individuals or gauge their advantages and expenses, are most effectively funded via taxes levied on local residents.
- Services with significant spillovers to neighbouring jurisdictions, such as health, education, and welfare, should be financed mainly through inter-governmental transfers from the state or national level to account for the cross-border impacts.
- Taking on debt represents a suitable avenue for funding capital investments in infrastructure services, particularly for public utilities and road networks.

These principles provide guidelines for selecting appropriate financing mechanisms based on the nature of the services, the extent of individual benefits, the presence of spillover effects, and the long-term capital requirements of infrastructure projects. User charges play a pivotal role in enhancing efficiency by "supplying demand insights to public service providers" and guaranteeing that citizens place value on the services furnished by the public sector. To attain efficiency, user fees should be imposed on those who directly receive the benefits. Direct subsidies can be provided to the poor when necessary, rather than relying on reduced prices that can distort the entire market for services. This approach allows for a more targeted and efficient allocation of resources. In situations where imposing user charges becomes unfeasible because of challenges in quantifying benefits or identifying recipients, the preference leans toward implementing particular "benefit taxes" levied on the local populace. These taxes help align the financing of services with the perceived benefits received by the local community.

Inter-governmental transfers are necessary to finance services when user charges and benefit taxes are not sufficient. These transfers ensure that adequate resources are allocated to provide essential services, particularly in cases where local revenues are insufficient. It is crucial for urban local bodies (ULBs) to face a hard budget constraint, meaning they should operate within a strict financial framework (Mishra et. al 2021). This ensures accountability and responsibility in financial management, and it should go hand-in-hand with the autonomy granted to ULBs. By implementing these principles, local governments can promote efficiency, allocate resources effectively, and ensure accountability in the provision of public services.

Benefit taxes play an important role in the realm of local public finance. Many local public services have collective benefits that are difficult to measure and beneficiaries who are challenging to identify. This makes it challenging to impose user charges directly. Nonetheless, when a transparent link between taxes and services is firmly established, designated benefit taxes can function as indirect user charges or 'substitute prices.' Earmarking, as championed by Nobel laureate Buchanan (1963) and other experts, is regarded as a 'top-tier' practical strategy for addressing the normative quandary in public economics: the provision of services in line with people's preferences. Earmarking introduces market pricing into the budgetary framework, facilitating rational decision-making by taxpayers. Nevertheless, the efficacy of earmarking hinges on the following conditions:

- Expenditure specificity: The expenses slated for funding via earmarked revenues are meticulously delineated and particular, enabling taxpayers to discern the direct benefits linked to them.
- Tight earmarking: There is a strong and direct connection between the earmarked revenues and the corresponding expenditures, ensuring a close linkage at the margin.
- Strong benefit linkage: The funds amassed through earmarking manifest as explicit user fees, such as usage charges, as well as implicit user fees, like particular benefit taxes.

Drawing lessons from public economics, the study makes the following broad suggestions for matching municipal revenues and responsibilities: i) municipal functions that are essential in nature should be financed through user charges, fees, and locally generated revenues, which may include benefit taxes. (ii) functions that involve agency roles should be funded through inter-governmental transfers, primarily established through a partnership between the union and state governments, with a minor contribution from the local body to promote a sense of ownership. (iii) the ‘shared’ functions be financed through user charges, benefit taxes and ‘revenue-shared’ taxes devolved from higher levels of government. Earmarking of benefit taxes is useful when clear linkages are established between services and such taxes. Inter-governmental transfers are appropriate when functions involve significant spillovers, and when vertical and horizontal imbalances need to be corrected. As the benefits from lumpy infrastructure investments spread over generations, borrowing is appropriate for financing the same.

However, most local expenditures being connected to the everyday needs of residents and business, adequacy, revenue stability, local autonomy and immobility of tax base are cited as important criteria for choosing local taxes. Boadway, *et al* (2000) recommend piggy-backing on personal income taxes, royalties, taxes on gambling/betting, motor fuel tax, congestion tolls, parking fees and user charges for assignment to local bodies in a three-tier federation. Bahl and Bird (2008) propose various revenue sources for sub-national expenditures, including real-estate levies, vehicle taxation, additions to national personal income taxes, payroll taxes, as well as well-designed regional value-added taxes and business taxes. In the field of public finance, it is recognized that land-based instruments are particularly suitable for local financing. This is primarily because land is immobile and a significant portion of land value appreciation is considered unearned. Moreover, local government investments in capital projects contribute to the increase in land values, resulting in landowners benefiting from spatial planning and infrastructure development.

The research findings regarding the allocation of taxes between states and local bodies do not provide a conclusive consensus. However, it clarifies that no single framework fits all. The contexts of countries determine their model of revenue assignment. In the context of fiscal federalism in India, the HPEC report has proposed a 'municipal finance list' for inclusion in the Constitution of India, which consists of the following recommendations:

Exclusive taxes:	Real estate levies, which encompass taxes on unused land, professional taxes, amusement taxes, and promotional taxes.
Revenue-shared Taxes:	All taxes on goods and services levied by the State Government.
Non-tax revenues:	Consumer fees, commercial licensing charges, Floor Space Index (FSI) levies, betterment fees, impact fees, and development fees.

The framework proposed by HPEC is justified in terms of the broad principles of tax assignment.

Property tax serves as a form of benefit tax, with vacant land tax often considered as a derivative of property tax (Mishra et. al 2022). Profession tax, entertainment tax, and advertisement tax, which are already implemented by municipalities in certain states, meet the criteria of being local taxes. The inclusion of revenue-shared taxes can be justified by the

fact that no state has been able to find a suitable alternative tax for municipalities in place of Octroi. Additionally, some states share motor vehicle taxes, a benefit tax, as well as stamp duty on land registration, a tax related to land. User charges are widely regarded as the most effective method for funding local public services. In India, trade licensing fees are commonly collected by municipalities. Revenue streams associated with land development, such as Floor Space Index (FSI) charges, betterment levies, impact fees, and development charges, are in accordance with the benefit principle.

Land and property taxes are unpopular with taxpayers for at least three reasons. First, these are levied on the potential income from an asset. If land or property is not sold or rented out, this potential does not translate into liquid funds to pay the tax bills. Second, if a land or property has not been recently sold, it does not have a determined value which is agreed upon by the landowner and local authority. Thirdly, land and property taxes provide greater transparency regarding the amount paid by taxpayers compared to income or sales taxes. Income taxes are commonly withheld by employers directly from individuals' income sources, while sales taxes tend to be included in small increments and integrated into the prices of goods and services. Conversely, land and property taxes are collected in larger sums, usually once or twice a year. Considering these factors, there is a call to expand the municipal tax base, moving beyond reliance solely on land and property taxes.

2.6. Infrastructure Financing: International Practice

Infrastructure development plays a significant role in enhancing trade and exchange, increasing output capacity, enhancing productivity, reducing congestion, and lowering transaction costs for all the users in an economy. However, governments worldwide are facing challenges in maintaining the necessary investment levels to meet current and future infrastructure needs. This situation has led to an infrastructure deficit, requiring an estimated annual funding of about $800 billion for the Asia-Pacific region (Moore and Kerr 2014). In developed industrialized nations worldwide, infrastructure investment typically hovers around 3.9 per cent of their gross domestic product (GDP). However, developed countries in the Asia-Pacific region invest more generously, like Malaysia at 10.5 per cent, Australia and Canada at 6.0 per cent, Japan and New Zealand at 5.0 per cent, and the Republic of Korea at

4.0 per cent. Emerging economies are witnessing increased investment, driven by factors such as population growth and rapid urbanization, particularly in energy (electricity, oil, and gas), transportation (roads, ports, rail, and urban transit), and water and sanitation services. In the Asia-Pacific region, infrastructure investment varies, with Indonesia at approximately 29.0 per cent of GDP, Thailand at 21.0 per cent, Vietnam at 19.0 per cent, the Philippines at 15.0 per cent, the People's Republic of China at 8.5 per cent, and India at 4.7 per cent (Chong and Poole 2013; McKinsey Global Institute 2013; Seneviratne and Sun 2013). In developed economies, infrastructure capital stock tends to be older compared to emerging economies. Approximately half of all new investments are allocated to depreciation, nearly double the rate observed in emerging nations (Mackenzie 2013; Australian Bureau of Statistics 2014). Post-2008 market conditions have led to changes in global infrastructure finance. There have been historically high levels of project finance in 2014, increased investment indications from fund managers and sovereign wealth funds (SWFs), a revived interest in alternative financing options, and the evolution of public-private partnership (PPP) procurement models with enhanced risk-sharing and credit enhancement choices. These developments reflect a shifting landscape in infrastructure financing, influenced by various factors and a commitment to inventive approaches to tackle funding challenges. Below, the study explores some of these methods of infrastructure financing:

i. Government Provision

Traditionally, governments have played a key role as the primary source of infrastructure capital, funding projects through consolidated revenue and providing services as a public good. As a general guideline, government funding typically accounts for around 50 per cent of infrastructure investment, government business enterprises contribute approximately 30 per cent, and private investment makes up the remaining 20 per cent (although these percentages can vary across countries) (Chan et al. 2009). Government funding primarily focuses on sectors such as health, education, transportation, and utilities, reflecting the essential priorities of developing economies undergoing industrial transformation, rapid urbanization, and increasing congestion (PricewaterhouseCoopers and Oxford Economics 2014: 11). On the other hand, private investors tend to concentrate their investments in the

energy, resources, and transportation sectors, suggesting that private participation in infrastructure is driven not only by the availability of capital but also by the underlying economics of the asset class. Governments employ various approaches to finance new infrastructure projects.

a) Reordering Budget Appropriations

Governments primarily finance public infrastructure through general budget allocations, providing flexibility to adjust appropriations and estimates to address immediate investment needs (Chong and Poole 2013; Productivity Commission 2014). However, public investment is vulnerable to volatility due to factors like mid-cycle budget adjustments, reviews by parliamentary expenditure committees, fiscal deficit concerns, and changes in government. In regions with many projects managed by provincial and local agencies, this vertical fiscal imbalance can worsen instability. While accounting, reporting, and governance practices differ among countries, many governments follow 3- or 5-year plans or forward estimates for public spending. Budget allocations are typically funded through general taxation or public borrowing, both of which may involve varying levels of inefficiency. Allocations provide transparency and accountability in government fiscal management but lack market discipline in project selection and evaluation (Chan et al. 2009: 228). It's essential to note that sudden shifts in priorities can lead to investment disruptions, reducing capital productivity and efficiency (International Monetary Fund 2015).

b) By Raising Taxes

Consolidated revenue serves as the foundation for most state appropriations towards infrastructure spending, and it can be derived from various sources. These include:

(i) An economy-wide increase in direct and indirect taxes: Governments may raise taxes across the board to generate additional revenue for infrastructure investments.

(ii) The imposition of a tax or levy limited to a specific province or local government area: Governments may introduce specific taxes or levies at the regional or local level to fund infrastructure projects in those areas.

(iii) The allocation of existing taxes to specific investment objectives: Governments can dedicate existing taxes, such as fuel taxes, to fund the construction and maintenance of roads, thereby aligning tax revenues with infrastructure development goals.

(iv) The implementation of user charges: Governments may impose charges or fees on users of specific infrastructure assets or services, with the revenue generated being directed towards their maintenance, operation, or expansion.

These various funding mechanisms help governments secure the necessary financial resources to support infrastructure development and maintenance, ensuring that the costs are appropriately allocated among different stakeholders and users of the infrastructure. Taxes can have adverse effects on regional savings and growth by distorting economic choices and creating counterproductive incentives (Chan et al. 2009: 53). However, the magnitude of these consequences hinges on the tax's intended purpose and whether it targets consumption or income (Helms 1985).

c) Privatization, Initial Public Offerings, and Capital Recycling of Brownfield Assets

During the 1980s, numerous countries in the Asia-Pacific region underwent a series of privatizations. These privatizations encompassed the sale of shares in existing government business enterprises (GBEs), the divestiture of assets through trade sales, and initial public offerings (IPOs) on stock exchanges. Initially, the focus of privatization efforts was primarily on fully integrated and operational businesses (known as brownfield projects) with established trading track records, making them relatively straightforward to sell to private investors. The privatization process led to substantial changes in various sectors, including state banks, airports, insurance firms, telecommunications service providers, railways, ports, and various segments of the energy supply chain, such as generation, transmission, and distribution assets (Megginson 2005: 14-21). After the initial wave of privatizations, a second wave emerged, marked by trade sales and a limited number of initial public offerings (IPOs), especially in emerging economies experiencing industrialization. By 2001, governments globally had generated $1.5 trillion through privatizations, although the pool of readily marketable assets had begun to shrink (Megginson 2005: 21-25). Presently, a third wave of privatization, termed "asset recycling," is underway. This wave involves leasing or selling well-established income-generating infrastructure assets for the purpose of generating funds for the construction of new assets. These recycled assets encompass toll roads, airports, electricity generators, transmission companies, defence establishments, ports, and commercial property portfolios. While these assets should be financially self-sustaining, they may necessitate subsidies or ongoing support during their initial operational years. In contrast

to previous enterprise privatizations, asset recycling presents a sustainable means of raising additional investment capital (Government of Australia 2014).

d) Public Borrowings and Budget Deficits

Public debt is essential for financing investments and can be sourced through various avenues. These include general public borrowings, loans from overseas development assistance (ODA), and the issuance of various types of bonds like conventional, indexed, or tax-advantaged bonds. In some countries in the region, tax incentives are offered to local investors participating in public bond offerings, which can encourage their involvement in these investments. These various means of acquiring public debt contribute to financing investment projects and addressing infrastructure funding needs. Indeed, public debt is not without its drawbacks. It incurs deadweight costs, creates credit rationing, and can lead to the "crowding out" of private debt, which can result in higher interest rates and divert capital from potentially more profitable private investments (Regan 2009: 31-32). It is essential to carefully manage public debt to avoid these adverse effects. Furthermore, as of 2014, the average public debt in many regional countries exceeded their GDP-weighted average external debt during the period of 2007-2014 (International Monetary Fund 2014a, 2014b). This highlights the significance of monitoring and managing public debt levels to ensure sustainability and avoid potential risks to fiscal stability. Governments must strike a balance between utilizing public debt as a financing tool for investment and infrastructure development while also maintaining prudent fiscal management practices to mitigate the negative consequences associated with excessive debt burdens.

e) Tax-Exempt Bonds

Tax-exempt bonds are interest-bearing securities that governments issue to fund national interest projects or general infrastructure initiatives. These bonds are typically included in governments' capital budgets for infrastructure spending and are classified as liabilities. The issuance of tax-exempt bonds allows governments to attract investment for infrastructure projects. In the United States (US), local government bonds may be granted federal tax-exempt status, providing additional incentives for investors.

f) Revenue Bonds

In situations where fiscal constraints exist, governments have the option to issue project-specific revenue bonds as a means of financing infrastructure projects. Revenue bonds are designed to cater to investors' preferences regarding currency, maturity, and interest rate

risks. These bonds can be utilized to finance infrastructure projects managed by public or private entities. They may be issued with limited recourse, and may receive full or partial government guarantee support. Revenue bonds can be issued by government business enterprises, project special purpose vehicles, or private sponsors.

g) Government Business Enterprises

In the realm of infrastructure investment, governments have conventionally depended on government business enterprises (GBEs) to supply funding in particular sectors like energy, transportation, and water resources. GBEs are distinct legal entities with their own board of directors, and the loans they acquire are not regarded as part of the public debt of the government that possesses shares in them. This arrangement allows GBEs to operate independently and raise funds for infrastructure projects while maintaining a certain degree of financial autonomy. GBEs fund their activities through several avenues, such as retained earnings, budget allocations (usually in the form of equity or payments for community service obligations), and loans. These entities can raise funds by borrowing or issuing bonds in the capital markets, often leveraging sovereign credit ratings for their borrowing efforts. Government guarantees may be extended, either entirely or partially, for the obligations of GBEs. Moreover, Treasury Departments may secure loans or issue bonds on behalf of GBEs when it presents a more cost-effective means of obtaining funding.

ii. Bank loans and Project finance

Traditionally, governments have held responsibility for supplying approximately 70 to 80 per cent of the funding required for global infrastructure ventures. But this situation is undergoing a transformation as project finance, corporate investment, and project bonds now constitute a considerably larger share of investment (Project Finance International 2015). Infrastructure bank lending commonly adopts the project finance model, characterized by limited recourse security, extended repayment periods, heightened lender supervision, and greater leverage in contrast to conventional corporate funding alternatives. Project finance relies on projected future cash flows to meet debt repayment commitments, leading lenders to conduct extensive due diligence, employ credit assessments more extensively, and uphold financial compliance standards over the loan duration.

iii. Bond finance

Bonds are financial instruments issued by governments or corporations, creating a commitment for the issuer to make regular interest payments and repay the principal amount when the bond matures. They offer an alternative source of capital compared to intermediary credit and equity financing (Hack and Close 2013). Bonds come in various forms and are frequently employed by governments, corporations, and project sponsors to secure funding for infrastructure projects. These bonds can be tax-exempt, revenue-based, or corporate in nature. They may feature fixed or variable interest payments, and a single bond issuance can consist of various tranches with different currencies and tenures. Interest payments can be indexed or guaranteed by the issuer or a third party, such as a government or a bank. Infrastructure bonds often undergo credit rating evaluations to assess their creditworthiness and determine the associated risk level.

iv. Multilateral Development Banks

Multilateral Development Banks (MDBs), like the Asian Development Bank (ADB) and the World Bank, have a vital role in promoting infrastructure development in the Asia-Pacific area. As per Moore and Kerr (2014), in 2011, the World Bank extended $25.2 billion, and the ADB provided $7.5 billion in loans for infrastructure projects. MDBs offer a variety of services, including loans in different currencies, grants, equity investments, guarantees, technical assistance initiatives, and collaborative financing efforts with other MDBs, multilateral development bodies, as well as public and private entities. In contrast to private financial institutions, MDBs frequently offer extended loan durations, reduced interest rates, and increased adaptability when structuring debt repayment conditions (Asian Development Fund 2014). The loans and financial commitments of the ADB generally maintain an investment-grade credit evaluation (ADB 2014). The ADB employs infrastructure ventures to attain reduced costs and an investment-grade credit position by means of its Credit Guarantee and Investment Facility, which offers safeguards against defaults. MDBs extend assistance and concessional loans to less affluent and emerging nations (Chong and Poole 2013). They additionally serve as middlemen, drawing other financial organizations into deals and organizing debt syndications and sponsorships. Moreover, they oversee donor initiatives like

the Asian Development Fund and provide non-commercial risk coverage, encompassing safeguarding against sovereign, political, and currency non-convertibility risks (Moore and Kerr 2014).

v. International Development Agencies

International development organizations have a significant part in furnishing loans, subsidies, financial solutions, and professional guidance for infrastructure undertakings in the Asia-Pacific zone. These organizations, alongside Multilateral Financial Institutions (MFIs), are pivotal in closing the feasibility shortfall that frequently emerges in relation to private investment in infrastructure initiatives spanning diverse industries in emerging economies. IDA assistance for infrastructure projects takes various forms, including official development assistance that draws funding from numerous national agencies, non-governmental organizations, and international institutions (as of 2015). Development assistance is provided through loans, grants, and technical cooperation agreements, which support activities such as training, development planning, financing study teams, expert consultations, and equipment provision. As an example, in 2013, the Japan Overseas Cooperation Agency (JOCA) distributed its international development support in the shape of loan support (72 per cent), technical collaboration (17 per cent), and subsidy support (11 per cent) (Japan Overseas Cooperation Agency 2014). Loan support mainly involves extended loans for development objectives, featuring lower interest rates compared to those presented by private lenders. This support from IDAs helps address the financing needs of infrastructure projects and promotes sustainable development in the region.

vi. Pension Funds

Global pension funds, which hold an estimated $64.0 trillion in assets, play a significant role as investors (Towers Watson 2014). Within the leading 300 funds in the 2014 Global Pension Asset Study by the Organisation for Economic Co-operation and Development (OECD), these funds possessed $33.8 trillion, experiencing an annual expansion of 7.3 per cent from 2010 to 2014 (Towers Watson 2014). Superannuation funds with defined benefits offer fund managers the chance to invest in extended-term assets without the stress of meeting quarterly

market performance benchmarks and keeping higher liquidity ratios. Conversely, accumulation funds place more significance on fund managers' capacity to actively trade securities and attain competitive yield results, particularly when regulations permit members to switch their accounts between fund managers. Asset allocation practices differ significantly among fund managers, with variations observed in different countries. As an illustration, in countries like Australia, Chile, and the United Kingdom, funds generally assign 40 per cent or more of their assets to stocks, whereas the People's Republic of China, Denmark, the Netherlands, and the Republic of Korea allocate 20 per cent or less of their assets to equities (Mercer 2014). According to the OECD study, equities accounted for 41.2 per cent of assets on a weighted average basis, bonds accounted for 44.9 per cent, and cash and alternatives accounted for 13.9 per cent (OECD 2014). Pension funds engage in infrastructure investments using diverse methods, including direct and indirect equity investments, debt instruments, and dedicated infrastructure funds. As per the OECD's 2014 Annual Survey of 104 Major Pension Funds, the average allocation to infrastructure stood at about 1per cent (Inderst 2014; OECD 2014: 51). However, countries like Australia allocate around 6 per cent of funds under management to infrastructure, while Canada allocates around 5 per cent (Inderst and Della Croce 2013).

vii. Sovereign Wealth Funds

Sovereign Wealth Funds (SWFs) are specific institutions established by governments to safeguard financial stability and security, especially during global economic uncertainties. As emphasized by Clark, Dixon, and Ashby (2013: 4), SWFs function as a policy tool enabling states to diversify their investment avenues beyond conventional capital markets. These funds possess substantial capital that can be allocated to long-term investments in equity and debt within the infrastructure asset class. Infrastructure securities generally possess investment characteristics that are attractive to portfolio investors. SWFs, with their limited liabilities, have the flexibility to directly participate in the infrastructure sector. Like pension funds, infrastructure investments provide robust diversification attributes, as evidenced by research highlighting their minimal correlation with other asset classes and steady price-return performance concerning key economic factors (Peng and Newell 2007). SWFs utilize these characteristics to engage in infrastructure projects and support the sector's growth.

viii. Initial Public Offering

One approach to raise equity capital is through conducting an Initial Public Offering (IPO) or securitizing government-owned business enterprises and listing them on global securities exchanges. A similar approach has been observed in recent privately financed infrastructure projects, where securitization was employed by issuing stapled securities across multiple entities. In this process, one entity would "loan" its share of the offer proceeds to another vehicle within the group. This method was utilized for four motorways in Australia (Hills Motorway, Eastlink, Clem 7, and Airport Link) between 1997 and 2011. However, it is important to note that the overall performance of these projects was subpar, resulting in the delisting of the vehicles and the sale of assets. This highlights the limitations and challenges associated with implementing IPOs or securitization in countries with less developed capital markets, as these methods have been primarily implemented in countries with well-established capital markets.

ix. Public–Private Partnerships

Public-Private Partnerships (PPPs) encompass extended contractual arrangements between public and private organizations for the delivery and administration of infrastructure services. In this arrangement, the private firm takes on the responsibility of providing the necessary capital, constructing the infrastructure assets, and bearing a majority of the development and operational risks over the contract term. The private company generates income to secure a fair return on its investment, either through user fees or a government availability payment. Debt repayments are sustained by cash flow, and there might be limitations on equity disbursements in the project's early phases. Construction risk is typically managed with a short-term construction loan that is replaced with long-term financing upon project completion. However, financing projects solely reliant on user tariffs, which involve market risk, can present challenges. Recent research indicates that PPP projects have an increased risk of failure (Regan, Smith, and Love 2015). PPPs typically involve significant borrowing, often using bonds or project finance to secure funding. Service delivery in PPPs is governed by the PPP contract and, in some cases, an independent regulator. At the end of the contract,

ownership of the assets is transferred back to the government. In recent projects that involve availability payment transactions, lenders have insisted on core service payments to support debt servicing, and these payments are not affected by performance issues. Such negotiated terms and "take or pay" contracts effectively transfer operator performance risk to sovereign risk, resulting in significantly reduced risk for lenders. PPPs have shown lower failure rates when compared to projects financed through traditional corporate loans. Evidence from the mid-1990s onward suggests that PPPs foster innovations in design and construction, enable substantial risk transfer from governments to private entities, and provide enhanced and more sustainable services in comparison to traditional procurement methods (Infrastructure Partnerships Australia 2007).

x. Securitization

The combination and financial packaging of income flows from well-established infrastructure assets provide a funding alternative for both public entities and private financiers. Developed infrastructure assets exhibit investment qualities that render them appealing, such as restricted rivalry, controlled pricing structures, steady and frequently inflation-linked income flows, minimal variable expenditures, substantial borrowing potential for heightened equity gains, and low responsiveness to changes in demand. Incorporating infrastructure assets into blended asset collections presents a chance for broadening investments (Della Croce and Gatti 2014). The process of securitization has been utilized to fund credit-boosted bonds, which assist in backing projects related to social and economic infrastructure across diverse domains like waste management, the construction of hospitals and schools, and the operation of regulated utilities providing water, electricity, and gas services (Dexia 2007). Prominent instances of securitization encompass the release of notes linked to consumer price indices for a solar energy venture in the United Kingdom in 2012, orchestrated by the Independent Debt Capital Markets Group. Furthermore, resource sector transactions have been conducted in areas including the Russian Federation, Europe, and the Asia-Pacific region (Project Finance International 2015). These securitization endeavours play a role in broadening funding origins and rallying private investments for infrastructure expansion.

xi. Viability Gap Funding

Infrastructure projects may face challenges in attracting private investors if the generated revenue stream is insufficient to cover the required debt service. This situation can arise when user fees fail to generate sufficient revenue to cover debt commitments, when pricing is subject to discretionary state regulation or price limits, or when the risk assigned to the private entity is deemed unacceptable by lenders. To address this challenge, governments globally have adopted Viability Gap Funding (VGF) policies as a substitute for sporadic project assistance on a case-by-case basis. VGF involves financial support from the government for privately funded infrastructure projects, with the goal of improving their financial viability. It is integrated, either formally or informally, into Build-Own-Operate and Public-Private Partnership agreements. The purpose of VGF is to prevent the failure of marginally viable projects that are designated for private financing. By internalizing externalities in infrastructure markets (Irwin 2006), VGF enables governments to lower costs of projects, allow timely completion, and establish a foundation for sustainable service delivery over the long term (Regan 2009). VGF can take various forms, including upfront capital contributions, debt provisions, subsidies during the operational stage, or guarantees against specific transaction risks. The specifics of VGF are typically defined in policy documents, which might specify contribution limits, conditions for complete disbursement of private equity and debt prior to payment, and directing payments to project lenders upon project completion. The allocation of VGF is documented as a budget allocation for capital contributions or as a potential financial obligation for subsidies or guarantees. VGF plays an important role in addressing the viability challenges of infrastructure projects and ensuring their successful implementation and long-term sustainability.

xii. European Investment Bank Mezzanine Bond Finance Project

In 2010, the EIB (European Investment Bank) introduced the Mezzanine Bond Finance Pilot Project with the aim of strengthening the credit position of senior bondholders in privately financed infrastructure projects that meet the qualifying criteria. Through this initiative, the EIB offers subordinated mezzanine bonds or a guarantee, which are rated AAA by S&P (Standard & Poor's), to cover up to 20 per cent of the senior debt. This support is provided to

handle possible construction budget excesses or gaps in debt servicing capability during the initial operational phase of an infrastructure venture. The funding or guarantee can be supplied by the government or a multilateral development institution like the EIB or the European Central Bank. The introduction of the mezzanine bonds is designed to redistribute project risks and brings benefits to senior lenders by enhancing their credit risk profile, reducing the project's overall cost of capital, and allowing for higher debt-equity ratios within specified leverage limits (EIB 2012). The implementation of such programs enhances the overall financial viability and appeal of infrastructure projects, making their financing and development more feasible.

xiii. Lender of Last Resort

After the global financial crisis, lenders adopted a more cautious approach towards providing debt for syndicated projects. This cautiousness was particularly visible in large-scale PPPs in countries like Canada and Australia, leading to swift government interventions. An illustration of this is the A$3.5 billion Victorian Desalination Project, which was presented to the market in 2009 during the height of the crisis. Two consortia submitted bids but couldn't secure the entire debt needed for the project. In reaction, the government promptly revealed a winning bidder for the ultimate negotiations and consolidated the lender commitments from both consortia. This proactive response by the government ensured the successful financing of the project despite the challenges faced during the financial crisis. The government, in its role as the ultimate financial backstop, played a pivotal role in alleviating the financial risk associated with the project. It did so by offering senior debt and guaranteeing the purchase of a minimum volume of water (the plant's base load). This strategy enabled the winning bidder to obtain the entire debt needed from the market, eliminating the need for state loans. The involvement of the government as a senior debt provider instilled confidence and increased certainty for both bidders and capital markets (EIB 2012). However, it is crucial to note, when the state participates financially, it can impose limitations on project refinancing and leverage. This may lead to a higher equity or mezzanine capital component, ultimately elevating the project's cost of capital (McKenzie 2008). These considerations highlight the trade-offs associated with government involvement in infrastructure financing.

2.7. Urban Infrastructure Financing: International Practice

The link between urbanisation, infrastructure and development is inseparable. Cities impart economic dynamism in every economy (Rao and Bird 2010). Urban areas are playing an increasingly significant role in contributing to GDP. The growth and performance of cities are closely tied to the availability of urban infrastructure. However, the development of city infrastructure present significant challenges in accommodating the extent of urbanization. The problems of poverty, inequality, environmental degradation relies mostly on the urban infrastructure management and financing. It also affects the productivity of firms and accessibility of households. Financing urban infrastructure adequately and yet judiciously is the pursuit of every country. Cities face fiscal of legal restrains for investment. These restrictions take the form of poor credit rating, ceilings to guarantees by higher levels of government, off-balance sheet liability management, debt management, restrictions on revenue and expenditure allocations, etc. These challenges serve as opportunities to search for alternative revenue sources apart from leveraging public sector resources. Countries around the world have resorted to tools like value capture financing, payroll taxes, fuel taxes, congestion charging, transit oriented development, tax increment financing, land based financing and so on to generate funds and finances to develop urban infrastructure. Few urban infrastructure financing tools are described below.

A. Property-based alternatives

i. Value Capture

Globally, it is widely recognized that public transportation infrastructure has a productive impact on property and land prices. To leverage a portion or all of the increased property values resulting from infrastructure enhancements, a funding mechanism known as value capture or betterment tax is employed. The appreciation in property values is influenced by factors such as the proximity to transportation options, the modes of transportation, the quality of public service, and the availability of alternative transportation choices in the area. For example, properties located near rail lines tend to have a 20-25 per cent higher value

compared to properties farther away. Studies conducted in East Asia have shown that a 10 per cent rise in distance from a public transportation station corresponds to approximately a 1 per cent decrease in property values. There are two essential models of value capture:

- Tax Increment Financing (TIF): Under this model, an anticipated increase in value is projected within a specific region or district surrounding the development. A predetermined percentage or increment is then levied to generate funds for the infrastructure investment. The United States predominantly utilizes this approach.
- Joint Property Development: In this model, the government partners with infrastructure developers, allowing them to profit from their property development, generating funds for transportation projects or system reinvestment. Hong Kong illustrates this collaborative property development value capture approach.

Hong Kong

In contrast to many public transport systems in Western countries, the metro system in Hong Kong operates without subsidies from the government. Instead, it follows a self-funded model supported by various revenue sources. These sources include fare revenue from passengers, rental income from commercial spaces within the stations, and revenue generated from property developments associated with the metro system. This funding model in Hong Kong relies on a combination of strategies such as joint property development and value capture, as well as the promotion of transport-oriented developments. The government first introduced the metro system in 1973, with an initial cost estimate of HK$500 million. By 1982, the Hong Kong metro system had become profitable, partly due to the rise in land value along the metro route. In Hong Kong, land is state-owned, and the MTR Corporation, responsible for system operations, utilizes a "Rail+Property" strategy for financing metro investments. In the MTR Corporation's Hong Kong approach known as "joint property development," the company leases land near its rail extensions from the government. Subsequently, the corporation develops this land for various purposes, such as commercial, residential, or mixed-use. As part of the agreement, the corporation pays the government the land's value, disregarding the presence of the rail line. This enables the MTR Corporation to capture and profit from the increased land value resulting from the rail network expansion.

Downtown Kansas City

Kansas City's local government encountered difficulties in obtaining funding for a city-wide light rail network. To address this, they implemented an alternative approach: establishing a Transportation Development District (TDD) dedicated to a proposed two-mile streetcar route. This TDD was designed to encompass the area directly impacted by the streetcar project. To finance the Downtown Kansas City Streetcar's construction, the local government proposed a land value capture mechanism, often termed a "real estate tax," within the TDD's boundaries. They organized a public vote to determine its adoption. On December 12, 2012, property owners within the Transportation Development District (TDD) participated in a vote to decide on the land value capture mechanism. A majority of voters, with 319 in favor and 141 against, supported this approach. Additionally, a 1 cent sales tax within the TDD received approval. As per the Kansas City Streetcar project website, 75 per cent of the project's expenses will be covered by innovative local public and private funding. The revenue generated from the TDD's value capture and sales tax will be used to handle the streetcar project's net operating and maintenance costs. Previously, the Kansas City Government had attempted to secure funding for the project through a city-wide vote, which was unsuccessful. However, by pinpointing the specific area benefiting from the two-mile streetcar route and conducting a targeted vote within the TDD, they achieved 60 percent support for funding assistance. This successful outcome has enabled the project to proceed.

ii. Local levies

Sydney and Melbourne have implemented land value capture taxes, commonly referred to as "betterment levies," as a means of financing infrastructure projects. The Gold Coast has also adopted a similar approach by introducing a land value capture tax to support the funding of the Gold Coast Light Rail line. In 1970, the NSW State Planning Authority enacted two Acts that authorized the imposition of a 30 percent land value increment levy on land that experienced rezoning from rural to urban use within the Sydney metropolitan area. The revenue generated from this levy was specifically designated for urban works, services, sewerage projects, and metropolitan infrastructure investments to accommodate the

expansion of Sydney. By 1972/73, the betterment levy had successfully generated $9 million. However, the legislation was repealed in 1973, just before a state election, under the pretext that it was negatively impacting land prices during a time of severe housing and land shortages. In addition, there was a betterment tax imposed on landowners located north and south of Sydney Harbour to contribute to the construction of the Sydney Harbour Bridge. This tax was equivalent to 0.2 per cent of the unimproved capital value of the lands and was implemented for a period of 15 years to recognize the beneficiaries of the city and North Shore connection. Similarly, in Melbourne, a "benefited area levy" was implemented to fund the construction of the City Loop, a significant rail infrastructure project that began in 1971 and was completed over a decade. A more recent example can be seen on the Gold Coast, where the Council introduced an annual transport improvement levy of $111 to support the initial phase of the Gold Coast Rapid Transit Light Rail Line. Property owners in the vicinity believed to benefit from the construction of the light rail line are required to make contributions through this levy.

Jubilee Line Extension, London

Don Riley, a property developer based in London, authored the book "Taken for a Ride," offering a detailed examination of the £3.5 billion Jubilee Line Extension of the London Underground. This extension aimed to connect Central London with East London and is notable for being entirely funded by government general revenue, without any attempts to recoup the increased property values it generated for local property owners. Riley's book illuminates the impact of the Jubilee Line Extension on property values in the surrounding area. According to Riley's research, over a decade from 1992 to 2002, properties within a 1000-yard radius of the new underground stations witnessed a substantial estimated increase in value, totalling around £13 billion. This case serves as a prominent illustration, emphasizing the potential advantages of implementing value capture mechanisms as a means to finance significant investments in transportation infrastructure.

B. Transit-Oriented Developments

Transport-oriented developments (TODs) have gained significant popularity as mixed-use spaces that combine commercial, residential, and retail functions. These developments are strategically located either at or within walking distance of transportation hubs, serving as revenue generators to finance or support transportation investments while also stimulating urban enhancements. TODs can take various forms, including the construction of new buildings or the redevelopment of existing structures. One approach to financing transportation developments through TODs involves selling air rights above a transportation station to property developers. This allows the transport operator or authority to generate revenue while leveraging the potential of the surrounding land. Another approach is for the transport operator or authority to develop and manage the TOD themselves, ensuring ongoing funding for the transportation system. TODs have been widely implemented across Asia and have become a primary funding source for transportation infrastructure. Notably, Hong Kong's metro system has successfully utilized TODs as a sustainable funding mechanism, eliminating the need for government subsidies. In addition to their financial benefits, TODs are recognized for their ability to increase public transport ridership by providing convenient access to transportation services and creating vibrant, liveable communities.

Hong Kong

MTR Hong Kong credits its enduring success to the strategic integration of rail and property development, as highlighted on the MTR website. This unique approach enables the company to effectively fund its daily railway operations, ensure affordable fare structures, and cultivate a consistent and loyal patronage for its transportation system. In a review conducted in 2010, it was found that the addition of a transit-oriented development (TOD) to an MTR station resulted in an increase of approximately 35,000 weekday passengers. Among MTR's various TOD projects, the Tung Chung Station Development stands out. The original plan for the Tung Chung New Town Development, formulated in 2007, aimed to accommodate a population of 108,000 individuals. The success of the initial development surpassed expectations, leading to the introduction of the Tung Chung New Town Development

Extension in 2012. The Tung Chung Station Development, aimed at accommodating a larger population of 220,000 people. The development comprises three interconnected sites with elevated walkways and incorporates a mix of high-rise and low-rise buildings, offering various housing options. There are 32 high-rise residential blocks, providing different housing types and sizes to cater to diverse needs. In addition to the residential component, the Tung Chung Station Development includes approximately 56,000 square meters of dedicated retail space, featuring a prominent shopping center. It also houses a 15,000 square meter office tower, a 440-room hotel with conference facilities and restaurants, over 3,800 car parking spaces, as well as landscaped open areas, a wet market, and four kindergartens. The comprehensive design of the development aims to create a vibrant and self-contained community, providing a wide range of amenities and services to enhance the quality of life for its residents. The inclusion of housing options, retail space, office facilities, hotel accommodations, and educational facilities, along with recreational and open spaces, contributes to making it a self-sustaining and well-rounded community.

San Francisco Bay Area Rapid Transit

The San Francisco Bay Area Rapid Transit District (BART) operates a 104-mile rail system encompassing four counties, serving commuters through 43 train stations. In July 2005, BART's Board of Directors approved a Transit-Oriented Development Policy with the aim of boosting ridership, generating consistent annual revenue, reducing reliance on taxpayer subsidies, fostering community connections, and creating a more liveable environment. As a result, BART is currently actively involved in 18 transit-oriented development (TOD) projects at its stations, attracting over $2.7 billion in private investment. Additionally, the organization is in negotiations for another 7 TOD projects with an estimated value of $1.15 billion.

C. Road-User Charging

i. Congestion Charging

Also referred as congestion pricing, is a mechanism based on the "user pays" principle and is commonly employed to manage traffic demand. It involves imposing fees on road users for accessing specific roads or designated areas within a city. The primary objective of congestion charging is to alleviate road congestion and mitigate transport-related emissions by incentivizing individuals to explore alternative transportation modes. These charging systems not only help reduce traffic congestion but also generate substantial revenue, which can be reinvested to enhance public transport services and infrastructure. The primary categories of congestion charging or pricing methods are discussed below:

a) Cordon Area: This approach involves charging drivers for entering a designated zone or "cordon area." The charges can be levied per entry, a flat daily rate, or vary based on the time of travel and vehicle type. Cities like Singapore and London employ cordon-based congestion charging systems to effectively manage road congestion. Detailed case studies on these approaches are provided below.
b) Single Facility: Charges are imposed for using a specific facility, such as a particular road, lane, bridge, or tunnel. Similar to cordon area charging, the fees can be a flat daily rate, vary based on the time of travel and vehicle type, or be assessed per usage of the facility.
c) Toll Ring Road(s): Ring roads typically encircle a city, and a toll ring road approach involves charging drivers for accessing specific lanes or segments of the ring road. This can result in reduced traffic congestion and faster travel times. Alternatively, the ring road itself can act as a barrier to tolled roads entering the city. Norway extensively utilizes toll road charging, which is discussed in more detail below.
d) Distance-Based: In this method, vehicles are equipped with a distance-monitoring system, and road users are charged based on the distance they travel within the charging zone. The fees can vary depending on the vehicle type.

Singapore

In 1975, Singapore implemented the Area License System (ALS) to address road congestion in the Central Business District (CBD). At that time, the system relied heavily on manual operations due to limited technological capabilities. During the morning peak period, drivers entering the restricted zone of the CBD were required to pay $3 Singapore dollars and display a daily or monthly sticker on their windshields (vehicles with four or more occupants were exempt from charges). Evening peak charges were later introduced in 1989, and the system transitioned to a flat-rate structure for the entire day in 1994. Despite its labour-intensive nature, with approximately 150 staff stationed at 34 locations to check vehicles, the ALS system quickly resulted in a significant 45 percent reduction in road congestion and nearly doubled average road travel speeds from 11 mph to 21 mph. In 1998, the ALS was modernized and replaced with the Electronic Road Pricing (ERP) system. Singaporean cars were equipped with on-board units capable of charging variable prices based on factors such as vehicle type, travel time, and location. The implementation of ERP led to an additional 15 per cent decrease in road congestion, and by 2012, an estimated 65 per cent of Singaporean commuters were reported to be using public transport. The ERP system undergoes quarterly revisions, and only emergency vehicles are exempt from charges. It encompasses Singapore's CBD, major arterials, and expressways, generating approximately $150 million annually. These funds are utilized for the construction, maintenance, and improvement of roads and public transport infrastructure in the city-state.

Bergen and Oslo, Norway

For seven decades, Norway has employed toll road fees not only to control traffic flow but also to bankroll and accelerate infrastructure enhancements. Bergen blazed a trail by launching Norway's inaugural toll ring road in 1986, a significant milestone in the Western world. The objective of this system was to generate resources for the speedy execution of a 1983 masterplan, encompassing the expansion of additional parking areas and roads. Buses were exempt from tolls, while other vehicles entering the tolled zone between 6 am and 10 pm on weekdays incurred charges. Cars faced a 5 Norwegian Krone (NOK) fee, and trucks

were levied 10 NOK. Originally projected to raise 35 million NOK (£3.2 million), the system surpassed expectations, yielding around 70 million NOK annually for the city by 2000. Roughly 20 per cent of the funds raised covered operating expenses, 70 per cent went into road construction, and the remaining 10% was earmarked for a fund. Following Bergen's lead, Oslo has gained international acclaim for its implementation of three toll packages. The first toll ring initiative kicked off in February 1990 with a similar aim to Bergen's, generating funds for road construction and shortening the timeline from 35 to 15 years. Initially, 10 per cent of the first package's revenue was dedicated to public transport investments, later revised to 20 per cent. Though the system wasn't primarily designed for traffic management, estimates suggest that the toll road charges led approximately 10 per cent of motorists to explore alternative transportation options, reducing car usage. Oslo's second package, operational from 2001 to 2011, witnessed a shift in funding allocation, with 45 per cent of revenue channeled into public transport. Over the decade, it generated 1.85 billion euros, supporting a new metro ring, the creation of bus lanes, enhancements to the reliability, user-friendliness, and appeal of public transit networks, along with station modernization. These collective improvements, funded via Oslo's toll roads, led to a 7 per cent increase in public transit utilization and a 1.5 per cent decline in road traffic. Currently, Oslo is under its third toll package, initiated in 2008 and set to continue until 2030. This package designates 60 per cent of revenue for further enhancing public transport and promoting eco-friendly mobility options to benefit Oslo residents. Oslo's growing focus on channelling funds into public transit aligns with the global recognition of the broader advantages of efficient and sustainable public transportation systems.

London, United Kingdom

In February 2003, London grappled with severe traffic jams, with Central London's average speed crawling at just 13 km/hr. To combat this problem and enhance travel speeds, the city introduced a congestion charge in the form of a restricted zone on February 17, 2003. This system covered an 8 square mile (21 square kilometer) area within the inner ring road of London's Central Business District (CBD). It employed Automatic Number Plate Recognition cameras to record vehicles entering or exiting this zone between 7:00 AM and 6:00 PM on

weekdays. Both commercial and private vehicles paid a single fee, allowing multiple entries and exits, while exemptions and discounts applied to motorcycles, mopeds, bicycles, zone residents (who received a 90 per cent discount), and certain vehicles like those with nine or more seats or classified as Ultra-Low Emission Vehicles (including electric and plug-in hybrid cars). The initial congestion charge in 2003 was £5, later increasing to £8 in July 2005. In February 2007, the "Western Extension Zone" was added, but this extension was removed in January 2011. Presently, the charge stands at £10 if paid in advance or on the travel day, £12 if paid by midnight the day after travel, or £9 for those registered for Congestion Charging Auto Pay. The system relies on 1,360 closed-circuit cameras at 348 locations for enforcement. London introduced the congestion charge to ease CBD congestion, enhance bus services, improve road user journey times and reliability, facilitate goods and services distribution, and promote public transport usage among residents. UK law dictates that the revenue generated must be reinvested in London's transportation infrastructure. In the 2009/10 fiscal year, the congestion charge yielded a net revenue of £148 million, with a significant portion allocated to improving bus operations in Greater London. In anticipation of the congestion charge's introduction in 2003, London expanded its bus services to accommodate the anticipated shift from road to public transport. According to the sixth Annual Impact Report, the congestion charge achieved a 30% reduction in congestion compared to pre-charge levels in 2002 during its initial two years. By 2005, congestion levels had slightly risen but remained 21% lower than 2002 levels. In 2006, congestion was only 8% below 2002 levels. Presently, congestion levels are similar to those of 2002, but the London congestion charge still plays a crucial role in curbing congestion's growth and preventing it from reaching the levels it would have attained without the charge. Despite facing criticism, the congestion charging system undergoes periodic reviews and public consultations. According to the Victoria Transport Policy Institute, potential improvements include adopting distance-based charges, varying fees by time, adjusting charges based on vehicle emissions, reducing overhead costs, and further enhancing the public transit system, particularly the London Tube (underground rail network).

D. Taxes

i. Payroll tax

A payroll tax is a type of levy imposed on taxable income or wages, which employers either deduct from their employees' pay or pay on their behalf to the government. In certain regions, payroll taxes have been implemented to generate specific revenue for public transportation. Below are two notable examples of payroll taxes dedicated to transportation funding, one levied on employees and the other on employers or self-employed individuals.

France

Since 1971, French employers have been involved in financing public transportation through the implementation of the "Versement Transport" (Transport Contribution). Initially introduced in the Île-de-France region, which includes Paris, this mandatory payroll tax has expanded its coverage to include towns with a population of 10,000 or more. Employers with nine workers or greater, contribute a portion of their employees' gross earnings to the local Transport Authority. These contributions are then used to support and invest in the local transportation systems. The specific percentage paid by employers varies based on the region's size, with the Paris District having the highest rate. For towns with populations up to 100,000, there is a maximum rate of 0.9 percent, while residents in Paris face tax rates ranging from 1.4 percent to 2.6 percent. In 2008, the Versement Transport in the Paris region made up 35 percent of the funding for public transportation. Interestingly, parking tickets also contributed to 12.1 percent of the region's public transport funding during the same year.The funding generated through the Versement Transportation has a significant role in supporting the development of numerous light rail networks across France.

Portland, Oregon

The Tri-County Metropolitan Transportation District, also known as TriMet, in Portland, Oregon, obtains funding for the Portland metropolitan region through its self-employment tax. This tax is imposed on individuals who have businesses within the designated region based on postal codes outlined in the TriMet District Boundary Map. As per the 2012 Approved Budget, the self-employment tax constituted 55 percent of TriMet's operational budget, while fare revenues contributed 25 percent. To be more precise, during the 2011-12 fiscal year, this tax represented 26.79 percent or more than $232 million of TriMet's total budget of $867 million. Starting from January 1, 2013, the tax rate experienced a slight increase to 0.7137 percent, equivalent to $7.14 per $1,000.00 of net earnings.

ii. Sales tax

A sales tax is a portion that is applied to the cost of goods or services at the time of purchase. In few cases, sales tax also refers to those that are specifically implemented to garner funds for investment in transportation, like in the following examples below.

Los Angeles County

Since the 1960s, counties in California have been granted the authority to implement regional sales taxes. On November 4, 2008, Measure R was approved by Los Angeles County residents with a support rate of 62.7 per cent. This measure entailed a 0.5 cent increase in the sales tax, raising it from 8.25 per cent to 8.75 per cent for a duration of 30 years. The purpose of this tax increase was to fund infrastructure projects for public transportation and road systems. It was estimated to generate $40 billion over the course of three decades. Additionally, the allocation of funding was determined through a vote, with 40 per cent designated for specific transport projects, 25 per cent for transport operations, 20 per cent for highway projects, and 15 per cent for local jurisdictions.

iii. Fuel tax

In 1919, the State of Oregon implemented the first state-based fuel tax in the United States. Over the course of nearly a century, fuel taxes have become a significant source of funding

for transit in the US, contributing 9.2 per cent of transit funds. Canada also utilizes gas taxes to generate revenue for public transportation. In 2010, Metro Vancouver introduced a specific 15-cent per liter fuel tax designated for transit-related purposes. Likewise, during the same year, Ontario directed two cents per liter of its provincial gas tax towards the advancement of public transit. In contrast, Calgary and Edmonton allocated 5 cents from the state-based gas tax they collected in their respective cities to finance both road and transit initiatives.

United States

In 1956, the United States initiated the Highway Trust Fund to finance the interstate highway system, primarily through a national gas tax. In 1982, the Surface Transportation Assistance Act established the Mass Transit Account, allocating one cent from a five-cent per gallon gas tax increase for public transportation projects. In 1993, CPI increases to gas taxes were halted, reducing revenue for both funds. The Highway Trust Fund now fluctuates between $33 billion and $35 billion annually, while the Mass Transit Account receives around $5 billion, including interest. In 2008, a $41 billion shortfall in the Highway Trust Fund was addressed with general Treasury funds. The financial sustainability of both funds is a major concern. A 2003 report projected the Highway Trust Fund to be underfunded by 2015, with a $92 billion deficit by 2023. If CPI increases were maintained, gas taxes would now be at 29 cents per gallon for fuel and 39 cents for diesel. However, due to no adjustments since 1993, revenue is only 62 percent of its level two decades ago. A one-cent gas tax increase would generate $1.5 billion annually, but a ten-cent hike may be needed to maintain infrastructure investments or explore alternative revenue sources.

E. Superannuation funds

Private superannuation funds for infrastructure projects has been a well-established practice in Australia. Over the years, these funds have played a significant role, both directly and indirectly, in funding various infrastructure projects throughout the country. Examples of infrastructure projects that have received funding from superannuation funds include the Lane Cove Tunnel and Cross City Tunnel in NSW, Port of Brisbane, Adelaide Airport, and

Melbourne Airport. These projects have benefited from the involvement of super funds, which have provided the necessary capital for their development and operation. One notable recent example is the privatisation of Port Botany in NSW. The NSW Ports Consortium, led by Industry Funds Management, AustralianSuper, CBus, HESTA, HOSTPLUS, and Tawreed Investments Limited (a subsidiary of the Abu Dhabi Investment Authority), emerged as the successful bidder for the project. The initial estimates for the privatisation of Port Botany ranged from $3-4 billion, but the final sale price exceeded expectations, reaching $5.1 billion. This outcome reflects the strong global demand for high-quality infrastructure assets in Australia. The participation of superannuation funds in infrastructure financing demonstrates their significant role in supporting the development and expansion of critical infrastructure assets in the country. Although there has been significant growth in the super industry, with assets reaching around $1,225 billion, the investment in infrastructure projects represents only a small portion of total super funds' assets. The actual range of investment varies among super funds, with some not investing in infrastructure at all, while others allocate over ten percent of their total assets to this sector. Currently, specialist infrastructure investment managers handle approximately $48.8 billion. In order to bolster infrastructure investment, the Australian government, state governments, and the superannuation industry have expressed their shared intention to expand the involvement of superannuation funds in infrastructure projects. In 2012, the federal government introduced tax and infrastructure reforms with the aim of creating a more favorable investment climate for super funds. These reforms included measures to reduce costs and increase certainty for investors. Another initiative demonstrating the government's commitment to promoting infrastructure investment is the reform of public-private partnerships (PPPs) in Victoria. The government has implemented changes to the PPP framework with the goal of lowering bid costs, modifying finance structures, and expanding the scope of services covered. These reforms are intended to attract greater investment in PPP projects within the state. Through these collaborative efforts, the government, superannuation industry, and state governments are working together to create an environment that encourages increased participation of super funds in infrastructure development, ultimately contributing to the advancement of critical infrastructure projects in Australia. Although super funds and governments express eagerness, their participation in transport infrastructure projects remains limited, primarily because of regulatory, structural, and political obstacles. These challenges encompass the

absence of a well-defined project pipeline and government dedication, inadequately structured projects for institutional investments, intricate procurement procedures, and regulatory pressures. It is imperative to overcome these hurdles to empower super funds to make a more substantial contribution to Australia's infrastructure advancement.

F. Public-Private Partnerships (PPPs)

In Australia, there are two main types of Public-Private Partnerships (PPPs). One is government-funded PPPs, where the government provides the primary revenue stream through service payments to repay the private sector financing. The other is user-funded PPPs, where the funding primarily comes from charges paid by the infrastructure users. In recent years, there have been calls for the federal and state governments in Australia to enhance and refine the existing frameworks for PPPs. A report published by KPMG in June 2013 highlights the importance of implementing measures that reduce barriers for both domestic and international bidders and promote cost reduction in PPP projects. These recommendations aim to foster a more competitive and efficient PPP environment. The report highlights the increased costs of PPPs projects in Australia and the decreased market capacity due to the Global Financial Crisis. The barriers mentioned earlier are consistently addressed in the KPMG report. The report recommends practical actions that governments should take to reduce these barriers, including:

i. Reducing the required level of financial commitment in bids, departing from the conventional model that mandates underwritten finance commitments lasting six months or more.
ii. Promoting intense competition for debt financing, potentially holding a funding competition following the selection of a preferred bidder.
iii. Evaluating the possibility of offering capital grants or debt financing as needed.
iv. Investigating credit-guaranteed financing or counter-indemnity models to expand market capacity and lower funding expenses.
v. Expanding the Commonwealth's guarantee to encompass long-term PPP obligations of the states.

The private sector has put forth various suggestions to tackle the challenges and opportunities in infrastructure project funding and financing. These recommendations include increased

risk-sharing among participants, stronger financing structures, improved probity management, enhanced project governance frameworks, broader service scopes, and transparent disclosure of evaluation criteria weightings. In response to these challenges, financial advisory firm Pottinger has devised innovative delivery models and financial structures. These include infrastructure bond conversions, initial superannuation offerings, and credit insurance. The aim is to encourage superannuation funds to participate in infrastructure project financing. By blending a traditional government-funded "Design, Build, and Operate" construction contract with a prearranged asset sale on guaranteed terms, significant projects can secure funding through low-cost government debt during construction. This approach enables the transfer of the asset's capital cost and associated interim borrowings off the government's balance sheet upon project completion. It mirrors a typical Public-Private Partnership (PPP) while enhancing risk allocation. Under this approach, construction companies would be responsible for managing construction risks, while long-term investors would take on the ownership risks over the project's life. This framework allows project proponents to tap into a broader pool of investment capital, safeguarding long-term investors from short-term construction risks. Consequently, it facilitates the financing of more projects at lower costs compared to traditional PPPs. The construction phase would be funded by long-term investors through investments in government bonds. These bonds would later be converted into equity ownership once the construction is successfully completed. This approach ensures that the government's debt incurred for construction financing is directly tied to the asset. As a result, there is complete assurance that this debt will be eliminated upon project completion, minimizing any potential short-term implications for the state's credit ratings.

G. Initial superannuation offerings (ISOs)

By merging the features of a traditional Initial Public Offering (IPO) with a model of private ownership for infrastructure assets, institutions and governments can leverage a more accessible and cost-effective mechanism to attract long-term capital from investors. The implementation of this approach can be relatively simple. The infrastructure business that is being privatized would follow standard procedures leading up to an IPO, including thorough preparation for the sale. As needed, appropriate governance and management structures

would be established to ensure smooth operations post-privatization. Under this model, superannuation funds and other interested investors would have the opportunity to directly bid for ownership shares in the company, eliminating the need to participate in bidding consortiums. Once the Initial Superannuation Offering (ISO) is completed, the company would become a prudently leveraged, unlisted public company. Investors would have the flexibility to negotiate private transactions among themselves to increase or reduce their holdings. The ISO (Infrastructure Share Offer) structure offers a solution that combines the benefits of a public offering financing structure with the ability to address its limitations for infrastructure investors. It provides long-term investors, like superannuation funds, with the opportunity to make direct investments in infrastructure assets, ensuring sustained ownership over the long run. This approach helps avoid the additional management costs typically associated with external consortiums and mitigates uncertainties related to mark-to-market valuations. Governments also have the flexibility to retain minority holdings in assets if desired, while still maintaining high governance standards by imposing requirements similar to those imposed on listed public companies.

H. Credit insurance

After the global financial crisis (GFC), credit insurers have withdrawn from the Australian market, and their comeback in the foreseeable future is uncertain. As a result, there is a necessity for the Australian Government to step in and support the creation of a credit reinsurance provider to rectify this market failure. This approach would be akin to the creation of the Australian Reinsurance Pool Corporation, which was established to tackle a similar market failure related to terrorism risk. The proposed credit reinsurance provider would offer credit insurance on commercial terms, operating independently to help larger projects secure financing that would otherwise be difficult to obtain. Additionally, this entity would play a crucial role in providing credit enhancement to mortgage securitization vehicles. This action would enhance the competitive landscape for smaller residential mortgage lenders in Australia and promote a fairer playing field between these lenders and the nation's major banks.

2.8. Approaches to Financing Urban Infrastructure in India

The pace of Indian urbanization is notable, with an urbanization rate of 1.1 per cent, surpassing the global average rate of 0.9 percent (IOM 2015). A significant proportion, approximately one-third to half, of Indian population resides in cities (Census of India 2011). This trend towards urban area will continue to grow as India structurally changes and gets connected with global ecosystems. By 2050, there shall be an additional 900 million city dwellers which will require city capacity growth of nearly 400 per cent in the next 50 years (FICCI 2011). The number of metropolitan cities has witnessed an upward trend, increasing from only 5 in 1951 to 35 in 2001, and further expanding to 53 in 2011, with a projected growth to 68 by 2030 (Census of India 2011). Cities being the major index of economic growth, contribute 63 per cent to GDP and this shall rise to 70-75 per cent by 2031 (KPMG 2016). The growth effect of India's urbanization has to be contained, sustained and enhanced. Ensuring adequate financing for urban infrastructure is crucial for fostering inclusive growth, as a thriving urban sector has a significant positive impact on the surrounding rural areas (GoI 2011).

The urban local bodies in India face a significant financing requirement. According to the report from the HPEC (2011), one of the major challenges for Indian planners is to adequately prepare Indian cities to accommodate the increasing urbanization demands. The estimated infrastructure financing needed for a 20-year period is Rs.39.2 lakh crores, as stated in the HPEC 2011 report. Additionally, the McKinsey Report from 2010 estimates an infrastructure investment requirement of Rs.53.1 lakh crores. Furthermore, the JNNURM projects the urban infrastructure investment needs to be around Rs. 1.2 trillion over the next seven years, according to Wadadekar (2011). To the Steering Committee on Urban Development for the Eleventh Five Year Plan in India, there is a financial requirement of Rs.12,702 billion for the implementation of proposed targets in areas such as water supply, sanitation, sewerage, drainage, and solid waste management. Additionally, the Twelfth Plan aims to allocate nearly 8.26 per cent of GDP for infrastructure expansion, including transportation, energy, communication, and other sectors, with a total target of $1000 billion. Also, the World Bank has independently estimated that countries with similar levels of urbanization should invest around 4 per cent of their GDP in urban infrastructure needs

(World Bank 2019). The challenge lies in gathering such a substantial amount of funds. Historically, the government has been the primary source of infrastructure investment through budgetary expenditure. However, the current requirement is immense, prompting the government to implement various measures over the past decade to mobilize finances. According to the twelfth plan, out of the total $1000 billion, approximately 48 per cent is projected to be sourced from the private sector, mainly via PPPs. The remaining 52 per cent is expected to be financed by the government through budgetary support and debt financing. Both the government and the private sector intend to secure loans from the banking system, capital market, External Commercial Borrowings (ECBs), and other sources.

Indian municipalities are facing a significant mismatch between their financial resources and the requirements they face. In terms of fiscal autonomy and revenue-raising capacity, they are considered to be among the weakest in the world. The primary sources of internal revenue for Indian Urban Local Bodies (ULBs) are property taxes and user fees, which are highly insufficient. According to the Thirteenth Finance Commission, property tax collection constitutes only 0.16 per cent to 0.24 per cent of GDP, while revenues from user charges account for 0.13 per cent of GDP (GoI 2009). Moreover, the introduction of the GST has led to the absorption of several revenue sources of ULBs, such as Octroi, local body tax, advertisements tax, and entry tax, without providing any compensation to the ULBs. This limitation hampers the scope for capital expenditure. Historically, urban infrastructure financing heavily relied on central government funding through budgetary allocations, grants from state and central governments, and borrowings from domestic financial institutions, including national insurance companies and specialized entities such as LIC, GIC, HUDCO, IDBI, ICICI, IL&FS, and IDFC. Urban investments were also supported through ULB's internal sources, sovereign borrowings, and grants from international development institutions and agencies. Since the mid-1990s, there has been a shift towards national capital markets and equity investments as additional sources of financing for ULBs. The various sources of finances for ULBs are depicted in Table 2.5.

Table 2.5

Revenue Sources of Urban Local Bodies in India

Revenue Head/Category	Sources
Tax Revenue	Property tax,tax on transfer of property, taxes on non-motorized vehicles, advertisement tax, toll tax, professional tax, local entertainment tax, vacant land tax.
Non-Tax Revenue	Such revenue sources for ULBs (Urban Local Bodies) include license fees, gate fees, rental income from properties, income from sources other than rent, permit fees, registration fees, service charges, benefit charges, and user charges.
Transfers from State Governments	• Compulsory Shared Resources: These resources are established in accordance with the guidance of state finance commissions. They typically include a portion of the divisible pool of resources generated by individual states, as defined by state laws. • Voluntary Transfers/Grants-in-Aid: Local authorities receive these grants from State Governments. The allocation of such grants is not bound by a particular framework and relies on the policies of the present government. These grants may be extended to incentivize tax contributions or assist in sustaining services, aligning with the endeavours of the local bodies.
Borrowing	Local authorities obtain loans for capital works and other purposes from various sources, including HUDCO, LIC, state and central governments, banks, and municipal bonds.

Source: Mishra et.al (2022); Author

Despite having multiple revenue sources, municipalities in India remains relatively small in comparison with other countries. The ratio of municipal revenues to GDP is estimated to be less than 1 per cent in India, while countries like Poland, South Africa, and Brazil have ratios of 4.5 per cent, 6 per cent, and 7.4 per cent respectively (Buckley 2005; Afonso & Araujo 2006; Pierce 2016). Data from the Eleventh and Twelfth Finance Commissions indicate that this ratio stagnated at around 0.70 per cent in the 1990s, and the Thirteenth Finance

Commission estimates it to be around 0.94 per cent for 2007-08. A study by the Reserve Bank of India reveals that the total revenues of Urban Local Bodies (ULBs) in India have been growing at a slower rate compared to the combined revenues of the Central and State governments, resulting in a decline in the share of ULBs in total government revenues (Mohanty et al. 2007). Based on data from 35 metropolitan cities' Municipal Corporations for the period of 1999-2000 to 2003-2004, the study found significant under-spending by these authorities relative to normative requirements, ranging from 30.78 per cent for Pune to 94.43 per cent for Patna, with an average under-spending of 76 per cent. As per the Thirteenth Finance Commission, municipal revenues classified as 'own' revenues, primarily stemming from property taxes, constituted roughly 53 percent of the total revenues for Municipalities in India in the fiscal year 2007-08. The remainder of the revenue sources comprised grants, assignments, and transfers from State Governments (33 per cent), grants from the Central Government (5 per cent), and allocations from Finance Commissions (2 per cent). In terms of the municipal 'own' revenues as a percentage of GDP, it was a modest 0.50 per cent for the year 2007-08, in stark contrast to the Central tax-GDP ratio of 11.99 per cent and the States' tax-GDP ratio of 5.60 per cent for the same year. Municipal 'own' revenues fell short of revenue expenditure in all states except Maharashtra and Punjab. This issue was particularly acute in low-income states like Bihar, Madhya Pradesh, Odisha, and Uttar Pradesh, where municipal 'own' revenues accounted for only one-fifth of revenue expenditure. In terms of property tax, India lags behind with a property tax-GDP ratio of 0.25 per cent, which is considerably lower than the average of developing countries (0.60 per cent), transition countries (0.67 per cent), and developed countries (2.12 per cent) for the period of 2000-2009. The per capita property tax revenue for the 36 largest cities in India was Rs. 486 in 2008-09, ranging from Rs. 1334 for the Mumbai Municipal Corporation to Rs. 25 for the Patna Municipal Corporation. The share of own revenue sources in most ULBs accounted for only about 1 per cent of city income, but implementing appropriate revenue instruments could raise their own revenue sources to approximately 6-7 per cent of city income.

The city infrastructure investment requirements are huge. The two-fold challenge of ULBs are firstly cities need to find resources to meet the huge ‘backlog’ and ‘current’ needs of existing urban population. Second, they also have to generate resources to accommodate the ‘growth’ needs of urbanization. To promote urban investments and enhance the capabilities of Urban Local Bodies (ULBs), various initiatives have been undertaken. These

include the Smart City Mission, AMRUT, the JnNURM, and HRIDAY. These initiatives aim to address the inherent weaknesses of ULBs and stimulate investments in urban infrastructure.

Smart City Mission

The Indian government initiated three major initiatives in 2015, replacing the JNNURM (Jawaharlal Nehru National Urban Renewal Mission): they are the Smart Cities Mission, the Atal Mission for Rejuvenation and Urban Transformation, and the Housing for All by 2022 program. These initiatives aim to enhance the efficiency, sustainability, and fairness of the urbanization process in India. Specifically, the Smart Cities Mission concentrates on fostering economic advancement, reinforcing governance, and enhancing the delivery of services in urban regions by assisting in the creation of "smart" cities chosen through a nationwide competitive procedure. These smart cities aim to enhance civic services through the implementation of infrastructure facilities that utilize smart solutions. The mission is scheduled from 2015-16 to 2019-20. The Indian government has pledged substantial central assistance of Rs. 48,000 crores for 100 smart cities, with each city receiving Rs. 100 crores annually over a five-year period. States and Urban Local Bodies (ULBs) are anticipated to generate a matching sum, adhering to a 50:50 cost-sharing arrangement between the central and state governments. These central and state contributions will serve as initial funding to draw in local and external resources. Collectively, the 100 smart cities have proposed 5,151 projects worth Rs. 2,05,018 crores to be executed over five years from their respective selection dates. Financial innovation has been incorporated into the capital investment plans, with funding expected to come from various sources: 45 per cent from the central and state governments (Rs. 91,000 crore), 21 per cent from convergence with other programs (Rs. 42,000 crore), 21 per cent from Public-Private Partnerships (Rs. 42,000 crore), 4 per cent from loans (Rs. 10,000 crore), and 9 per cent from internal and other sources (Rs. 20,000 crore). As of November 2020, nearly 90 per cent of all approved mission projects had been tendered, and around 70 per cent of them were either completed or in advanced stages of implementation (The Smart City Mission Report 2021). The mission aims to meet its deadline by June 2024.

Swachh Bharat Mission

The Swachh Bharat Mission, also known as the Clean India Mission, was initiated by the Indian government in 2014 to eliminate open defecation and enhance solid waste management nationwide. The initial phase aimed to achieve an "open-defecation free" (ODF) India by October 2, 2019, coinciding with Mahatma Gandhi's 150th birth anniversary. It targeted the eradication of manual scavenging, sanitation awareness, and local capacity building. The project's estimated cost was Rs. 62,009 crore, with the central government committing Rs. 14,623 crore, states and ULBs contributing Rs. 4,874 crore, and the remainder from various sources, including beneficiary donations, user charges, CSR funds, and private sector participation. Urban Local Bodies (ULBs) identify beneficiaries for toilet construction, with the central government providing Rs. 4,000 for individual household toilets in urban areas. Public-Private Partnerships (PPPs) are encouraged for public toilets, which must have a minimum 5-year maintenance contract. Currently, Swachh Bharat Mission 2.0 aims to achieve garbage-free cities from 2021-22 to 2025-26.

National Heritage City Development and Augmentation Yojana (HRIDAY)

The Indian government, via the Ministry of Urban Development, introduced the HRIDAY scheme, which stands for National Heritage City Development and Augmentation Yojana. This initiative aims to comprehensively develop cities with rich cultural heritage. HRIDAY's primary objective is to conserve and rejuvenate the unique character and essence of heritage cities in India. Initially, twelve cities were chosen for development under this fully funded scheme, with a total budget of Rs. 500 crore provided by the central government. HRIDAY focuses on infrastructure projects that integrate heritage sites with the cities' overall urban infrastructure. Its implementation approach emphasizes a program-based rather than project-based approach, covering four main thematic areas: Physical Infrastructure, Institutional Infrastructure, Economic Infrastructure, and Social Infrastructure, all geared towards revitalizing the cultural essence of heritage cities. Funding for the projects can come from the government or other stakeholders, including the private sector. HRIDAY is a centrally sponsored scheme, with the Government of India providing full funding. The scheme was

active from December 2014 to March 2019, implemented in a mission mode to ensure effective execution, with a total budget of INR 500 Crore allocated.

The Jawaharlal Nehru National Urban Renewal Mission (JNNURM)

The Jawaharlal Nehru National Urban Renewal Mission (JNNURM) was initiated on December 3, 2005, as a significant nationwide effort to expedite planned development and implement reforms in 63 selected cities. Its primary goals included enhancing urban infrastructure, improving service delivery, encouraging community involvement, and ensuring accountability of urban local bodies (ULBs) and parastatal agencies to citizens. JNNURM aimed to tackle the challenges of urbanization by providing central grants to ULBs for infrastructure development and essential services for urban residents. The mission comprised four sub-Missions: Urban Infrastructure and Governance (UIG) and Basic Services to the Urban Poor (BSUP) for major cities, and Urban Infrastructure Development Scheme for Small and Medium Towns (UIDSSMT) and Integrated Housing and Slum Development Programme (IHSDP) for other cities and towns. To access central grants, ULBs had to prepare City Development Plans (CDPs) that determined the grant amount based on the city's category. JNNURM was subsequently succeeded by the Atal Mission for Rejuvenation and Urban Transformation (AMRUT).

Atal Mission for Rejuvenation and Urban Transformation (AMRUT)

To enhance the quality of life for its citizens, the Atal Mission for Rejuvenation and Urban Transformation (AMRUT) was launched on June 25, 2015, in 500 cities as the nation's first dedicated water mission. Sustainable Development Goal 6.4 seeks to enhance water-use efficiency, address water scarcity, and reduce the number of people affected by water scarcity by 2030. The total budget for AMRUT, a Centrally Sponsored Scheme (CSS), was set at Rs. 50,000 crore for a five-year period spanning from 2015-16 to 2019-20. Cities with a population of 10 lakh or more received one-third of the project cost as central assistance, while other cities received half of the project cost. The remaining funds were to be arranged by state governments and urban local bodies (ULBs), which could also include private

investments. To work towards achieving SDG 6 and extending water-related improvements to all statutory towns, the Atal Mission for Rejuvenation and Urban Transformation 2.0 (AMRUT 2.0) has been initiated. AMRUT 2.0 also aims for 100 percent coverage of sewerage and septage management in the 500 AMRUT cities. Public-Private Partnerships (PPPs) play a vital role in mission implementation, with a mandatory requirement for PPP projects in cities with populations exceeding ten lakhs. Projects focused on selling treated water to industries and other users can be carried out under PPP mode, including the Hybrid Annuity Model (HAM) or other suitable models. Viability gap funding for such projects will be provided through Central Assistance, covering 50 per cent of the viability gap up to a maximum of 30 per cent of the project cost. The remaining viability gap will be borne by the state/ULB, ensuring that the total viability gap does not exceed 60 per cent of the project cost. The total indicative outlay for AMRUT 2.0 is Rs. 2,99,000 crore, including a Central outlay of Rs. 76,760 crore for a five-year period. This outlay also includes funding of Rs. 22,000 crore (Rs. 10,000 crore as Central Assistance) for ongoing AMRUT projects until March 2023.

National Urban Transport Policy

To promote sustainable transportation modes and address mounting challenges like congestion, pollution, and declining urban mobility, the National Urban Transport Policy (NUTP) was introduced in 2006. NUTP highlights the importance of Bus Rapid Transit Systems (BRTS), Non-Motorized Transport (NMT), and other mass transit systems due to their efficiency and reduced environmental impact. In 2014, the NUTP was updated to address the deficiencies in India's urban transport services and infrastructure. It recognizes sustained urban transport investment as a driver of economic growth, prioritizing public transport like Mass Rapid Transit (MRT), para-transit, and personalized public transport. MRT, both rail and road-based, along with city buses, form the core of urban transport for efficiently moving large numbers of people. In bigger cities, para-transit modes like tempos and mini-buses complement MRT, while personalized options such as autos, taxis, and cycle rickshaws serve commuters seeking alternatives to private vehicles. The NUTP envisions a comprehensive citywide integrated multimodal public transport network, including first and

last-mile connectivity to MRT stations. The Government of India supports this through Special Purpose Vehicles (SPVs) and financial assistance in the form of equity or viability gap funding. Financing high-capacity rapid transit systems like MRTS is challenging due to their significant long-term infrastructure investment requirements. The NUTP underscores the necessity for innovative financing mechanisms, such as leveraging land as an asset, implementing levies/taxes, and establishing dedicated transport funds at the central and state levels. Several government initiatives, including the Cabinet Committee on Investment (CCI), the India Infrastructure Finance Company Limited (IIFCL), infrastructure debt funds (IDFs), tax-free bonds for infrastructure, and municipal borrowing, aim to encourage infrastructure financing. Public-Private Partnerships (PPPs) are also promoted, with the Viability Gap Funding (VGF) Scheme and the India Infrastructure Project Development Fund (IIPDF) facilitating private sector involvement in infrastructure projects.

A combination of tax and non-tax incentives has been implemented to attract investments in the urban infrastructure and housing sectors. Incentives include reducing the minimum built-up area and capital requirements for foreign direct investment (FDI) in Smart Cities, exempting certain low-cost affordable housing projects from minimum requirements, and providing tax incentives for urban infrastructure development. Apart from Government and Corporate finance various other sources of financing have gradually evolved and described below.

I. Debt Finance

Debt to finance infrastructure investment is the most commonly used source of finance. The capacity to take on debt is influenced by three main factors: pressures related to expenditures, the availability of resources, and the willingness of voters to support debt. (Lee et al. 2021). Debt can be in the form of loans, debentures or export credit.

Debt instruments:

i. Government, municipal, and other sub-sovereign bonds.

Infrastructure financing often involves the issuance of bonds by public entities in the capital markets as a means to raise funds for the construction and operation of infrastructure assets. These bonds are usually sponsored by diverse entities, which may encompass federal governments, local governments, sub-sovereign entities like government agencies, and multi-

lateral development banks. They derive advantages from the implied support of the sovereign entity. Government financing has traditionally been a pivotal source for funding infrastructure projects, acknowledging the inherent connection between infrastructure services and funding channels. Among the various bond types utilized for infrastructure funding, "revenue bonds" are frequently employed. These bonds are explicitly linked to a specific infrastructure project and are deemed market-oriented instruments for infrastructure financing. Unlike general government bonds, revenue bonds are not intended to contribute to public deficits. Instead, they are issued by the sponsoring entity and marketed to investors through the fixed income markets. Revenue bonds typically come with extended maturity periods and can offer either fixed or variable coupon rates, and occasionally, zero coupon rates. They undergo assessments by prominent rating agencies to offer investors an evaluation of their creditworthiness. Although the majority of revenue bonds are publicly traded securities, some might exhibit limited liquidity, often because of factors like their small sizes of issue and not so frequent trading. Furthermore, specific quasi-sovereign bonds may also be classified as revenue bonds if the funds raised through the bond issuance are allocated to finance infrastructural projects.

ii. Debt instruments: Syndicated loans and bank loans

Syndicated loans, vital for infrastructure finance, often start with commercial or development banks. These loans can be sold directly to investors in the syndicated loan market, or major institutional investors can join through co-investments. They offer flexibility through corporate or project finance structures. In the infrastructure finance banking model, banks underwrite and retain loans for projects, managing them until maturity. Yet, a more common approach involves initiating loans by a lead bank or bank consortium, which then distributes them among various financial institutions and investors. In a club deal, multiple banks collaborate to structure the loan. Syndicated loans may be underwritten with the aim of selling portions in the syndicated loan market. These loans can be requested by a project's Special Purpose Vehicle (SPV) or a corporate entity, representing traditional balance sheet financing. Bank loans in project finance are typically low-risk, being senior debt instruments, often backed by collateral. The loan amount depends on the asset's liquidation value and its cash flow potential for debt repayment. Unlike generic credit risk, like unsecured corporate bonds, non-recourse asset-based loans rely on the asset's performance to repay the debt, not solely on the debtor's overall ability to meet payment obligations. While loan repayment isn't

directly linked to the project's success during operation, lenders are crucial in the restructuring process during defaults.

iii. Debt instruments: Corporate bonds

Corporate bonds, commonly used securities, offer financing for corporate balance sheets. They can be issued in public markets or privately placed. Infrastructure companies and utilities in the public domain are major issuers of corporate bonds in the infrastructure sector. These bonds are governed by bond indentures, which outline contractual obligations. Unlike project bonds tied to specific project risks, corporate bonds carry the risk of the issuing corporation. Thus, corporate bond creditworthiness relies on the issuer's general ability to meet debt obligations, making them generally less risky than project bonds. Corporate capital structures can be intricate, with multiple debt issues of varying seniority. Corporate bond issuance is linked to the overall financing strategy of the corporation's balance sheet. In infrastructure, many large firms use corporate bonds as part of their financing mix. Bond trading mainly occurs over-the-counter, with major investment banks as dealers and market makers.

iv. Debt instruments: Project bonds

Project bonds are standardized securities used to finance individual infrastructure projects, operating independently and with potential issuance in public markets or through private placements. These bonds are a valuable option for mature projects with long-term debt needs in project finance. Unlike corporate bonds that carry credit risks related to a diverse asset portfolio, project bonds are tailored to fund a single project, concentrating risk on that project, making them inherently riskier. Typically issued by a project's special purpose vehicle (SPV), a legally separate entity established during the project finance process, these bonds are then sold to banks or other bond investors. Project bond creditworthiness often hinges on the project vehicle's cash flow, earning them the nickname "straight bonds." Alternatively, credit enhancement mechanisms can secure project bonds. These bonds are mainly used during the operational phase of an asset, when construction risks have diminished, and the asset generates stable cash flow, supporting bond repayment.

v. Debt instruments: Green bonds

Green bonds encompass diverse bond types, including corporate, project, and sub-sovereign bonds, serving as funding for green infrastructure, particularly clean energy projects. Entities like development banks, governments, corporations, municipalities, banks (covered bonds),

or special purpose vehicles (SPVs) engaged in project finance and asset-backed instruments can issue them. Green bonds overlap with other categories like loans, project bonds, securitizations, and revenue bonds but are highlighted for their relevance in financing clean energy and addressing climate change. Financially, green bonds resemble project bonds or debt instruments, employing similar mechanisms and structures. They stand out due to their appeal to environmentally conscious investors, with frameworks and certifications verifying their green credentials, ensuring transparency and alignment with sustainability goals.

vi. Debt instruments: Sukuk and Sharia compliant finance

Sukuk, complying with Sharia law, offer unique investments structured to distribute income, capital gains/losses, or rents to investors periodically. Governments, multilateral development banks (MDBs), and private entities, including corporations, issue sukuk using various structures like project finance, asset-backed arrangements, and rent/income pass-through structures. Sukuk are suitable for infrastructure assets due to their asset-backed nature, sharing risk and return among parties. Cash flows rely on the asset's income, and investor returns are tied to its performance, similar to Public-Private Partnerships (PPPs). The Islamic Development Bank (IDB) actively promotes sukuk, issuing them and supporting infrastructure projects aligned with Islamic finance principles. IDB's efforts have expanded the global sukuk market, offering alternative financing for infrastructure development and investment.

vii. Debt instruments: Securitisation and asset-backed securities

Asset-backed securities (ABS) are bonds supported by infrastructure loans, sold directly to investors in capital markets. ABS is structured into tranches, representing varying credit and prepayment risks. Securitization involves bundling and selling contractual debt, like loans, to investors. In ABS, a bank transfers similar infrastructure loans to a Special Purpose Vehicle (SPV), a separate entity. The SPV issues notes to buy the loan pool from the bank, which are rated and sold to capital market investors. This process provides liquidity, earns originator fees for the bank, and converts long-term loans into cash, boosting lending capacity. Securitization turns illiquid infrastructure loans into tradable securities, attracting diverse investors and offering risk-diversification benefits based on asset fundamentals. Additionally, securitization provides investors with access to asset classes they may not directly invest in. It promotes market liquidity and allows for efficient allocation of capital in the infrastructure sector.

viii. Debt instruments: Debt funds

Debt funds are investment pools where limited partners contribute capital, which is then managed by a general partner or asset manager to invest in infrastructure debt instruments. These funds typically focus on private market loans, although they may also invest in bonds. Through debt funds and direct lending arrangements, institutional investors have the opportunity to bypass traditional banks and provide direct financing to infrastructure projects or companies. The debt fund model is an innovative capital market solution that serves as an emerging source of non-bank capital for infrastructure investments, carrying implications for policy and regulation. In this model, institutional investors contribute funds to a collective pool, managed by an asset manager who acts as a delegated agent for the investors. The asset manager takes charge of selecting, screening, and monitoring investments within the fund, which may involve participating in bank syndications, club deals, or directly lending to infrastructure projects. The debt fund model provides institutional investors with a structured framework to deploy their capital in the infrastructure debt market. It offers the potential for attractive risk-adjusted returns, diversification, and access to a broad range of infrastructure debt opportunities. It also allows investors to benefit from the expertise and network of the asset manager in sourcing and managing infrastructure debt investments.

ix. Debt instruments: Direct lending and co-investment platforms

The direct and co-investment model allows large, experienced investors to lend directly to infrastructure projects and companies, bypassing traditional capital markets. In this approach, an institutional investor makes direct investments in infrastructure loans, either through their in-house team or another institutional investor. The lead underwriter, often the investor themselves (like a pension fund or insurance company), organizes a syndicate and keeps a predetermined portion of each loan in their portfolio. The rest of the loan is sold to other investors. While banks may still be involved, the key difference is that the lead investor takes the lead role in due diligence and loan procurement. These loans can be for both new and existing projects and share characteristics with previously described debt instruments. This co-investment model allows institutional investors to build an infrastructure loan portfolio and rely on the original originator for loan servicing. It's akin to the syndicated loan market but involves institutional investors more directly, cutting out intermediaries like investment managers or banks. This approach offers investors more control, visibility, and tailored investment strategies for their infrastructure loans.

II. Equity Finance

Equity finance primarily takes two forms: public equity and private equity. Public equity refers to assets, funds, or companies listed and traded on stock exchanges, while private equity involves capital investments in unlisted companies. Public equity primarily deals with entities that are publicly traded, whereas private equity investors provide funding to companies that are not listed on stock exchanges. Additionally, public equity investors typically do not engage in the day-to-day management of the company and often hold minority stakes. On the other hand, private equity financiers can play a more active role, collaborating with or supporting the owners or managers in the growth and administration of the asset. The various types of equity instruments are described below:

i. Equity Instruments: Listed infrastructure funds

Infrastructure funds listed on public markets raise capital by issuing shares, which can be similar to an IPO or through investor contributions (open-ended funds). Fund managers oversee asset selection and daily operations. These funds enable retail investors to directly invest in infrastructure assets without the need for a corporate structure. Investors buy units representing indirect ownership of these assets. Listed infrastructure funds can be structured as closed-ended or open-ended vehicles or investment trusts. While they resemble traditional equities in terms of trading on public exchanges, the capital is invested in diversified infrastructure assets or sector-specific funds as per the fund's strategy. This makes them direct infrastructure investments managed by fund managers, offering easy access to retail and institutional investors for diversification and professional management.

ii. Equity Instruments: Yieldcos

Yieldcos are unique entities that create subsidiaries to house power projects with long-term power purchase agreements. These subsidiary shares are listed on stock exchanges through an IPO, with the parent company retaining an equity stake. Utilities often use yieldcos to separate and spin-off their power projects. For investors, yieldcos offer the potential for stable returns due to long-term contracts, making them associated with consistent income and dividends. Yieldcos provide a specialized equity investment option that diversifies portfolios for both institutional and retail investors. The rise of yieldcos is a significant trend in renewable energy finance, attracting various investors due to reliable cash flows and a stable income stream. This stable income stream allows yieldcos to distribute dividends to their

shareholders, making them an attractive investment for those seeking consistent returns. Yieldcos also offer the opportunity to invest in renewable energy projects, aligning with the growing focus on sustainability and clean energy. The listing of yieldco subsidiaries on stock exchanges provides investors with a liquid market to buy and sell shares, enhancing the liquidity and tradability of these investments. Overall, yieldcos provide a unique investment option in the renewable energy sector, offering investors the potential for steady income, diversification, and exposure to the growing clean energy market.

iii. Equity instruments: MLPs, REITs and IITs

Instruments within infrastructure finance employ specific legal structures to offer tax advantages and profits to investors, distinguishing them from traditional corporate setups. These instruments are traded as units in public markets. One example is Master Limited Partnerships (MLPs), which combine the tax benefits of limited partnerships with stock exchange listing advantages. MLPs structure as partnerships to avoid corporate taxes, thus eliminating double taxation for taxable investors. MLPs often yield higher dividends than common shares. Real Estate Investment Trusts (REITs) and Infrastructure Investment Trusts (IITs) also play roles in infrastructure finance. REITs are trusts that invest in properties, with shares listed on exchanges. Trust managers handle asset operations and management. Some infrastructure segments qualify as real estate assets under REIT rules, including railroads, pipelines, and storage facilities. In India, there are Infrastructure Investment Trusts (IITs) tailored for infrastructure finance, listed on the stock market, and sharing similarities with REITs but with variations in tax treatment and rules. These instruments offer tax benefits and investment opportunities in infrastructure assets, providing potential for stable income and attractive returns.

iv. Equity instruments: Unlisted direct equity investment and co-investment platforms

Direct equity investment in infrastructure involves making investments directly in independent and unlisted infrastructure assets. This approach is often associated with project finance and is pursued by sophisticated and large-scale investors who actively seek out opportunities, conduct thorough due diligence, select specific assets, and manage them over the long term. In recent years, there has been dissatisfaction among institutional investors with the infrastructure fund models offered by financial intermediaries, mainly due to the significant fees involved. In response to this, co-investment platforms have emerged as an alternative. These platforms aim to bypass the fees associated with investing through unlisted

equity funds by pooling the financial and internal resources of major pension funds and sovereign wealth funds. This allows them to engage in joint investments in infrastructure projects, directly investing in assets and managing them independently. Collaborative initiatives have also been undertaken, such as partnerships between pension funds from different countries. For example, Canadian and Australian pension funds have formed partnerships to leverage each other's expertise on a deal-by-deal basis. This allows them to share resources, knowledge, and experience in infrastructure investment, enhancing their capabilities and increasing their investment opportunities. Overall, direct equity investment and co-investment platforms provide investors with more control and potentially lower fees when investing in infrastructure assets. These approaches allow institutional investors to actively manage their infrastructure investments and leverage their expertise to maximize returns.

v. Equity instruments: Unlisted infrastructure equity funds

Unlisted infrastructure equity funds provide institutional investors with a platform to directly invest in infrastructure assets, particularly those involving project finance. These funds offer diversification benefits by providing exposure to a variety of infrastructure projects across different sectors and geographic locations. They also provide opportunities for smaller investors to participate in infrastructure development by pooling their capital with other investors. Institutional investors typically participate in unlisted infrastructure equity funds as limited partners (LPs). As LPs, they contribute capital to the fund and have limited liability. The overall management and administration of the fund are handled by the general partner (GP), which is usually an investment bank or investment management firm. The GP is responsible for deploying the capital commitments received from the LPs into various infrastructure assets. The GP plays a crucial role in managing the fund's operations. This includes sourcing investment opportunities, conducting thorough due diligence on potential projects, negotiating terms and agreements, and monitoring the ongoing performance of the assets within the fund's portfolio. The GP's expertise and experience in infrastructure investments are key factors in ensuring the success of the fund and maximizing returns for the LPs. Unlisted infrastructure equity funds provide institutional investors with access to a professionally managed portfolio of infrastructure assets, allowing them to benefit from the potential long-term income and capital appreciation associated with infrastructure investments.

III. Hybrid Finance

Hybrid instruments are financial instruments that combine characteristics of both debt and equity. In corporate finance, notable examples of these instruments include convertible bonds, subordinated debt, and preferred stock. These instruments serve a dual purpose of providing credit support to senior debt instruments while also offering the potential for higher returns. Hybrid instruments are important to recognize as a distinct category in finance because, although they primarily function as debt instruments, they incorporate features that resemble both equity and debt. They possess loss-absorbing capacities that provide credit support to senior debt, making them attractive to investors seeking additional security. At the same time, they offer the potential for higher returns due to their exposure to credit or equity risks. Subordinated loans and bonds are a significant subset within the category of hybrid instruments. They find applications in both corporate finance structures and project finance contexts. These instruments are structured to rank lower in priority of repayment compared to senior debt, hence the term "subordinated." This subordination allows them to provide additional credit support to senior debt while also potentially offering investors higher yields.The unique characteristics of hybrid instruments make them an important tool in corporate finance and project finance. They provide flexibility in structuring financing arrangements and offer investors the opportunity to balance risk and return according to their investment preferences.

i. Hybrid instruments: Mezzanine and subordinated debt

Mezzanine debt is a subordinate loan or bond commonly used in project finance or private equity, often with equity involvement. It can be in the form of interest-bearing instruments sharing in project value growth or interest-only instruments. Infrastructure projects often struggle to raise equity capital due to higher costs and risks, especially in regulated or tech-driven sectors. Equity sponsors may prefer financing through mezzanine debt to avoid diluting their asset exposure. Public entities like Multilateral Development Banks (MDBs) can introduce subordinated debt or mezzanine tranches to reduce required equity and provide internal credit support. Mezzanine debt is becoming popular among institutional investors like pension funds and insurance companies. General partners raise funds from limited partners and invest in subordinated or mezzanine debt instruments, facilitating bridge financing between commercial lenders and equity investors. It offers a risk/return profile

between equity and senior debt, suitable when issuing higher-quality debt is limited or equity holders aim to minimize dilution. Mezzanine finance provides attractive yields on shorter to medium-term issuances, appealing to institutional investors in private-equity-like structures.

ii. Hybrid Instruments: Convertible bonds and preferred equity

Convertible bonds and preferred equity are subordinate classes of debt used in corporate capital structures to enhance credit or access specific capital market segments. Infrastructure firms may issue these based on their financial strategies. Convertible bonds are junior bonds with embedded call options on shares, offering cost-effective borrowing for issuers. Investors accept lower coupon rates in exchange for potential share price appreciation. Convertible bonds combine bond-like downside protection with equity-like growth potential through conversion into common shares. Preferred equity is debt-like, prioritized over common shares but subordinate to other debts. It has no fixed maturity and can be perpetual. In infrastructure finance, convertible bonds and preferred equity are part of corporate balance sheets, not project finance. They belong to the global fixed income opportunity set in corporate finance. If sufficiently large and meeting specific criteria, they can be included in broader fixed income indexes. Convertible bonds exhibit characteristics of both equity and fixed income investments, providing potential capital appreciation and bond-like downside protection. Preferred equity offers fixed dividends and priority in liquidation but lacks the same capital appreciation potential as convertible bonds.

IV. Bank Guarantees/Letters of Credit/Performance Guarantees

Bank guarantees play a crucial role in project financing by providing parties with prompt payment access without tying up cash. They come in two types: "on demand," which is payable immediately, and those paid upon proven default through legal processes. When a bank issues a guarantee, letter of credit, or performance bond, they specify the amount and require a counter indemnity from the customer. This counter indemnity can be secured against fixed or floating charges or cash deposits. The bank can convert these payments into loans or demand immediate repayment if needed. Inter-creditor agreements are often used to ensure fair sharing of project asset rights and protect all parties' interests. These agreements outline the respective rights and priorities of different creditors and help establish a clear framework for the resolution of any potential conflicts or disputes. Bank guarantees provide a

level of security and assurance to project stakeholders, as they ensure that payments will be made promptly and reliably in accordance with the agreed terms. They help mitigate risks associated with non-payment or default and contribute to the smooth execution and completion of infrastructure projects.

V. Bond/Capital Markets Financing

Bond financing is a method that allows borrowers to access debt capital directly from individuals and institutions, bypassing the need for commercial lenders as intermediaries. In this process, the borrower (also known as the issuer) sells bonds to investors, while a lead manager assists in marketing and facilitating the bond issuance. To safeguard the rights of investors, a trustee is appointed to act on their behalf, ensuring that the terms and conditions of the bond are upheld and preventing individual investors from independently declaring a default. Rating agencies play a crucial role in bond financing by assessing the risk of the project and assigning a credit rating to the bonds. The credit rating provides an indication of the investment's attractiveness and helps determine the appropriate price for potential bond purchasers. Bonds with higher credit ratings typically offer lower borrowing costs, as they are considered less risky investments. Bond financing offers several advantages to projects. Firstly, it often provides access to lower interest rates compared to other forms of financing. Secondly, bonds can have longer maturity periods, which can be beneficial for projects with longer durations. Lastly, bonds can enhance liquidity by creating a secondary market where investors can buy and sell bonds, providing an additional avenue for investors to manage their investments. While bond financing is less commonly used for initial project financing due to the associated risks, it is frequently employed for refinancing once the construction risks have been mitigated. Refinancing through bond issuance allows projects to take advantage of improved creditworthiness, potentially securing lower interest rates and longer repayment periods. Overall, bond financing offers flexibility and can be an attractive option for infrastructure projects, providing access to capital from a diverse pool of investors and offering potential cost savings and longer-term financing options.

VI. Market vehicles

Market vehicles are crucial for pooling capital in infrastructure finance, allowing diversified portfolios of various securities, loans, or private investments. These options cater to both retail and institutional investors, providing access to different infrastructure assets. Public market funds, like mutual funds, index funds, exchange-traded funds (ETFs), and open-ended funds, are popular among a wide range of investors. They offer daily liquidity, regulatory oversight, and, in the case of ETFs and open-ended funds, stock exchange trading. Through these vehicles, investors can access infrastructure securities such as bonds and corporate shares, benefiting from diversification and transparency. Private market funds, often called general partnerships (GPs), mainly serve institutional investors. Investors join as limited partners (LPs) and access diverse infrastructure investments, including unlisted equity or private debt. Private market funds are especially appealing to smaller pension funds or insurance companies that may lack the expertise or resources to manage infrastructure assets directly. These funds offer institutional investors the opportunity to gain exposure to infrastructure assets through professionally managed portfolios. Both public and private market funds serve important roles in infrastructure finance, providing investors with options to participate in the infrastructure sector based on their preferences, risk appetite, and investment capabilities. Public market funds offer easy access, liquidity, and transparency, while private market funds provide access to a broader range of infrastructure investment opportunities and the expertise of professional fund managers.

2.9. Lessons from Indian Practice

As per a joint study carried out in 2009 by the Asian Development Bank (ADB) and the Asian Development Bank Institute (ADBI), discrepancies in infrastructural development result in approximately one-third of the total variations in per worker output between Latin America and East Asia. Additionally, infrastructure development has been linked to several favourable outcomes, including enhanced incomes for impoverished individuals, decreased infant mortality rates, improved school attendance, and extended learning hours (JBIC Today 2005). Infrastructure financing poses distinct challenges compared to other types of assets

due to the intricate nature of infrastructure projects. These projects involve multiple stakeholders and necessitate comprehensive legal arrangements to manage risks and cost-sharing. The extended duration of many infrastructure projects, coupled with the potential for substantial profits, renders the initial investments risky and prone to attrition. Moreover, quantifying the externalities or spillover effects that infrastructure projects have on other sectors of the economy within a short timeframe is often challenging. The substantial costs associated with such projects further discourage potential investors (Ehlers 2014). Furthermore, the lack of well-planned and feasible projects, commonly referred to as "bankable" projects, has further hindered infrastructure investment (World Bank 2014). Consequently, the public sector has assumed an increasingly prominent role in providing public goods and addressing market failures in the infrastructure sector.

Although it is not realistic to rely solely on public resources to bridge the infrastructure financing gaps, public sector spending remains crucial, especially in emerging economies. This is necessary to cater the maintenance needs of existing infrastructure and to fulfil the growing investment requirements necessary for sustaining economic growth. At the same time, more and more innovative tools should be explored for financing and funding of urban infrastructure. The common criteria that the innovative tools to finance urban infrastructure must adhere to are:

i. The tool must be Consumer Price Index (CPI) increasing. In other words, the revenue must rise with CPI for the funds to be sufficient.
ii. Revenue generating mechanism must ensure hypothecation. A specific revenue tool must dedicate funds, providing a scope for long-term planning and certainty.

The main approaches to infrastructure finance are three-folds. The first method involves government finance via direct fiscal support, which can be through capital expenditures or through contingent liabilities. Certain nations also investigate alternative approaches, such as the issuance of bonds, to supplement governmental financial resources. Entities like the Japan Finance Corporation, Japan Bank for International Cooperation, Korea Finance Corporation, and Industrial Bank of Korea have traditionally secured significant public funding for infrastructure advancement by means of issuing bonds. Bond financing tackles the issue of the "double mismatch" by substituting short-term infrastructure funding acquired via bank loans with extended-term commitments and effectively handling currency exchange disparities between local currency project earnings and foreign currency debt repayments

(Mieno et al. 2009). However, despite the need for diverse sources of infrastructure financing, there are several obstacles that hinder the development of bond markets in Asia. A hurdle arises from the hesitancy of domestic investors to back initiatives rated below A or AA. Attaining the requisite ratings frequently demands more substantial equity injections or credit improvements than investors are prepared to provide. Consequently, borrowers turn to banks for assistance, incurring elevated expenses to mitigate project vulnerabilities. To address this problem, economies should consider implementing regulations on minimum investments. Nevertheless, setting lower ratings can hinder financial creativity and the expansion of lucrative markets in emerging economies. Promoting domestic institutional investors to establish modest allocations for high-yield or infrastructure-linked funding can stimulate a need for these securities. For example, in Malaysia, the development of bond markets in the early 1990s was aided by provident and government pension funds. The introduction of high-yield or infrastructure bonds can additionally generate interest in lower-rated projects, enabling the sale of high-risk, high-reward bonds to investors who are inclined towards risk-taking (ADB 2015).

Private investment offers an alternative pathway for infrastructure funding and manifests in diverse formats, including equity investments, loans from commercial banks, project-based financing, bonds, and investment funds (Hansakul and Levinger 2016). Concessional bank loans continue to serve as a vital source of public funding in developing nations by providing extended-term financial support at interest rates below the prevailing market rates. Such loans are frequently accompanied by technical support to guarantee the successful execution of projects. Additionally, government bodies might offer corresponding guarantees for loans or equity investments to diminish risks for private collaborators. Bank loans provide greater adaptability than bonds in responding to unanticipated project construction delays, given that banks undertake more significant risks during the initial construction phase, which gradually diminishes as projects become less precarious. In contrast, bonds remain static, making it challenging to restructure debt during the construction stage (ADB 2015). Private investment in infrastructure, including syndicated loans extended by one or more financial institutions, has exhibited consistent expansion in emerging Asian nations (excluding China) over the past half-decade. This growth trajectory followed a minor dip during the economic downturn of 2008-2010. Nonetheless, project financing through loans lacks the assurance of credit guarantees from the public sector to

protect against defaults. A method to alleviate these risks involves the creation of a mezzanine credit foundation in collaboration with development banks. Mezzanine creditors would occupy a subordinate position among creditors, enabling their debt to be converted into equity in the event of project failure or the inability to make debt payments to senior creditors. In exchange, mezzanine creditors would receive elevated interest rates (Ehlers 2014).

In the last twenty years, public-private partnerships (PPPs) have garnered favour as a substantial means of infrastructure funding in numerous developing nations, especially in South Asia. PPPs have played a substantial role in advancing infrastructure in countries like Brazil, India, Mexico, and Indonesia. To illustrate, the adoption of PPPs in Indonesia holds the promise of generating $180 billion within the coming decade, which could help alleviate the country's fiscal shortfall (Lin 2014). Nonetheless, the effectiveness of PPPs in emerging Asian nations faces several impediments. A key hurdle is the absence of transparency in the selection and ranking of PPP projects, eroding trust among potential private investors. PPPs demand more meticulous examination, coordination, and risk distribution in comparison to public initiatives, rendering them less appealing than public budgets and international grants. Moreover, the formulation of PPP contracts with private investors often lacks the requisite proficiency in financial analysis and project structuring, leading to deficient feasibility reports that private financiers frequently reject. In certain instances, projects are eventually transformed into government undertakings due to a lack of interest from private investors (Lin 2014). Multilateral financial institutions and international funding organizations play a crucial role in co-financing infrastructure endeavours within developing Asian nations. In the past 15 years, the support from multilateral development banks (MDBs) to these countries has seen a significant uptick, encompassing both concessional and non-concessional loans, grants, and equity investments. Furthermore, MDBs offer technical assistance, policy guidance, capacity development, resource mobilization, and risk-sharing evaluations. As per research conducted by the World Bank, for every dollar invested in the private sector, MDBs have the potential to attract an additional $2-$5 of private investment. The assistance rendered by MDBs holds paramount importance in bolstering public infrastructure projects. As an example, the Asian Development Bank (ADB) has played a pivotal role in aiding the Philippine government in the effective execution of PPP projects spanning various sectors. The number of PPP projects in the country surged from 11 in 2010 to 61 in 2015, with nine of

them valued at over $3 billion. ADB is also engaged in collaborative efforts with the governments of India and the Philippines, in addition to partnering with the Economist Intelligence Unit, to amass data regarding public infrastructure initiatives in Asia and the Pacific. This partnership aims to benchmark these projects against more mature PPP nations like Australia and the United Kingdom, with a focus on pinpointing particular challenges faced by developing nations. The financial and capacity-building support offered by MDBs to developing nations continues to be indispensable for the progression of infrastructural projects (Abon and Chiplunkar 2013).

2.10. Developing Urban Infrastructure Financing Strategy in India

It is widely acknowledged that financing infrastructure projects presents several unique challenges. Firstly, many infrastructure projects, such as power plants and bridges, require long-term financing due to their lengthy gestation periods. However, banks primarily rely on short-term funding sources like deposits, leading to a mismatch between the durations of funds available and project requirements. Secondly, particular infrastructure initiatives face feasibility challenges, particularly in situations like road construction, where the expense of securing funds from financial institutions is elevated in comparison to the revenue generated through tolls or alternative income streams. Additionally, the operational costs associated with such projects can be significant, leading banks to hesitate or refrain from providing financing for them. Thirdly, infrastructure projects typically involve significant financial outlays, often amounting to billions of rupees. However, due to sectoral financing limits, banks may only offer partial funding for these projects, leading to the formation of consortia where each bank finances a portion of the project costs. This can result in delays in decision-making and give rise to challenges related to guarantees, interest rates, and recovery arrangements. Furthermore, investment determinations are often made by higher levels of government or state utility boards, leaving Urban Local Bodies (ULBs) without control over these decisions. Nevertheless, ULBs remain responsible for debt servicing, as well as the operationalization and maintenance of urban facilities.

The decentralization of ULBs following the 74th Amendment is changing the scenario of municipalities in India. In the last twenty years, municipal funding in India has witnessed

substantial transformation, moving away from depending on subsidies and favourable loans for infrastructure expansion towards a growing adoption of "creative and market-driven methods" aimed at drawing private investments for municipal entities. The creation of the municipal bond market has enabled Indian urban centres such as Bangalore and Ahmedabad to tap into private corporate resources for funding public amenities. There is a growing trend seen in other cities as well. Ahmedabad is the first city in India to issue municipal bonds in 1998 raising Rs.100 crores. Pune Municipal Corporation (PMC) raised Rs.200 crores in 2017 by issuing bonds for infrastructure investment. Similarly, Greater Hyderabad Municipal Corporation (GHMC) also raised Rs.200 crores, for financing infrastructure, through bond market in 2018. Amravati Bonds raised Rs.2000 crores in 2018 as well to develop infrastructure. For financing Smart City initiative Ahmedabad Municipal Corporation (AMC) also raised Rs.200 crores in 2019. In 2021, Lucknow Municipal Corporation (LMC) raised Rs.200 crores for infrastructure projects. Initiatives like Smart City Mission, JNNURM and AMRUT are providing impetus to municipal bond market in India. The introduction of Pooled Financing in states of India like Tamil Nadu, Gujarat, Karnataka, and Punjab has provided smaller cities with access to debt capital markets. This has facilitated the flow of private finance into economies with substantial infrastructure deficits. While these advancements have encountered specific obstacles, they are being diligently nurtured to guarantee an ongoing and enduring influx of private funding. However, to further promote these market mechanisms, appropriate reforms need to be implemented.

There are three significant endogenous revenue sources that form the crux of a robust municipality. The first is land assets, where municipalities should focus on enhancing property rights through measures such as land registration. Implementing a system for periodic updates on asset and property ownership is also essential for effective management. Reinforcing property rights enables municipalities to establish a foundation for land-value sharing, allowing them to garner additional revenue from property taxes and "betterment levies" for urban planning, renewal, and expansion. The second source is productive capacities, which involve improving and expanding the layout of cities to enhance productivity, mobility, and private sector income generation. Proper urban configuration, including transportation systems and public spaces, directly impacts a city's ability to attract people, firms, and sustainable sources of income. Lastly, financial management expertise represents a crucial endogenous revenue source that can vary among municipalities. Boosting

fundamental financial capabilities is imperative, encompassing enhancements in accounting regulations, capital investment blueprints, financial sustainability indicators, as well as spending and income guidelines. Furthermore, augmenting expertise in intricate financial instruments such as bonds, credit assessments, and environmentally-friendly financing is vital for proficient financial administration.

Governments at all tiers should actively identify and implement innovative funding tools to support infrastructure financing. According to Chen (2016), innovative infrastructure finance refers to approaches that complement conventional funding origins and financial strategies by incorporating new fund sources, financing mechanisms, and financial arrangements. New revenue sources involve measures that foster additional revenue for infrastructural projects, such as implementing local option taxes or utilizing value capture mechanisms like impact fees. These approaches help mobilize funds specifically dedicated to infrastructure development. Emerging financial mechanisms prioritize procuring capital in adaptable and cost-efficient manners, leveraging credit assistance tools, and utilizing alternative bond and debt financing instruments like GARVEE bonds, green bonds, and environmental impact bonds. These mechanisms provide opportunities for diversifying funding streams and attracting private and institutional investors interested in sustainable and environmentally-friendly projects. Fresh financial agreements involve engaging novel collaborators, such as the corporate sector, not-for-profit sector, or the general public, in funding infrastructure and project execution. Collaborative partnerships with these stakeholders can bring in additional expertise, resources, and innovative approaches to infrastructure financing. By embracing these innovative funding mechanisms, governments can expand their financial options, tap into new sources of revenue, and improve the overall efficiency and effectiveness of infrastructure financing and development. In light of these considerations, several recommendations can be made:

- Explore the use of value capture mechanisms to fund public transport improvements.
- Further develop Transit-Oriented Developments to generate finances for public transportation services.
- Hypothecate revenue garnered through fuel charges for public transportation and roadways sector investment.
- Consider a marginal increase in the Goods and Services Tax (GST) allocated to public transport infrastructure and services.

- Introduce a minor payroll tax earmarked for infrastructure investment.
- Utilize congestion tolls to manage congestion and allocate dedicated revenue streams for investing in city transport systems.
- Review current the Public-Private Partnerships (PPPs) and other financing models to stimulate increased participation of investors, both local and international, in economic infrastructure provisioning.
- Continue providing revenue grants to municipal bodies based on their needs.
- Promote fair and pervasive roles for credit rating agencies in providing services.
- Combine pooled financing with project design and management expertise.

Table 2.6 enlists some innovative infrastructure financing tools to generate finances for infrastructure.

Table 2.6

Tool Box of Innovative Infrastructure Finance

Local Option Taxes:	Options Tax for infrastructure-related purposes may be implemented at either the state level or municipal level. These options can be sanctioned by the regional administration or endorsed through local electorate decisions, with the assessments implemented at the county or municipal tiers. Chen and Afonso (2021) as well as Goldman and Wachs (2003) have discussed various forms of local option taxes that can be considered. These are the local option sales tax (LOST), that can be specifically allocated for transportation purposes, the local option fuel tax (LOFT), the local option vehicle tax (LOVT), and the local option income or payroll taxes (LOITs). These taxes often involve allocating the revenues for the construction of special local infrastructure projects."
Vehicle Mile Travelled (VMT) Tax:	Additionally referred to as a VMT fee, mileage-based user fee (MBUF), road usage charge (RUC), or per-mile tax, this taxation system computes fees for drivers according to the distance they traverse (Agrawal et al., 2016). In contrast to the fuel tax, which relies on the quantity of fuel consumed, the VMT tax is intricately tied to actual road usage. The per-mile tax rate can be tailored based on variables such as vehicle category and weight, geographic location, emissions, and the traffic congestion levels of the specific road network traversed by the vehicle (Agrawal et al., 2016).
Carbon Tax:	This is a type of tax imposed on energy product consumption, aimed at

	addressing carbon emissions (Brill 2017). It can be structured as an additional element of the existing fuel tax rate, taking into account the different carbon content of various fuels. The primary objective of a carbon tax is to lower carbon emissions, the funds generated from such a tax can also be utilized to support infrastructure development.
Value Capture:	Value capture is a term used to describe a range of strategies that leverage the increment in property values, economic prosperity, and developments associated with infrastructural projects to contribute towards their funding (U.S. DOT 2019). Through the utilization of value capture methodologies, individuals and entities that gain advantages from the fresh infrastructure investment, like property proprietors or developers, are obligated to share in covering its expenses. This approach helps alleviate the financial burden on taxpayers. Frequent illustrations of value capture tactics encompass tax increment financing (TIF), special assessments, collaborative development initiatives, transportation utility charges, developer contributions, and the sale of naming rights.
Resilience Fees:	These manifest as supplementary charges imposed on water and sewer consumption or may materialize as tax assessments or surtaxes on local property proprietors. The funds amassed through these resilience fees are expressly earmarked to fund sustainable infrastructure enhancements and projects which are resilient. The purpose of resilience fees is to capture the private benefits resulting from low risks and hence lowering insurance costs, which are direct outcomes of public investments in resilience. By investing in such infrastructure, significant potential climate change related damages, environmental costs and economic losses can be prevented, amounting to billions of dollars in savings for the future.
Grant Anticipation Revenue Vehicle Bonds (GARVEEs):	According to the U.S. Department of Transportation (DOT) (2016), GARVEEs, or Grant Anticipation Revenue Vehicles, are bonds or notes issued by state and local governments. These bonds are secured by the anticipated future central-aid highway grants. GARVEEs allow state and local governments to access upfront financing, thereby expediting highway construction projects. Moreover, they enable the leveraging of central funds and enhance the borrowing capacity of the state. It is important to note that GARVEEs represent the debt obligations of state and local governments and not central obligations.
Green Bonds:	In a general sense, green bonds resemble traditional bonds, but their primary

	purpose is to support or refinance fresh and/or current qualified "eco-friendly" endeavours that offer significant ecological advantages. These endeavours usually centre on fields like sustainable power generation, energy frugality, ecologically responsible waste handling, sustainable timber cultivation and land usage, and additional campaigns targeting the alleviation of climate transformation. The objective of green bonds is to direct investments explicitly towards ecologically sustainable undertakings.
Social Impact Bonds:	Social impact bonds, also recognized as pay-for-success funding, constitute an inventive financial instrument enabling governments to support initiatives founded on the accomplishment of particular societal outcomes. Unlike conventional civic bonds, community welfare bonds do not present a predetermined return rate. Instead, their structure hinges on the triumphant attainment of predetermined program targets for the reimbursement of the principal and conceivable yields. Typically, these bonds are employed to finance societal infrastructure undertakings, which encompass medical facilities, education, agricultural pursuits, detention facilities, and economical lodging. In 2010, the United Kingdom issued its inaugural community welfare bond, followed by 14 more in both the U.K. and the U.S. in 2012.
Catastrophe Bonds and Resilience Bonds:	In light of the escalating climate change impacts, governments have embraced disaster bonds and resilience bonds as mechanisms to shift risks to the capital market from the public sector. Such bonds, frequently known as cat bonds, operate more akin to insurance contracts than conventional municipal bonds. The purpose is to mitigate financial liabilities associated with infrequent yet high-impact natural disasters. If a catastrophe surpasses a predefined threshold, usually a specified loss amount, over the bond's tenure (typically 3-5 years), the catastrophe bond policyholder assumes responsibility for the full bond value to cover the incurred losses, while investors might experience a partial or complete loss of their primary investment. Conversely, resilience bonds represent a variant of catastrophe bonds, creating a connection between insurance premiums and resilience endeavours to monetize the lessened losses. By introducing a rebate framework, resilience bonds permit the reduction of insurance expenses and claims stemming from enhanced resilience initiatives, such as constructing hurricane-resistant infrastructure. The key divergence between catastrophe bonds and resilience bonds rests in the explicit consideration of the risk mitigation

	value offered by a particular resilience project to investors. As resilient infrastructure initiatives lower the risk of investors losing their initial investment, the premium payments made by public sector backers are subsequently diminished. With resilience bonds, the cost savings from reduced coupon payments to investors, known as the resilience rebate, are directed toward the public sector sponsors.
Public Private Partnerships:	Public-private partnerships (PPPs) involve collaborative contracts between the government and the private sector for infrastructure projects like roads, water facilities, and wastewater plants. PPPs vary based on how they combine design, finance, build, operate, and maintain elements. In a design-build (DB) agreement, a private firm handles both design and construction. In a design-build-operate-maintain (DBOM) setup, private entities manage design, construction, operation, and maintenance, while public agencies oversee financing and associated risks. In a design-build-finance-operate-maintain (DBFOM) model, private entities also fund transportation projects using project-generated revenue, but public agencies retain ownership of privately constructed projects. Concessions involve private entities making an initial payment and committing to operate, maintain, or enhance public assets during the lease term.
Privatization:	In the domain of infrastructure, privatization denotes the procedure of shifting publicly owned and managed infrastructure assets to private organizations via either a sale or an extended lease (Megginson & Netter 2001). Under these agreements, governments cede direct authority and ownership in return for private compensation for managing infrastructure services. Privatization can yield financial efficiencies for the government, harness the monetary assets and proficiency of the private sector, and elevate infrastructure services. Diverse privatization structures are viable, encompassing: Design-Build-Operate-Transfer (DBOT): Under this arrangement, a private firm is responsible for designing and constructing a new facility, operating it for a specified duration, and subsequently transferring ownership to the government. The financing for the project may come from public, private, or shared sources. Design-Build-Own-Operate (DBOO): Similar to DBOT, the private firm designs and constructs the facility, but in this case, the firm retains ownership of the infrastructure under a long-term contract or franchise agreement. The firm assumes the associated risks and retains the profits (Savas 2000).

Infrastructure Investment Funds (IIFs):	An infrastructure investment fund involves major investors like pension funds, sovereign wealth funds, private insurers, and investment banks pooling their resources. They employ skilled fund managers to invest in diverse infrastructure assets (Poole 2015). These funds typically target either privatized infrastructure assets or government entities dedicated to infrastructure management through extended public-private partnerships. They're drawn to extended infrastructure projects offering low-risk, steady cash flow, and reasonable returns.
Private Non-Profit Philanthropic Partners:	Philanthropic organizations, private foundations, and various non-profit organizations are increasingly demonstrating an interest in investing in local infrastructure. These entities can contribute through donations or grants with a charitable purpose to facilitate the construction or operation of local infrastructure. Additionally, foundations may opt to make program-related investments that align with their philanthropic mission, leveraging their donations to support initiatives like local affordable housing, community development projects, historic building rehabilitation, and open space preservation (U.S. Bipartisan Policy Center 2016). Through these approaches, philanthropic investments enable recipients to access capital at lower interest rates or reduce their borrowing needs. The repayment or return on equity can be reinvested for future charitable infrastructure projects.
Crowdfunding:	Crowdfunding is the practice of gathering small amounts of funding from a large number of individuals (Ross 2015). It has become a popular means of financing relatively modest civic infrastructure initiatives. Crowdfunding establishes a link between fundraisers, seeking capital, and a community of investors who make small contributions through an online platform. Three primary forms of crowdfunding exist (Shneor 2020): • Donation-based crowdfunding: This is the most recognized type, where an online platform invites individuals to make small monetary donations. By accumulating numerous small contributions, infrastructure projects can secure the necessary funding. • Equity crowdfunding: This form allows people to invest in early-stage start-ups via online platforms and obtain partial ownership in infrastructure projects. • Debt-based crowdfunding (also known as rewards-based crowdfunding): In this approach, a community is asked to contribute to a project or

	business in anticipation of a future financial return.

Source: Chen and Bartle (2022), Author

An effective and sustainable infrastructural development is important for the growth of a nation. As Indian population continues to grow, the demand for urban systems and urban infrastructure also increases. To ensure the uninterrupted provision of infrastructure services for the growing population, it is essential to secure long-term and dependable funding for planned investments. This chapter examines a range of funding tools and revenue sources currently employed in different cities, states, and countries worldwide. Each mechanism possesses its own unique strengths and weaknesses, necessitating a thorough evaluation in the context of specific projects or jurisdictions. However, it is clear that the present practices employed by Indian government to finance urban infrastructure is unsustainable.

A well-integrated urban infrastructure system that effectively serves the population's needs benefits the entire nation as a whole. To alleviate the burden on Urban Local Bodies (ULBs) and promote national development, it is necessary to expand the funding pool for infrastructure by employing innovative funding mechanisms that generate dedicated funds for essential services. Cities can generate public financial resources based on the principles of "user pays," "beneficiary pays," "polluter pays," "congestion charges," "external cost bearers pay," and "growth-related payments." The process of city development presents opportunities for value increment financing, which involves leveraging the creation, capture, and recycling of land and property value increments. This approach is particularly relevant in planned development and renewal programs within densely populated urban areas, as they have the potential to not only fund themselves but also generate surpluses. By adopting a strategy that focuses on increasing local revenues through these principles, urban development can become a self-financed process driven by the advantages of agglomeration externalities and knowledge externalities.

Chapter 3

Agglomeration and Network Externalities: A New Theoretical Framework for Urban Infrastructure Financing

3.1. The Smart Cities Mission

Developing nations worldwide, including India, are progressively adopting 'Smart City' initiatives to position their urban centres as catalysts for economic prosperity. Aligning with this trend, India launched the Smart Cities Mission in 2015, with the goal of cultivating 100 smart cities. A main objective of the mission is to enhance the core infrastructural services of cities through the utilization of 'smart' and tech-savvy solutions based on Information and Communication Technology (ICT). The Smart Cities Mission also emphasizes the need for convergence and synergy with other national missions and schemes, such as the AMRUT, SBM, PMAY, state government initiatives, and more. The mission's duration spans five years, covering the financial years 2015-16 to 2019-20. The Government has committed a total expenditure of Rs. 48,000 crores in 100 cities over this period, with each smart city getting Rs. 100 crores annually over five long years. Additionally, the states and ULBs will raise additional resources amounting to Rs. 48,000 crores, following a 50:50 funding mechanism. As of November 2020, nearly 90 per cent of all approved mission projects had been tendered, and around 70 per cent of them were either completed or in advanced stages of implementation (The Smart City Mission Report 2021). The mission aims to meet its deadline by June 2024. These finances will serve as a booster to attract further funding from both internal sources as well as external sources, including borrowing through municipal bonds.

The Smart City Mission aims to create robust models of planned urban development and financing that can be replicated in other cities. To achieve this, four models have been outlined:

(i) Urban enhancement (retrofitting): This entails improving the efficiency and quality of life within an already established built area spanning more than 500 acres.

(ii) Urban revitalization (redevelopment): In this context, the emphasis is on substituting the current built surroundings in an area surpassing 50 acres, facilitating the collaborative creation of a fresh layout encompassing enhanced infrastructure, diverse land utilization, and heightened density.

(iii) Urban expansion (greenfield development): This approach involves developing an erstwhile vacant area exceeding 250 acres, employing inventive planning, financing, and execution methods. It also places special emphasis on offering affordable housing, particularly for those with limited economic means.

(iv) Pan-city initiative: This initiative involves applying at least one smart solution that covers significant parts of the city.

These projects are expected to generate area-specific, city-wide, and regional benefits, contributing to productivity and growth. Nevertheless, a significant hurdle encountered by smart urban centres revolves around effectively harnessing financial support from both central and state governments, alongside locally generated revenues and external reservoirs, in order to fund inventive locality-focused and municipal growth initiatives. Regrettably, the execution of the Smart Cities Programme in India has brought to light the difficulties cities face in procuring resources for essential infrastructure projects and strategies. Paradoxically, not a single city or state in India has embraced an intelligent approach to funding envisioned urban progress so far.

Jawaharlal Nehru National Urban Renewal Mission (JNNURM), launched in 2005, also aimed to anchor central and state funds, along with municipal contributions and external finances. The objective of the mission was to offer a central grant of Rs. 100,000 crore for initiatives cantered around fundamental urban infrastructure and essential amenities for underprivileged populations, encompassing affordable housing and slum revitalization. Despite this, throughout the seven-year duration of the mission spanning from 2005-06 to 2011-12, the Planning Commission disbursed just Rs. 66,085 crore, with a mere Rs. 45,066 crore being allocated in accordance with the advancements made by cities under the JNNURM program. By the end of 2011-12, Rs.40,584 crore could be released.

One major issue encountered during the implementation of JNNURM was the inability of many urban local bodies (ULBs) to mobilize their share of funds in a timely manner, leading to a failure to raise resources as intended. The reforms outlined by JNNURM

encompassed endeavours to generate funds through user charges and property taxes; however, these reforms were executed only to a partial extent. Moreover, owing to the accessibility of central and state grants via the JNNURM avenue, municipal bodies displayed limited motivation to procure resources from the market using instruments such as municipal bonds. Merely three instances of municipal bonds issuance occurred during the seven-year mission period, accumulating a modest sum of Rs. 1500 crore from the market. This lack of a robust financing strategy continues to be a challenge for financing core urban infrastructure in Indian cities, despite the need to address the demands of urbanization and economic growth.

While smart cities require innovative financing approaches, research on urbanization in developing countries, including India, has largely neglected urban public finance. This is paradoxical considering that cities serve as engines of growth and generate tax bases due to their powerful externalities. The concentration of businesses, residences, and establishments within urban areas results in favourable side effects connected to expansion and innovative advancements. Large cities create agglomeration and networking benefits, resulting in what economist Edward Glaeser (2011) refers to as "collaborative brilliance." These externalities of cities reduce the costs of transportation, information sharing, and knowledge exchange, leading to specialization, diversity, and competition. Investments in infrastructure are pivotal in enhancing the favourable outcomes of population density while alleviating its adverse effects. Consequently, well-designed taxation and user charging systems that account for the benefits and costs induced by city externalities can generate sufficient resources to finance urban development.

Smart urban centres in developing nations, such as India must adopt intelligent financing approaches that leverage externalities as a resource. Merely relying on smart technology solutions will not be sufficient. In this context, this thesis aims to enhance local resources through revenue generated from externalities to facilitate sustained investments in urban infrastructure. This approach intends to create growth, benefits, values, rents, and tax bases. It suggests that beneficiaries, exacerbators, congesters, and polluters should bear the costs associated with growth impacts. This chapter combines theoretical literature on Wider Economic Benefits (WEB) resulting from key urban infrastructure investments, the Henry George Theorem (HGT) advocating for land value taxation, and the Mohring-Harwitz Theorem (MHT) suggesting congestion charging. These principles are combined to design a

robust strategy for financing urban infrastructure. The succeeding analysis contends that by integrating concepts such as "beneficiaries pay" and "congesters pay," developing countries' cities like India can amass adequate funds to manage long-term debts used for funding essential infrastructure through municipal bonds, thereby achieving self-sufficiency in urban infrastructure financing.

This chapter is organised in nine sections. Section 3.1 pens down the Smart Cities Mission of India. Section 3.2 chalks the Urban Infrastructure Crisis in India. The externalities of cities are discussed in Section 3.3. Further, the concept of Agglomeration rent and Infrastructure Financing is outlined in Section 3.4. Section 3.5 gives the concept of Land Value Tax and Infrastructure Financing. Similarly, Section 3.6 outlines congestion charging and infrastructure financing. A new model of urban infrastructure financing is derived in section 3.7. Adding to it, Section 3.8 discusses a tool-box of financing instruments. Thus, Section 3.9 concludes

3.2. India’s Urban Infrastructure Crisis

As of 2014, India's urban populace was approximated at 410 million, and it is anticipated to ascend to 814 million by 2050, as indicated by the United Nations report from 2015. Accommodating such a massive population in cities and towns, providing housing, infrastructure, and basic services, poses a colossal challenge. According to McKinsey's projections in 2010, India would have to build 38 million affordable residences to tackle the existing backlog and fulfil the anticipated requirement for affordable housing within urban regions. Achieving this goal would demand an annual creation of 700-900 million square meters of both commercial and residential space until 2030. To link these areas, it would be imperative to construct 2.5 billion square meters of new roads and introduce 7,400 kilometres of fresh metro and subway systems—amounting to a scale 20 times greater than the infrastructure capacity incorporated in India since 1999. While the requirements for urbanization-driven growth are enormous, there is also a substantial backlog and current demand to address. Based on the 2011 census data, a mere 71 per cent of the urban population had access to personal water connections. Furthermore, merely 44.5 per cent of urban households were connected to enclosed drainage systems, with 37.3 per cent depending on open drainage, and 18.2 percent having no drainage infrastructure available. Census data

from 2011 reveals that out of 78.9 million urban households in India, 3.1 per cent do not have an exclusive room, 32.1 per cent live in one room, and 32.6 percent live in two rooms. Additionally, 13.7 million households, or 65.5 million people, reside in slums, although this figure is possibly an underestimation, given that unnotified slums are not accounted or have less than 60 households are not included in the census count. A panel of experts commissioned by the Ministry of Housing & Urban Poverty Alleviation, Government of India, calculated the deficiency in urban housing in the country to be 18.78 million in 2012, with a significant 95.7 per cent of this scarcity affecting economically weaker sections (EWS) and low-income groups (LIG) (as per MoHUPA 2010).

While the financing challenges posed by urbanization are substantial, the challenges associated with rural development and poverty alleviation are even more formidable. In 2014, the rural population in India was estimated to be around 857 million, and by 2050, it is projected to still have around 806 million people living in rural areas (Census of India 2011, United Nations 2015). Consequently, India will grapple with the dual predicaments of rural and urban development for numerous decades. Paradoxically, it is the cities that shoulder the duty of accumulating resources to tackle the nation's issues concerning both rural and urban growth. Cities function as the foundation of tax revenues for all tiers of government: central, state, and local. The generation of resources for the all-round development of the country critically hinges on the financial stability of cities. However, the state of Indian municipal finances in is precarious, currently accounting for only about 1 per cent of the GDP (Mohanty 2014). Moreover, municipalities in India have not fully utilized the revenue sources assigned to them, failing to exploit their maximum potential. The ULBs must be assigned an appropriate basket of taxes and charges, they must also strive to exploit the existing sources, especially agglomeration-based and land-related taxes and congestion charges. At the same time they must adopt a sound escrowing mechanism to finance core infrastructure facilities based on long-tenor infrastructure bonds. While investments in core such infrastructure facilities lead to unearned benefits, especially to landowners by enhancing “accessibility” and “serviceability” of locations, they create agglomeration rents and scope for congestion charging. However, externality-based financing sources are yet be harnessed by cities in India.

3.3. Externalities of Cities

Cities possess two significant externalities: agglomeration and networking. These externalities grant cities a distinct role as catalysts for knowledge-driven growth. They facilitate the flow and exchange of knowledge, accelerating its generation, dissemination, diffusion, and accumulation, thereby stimulating innovation and fostering economic development. These externalities amplify the impact of growth factors beyond the scope of market mechanisms. Agglomeration externalities arise from the clustering of businesses, residences, and establishments in urban areas, leading to heightened productivity and lowered costs. These effects predominantly manifest on the supply side. On the other hand, network externalities arise from the demand side, wherein an upsurge in the user base within a network lowers the average cost of utilization and yields greater benefits for both network providers and businesses. Agglomeration and network externalities reinforce each other. They, in conjunction with market forces and public policies benefit many actors in the spatial economy. The endogenous growth theory suggests infrastructure can act as powerful driver of growth by impacting knowledge externalities.

Agglomeration Externalities

Agglomeration refers to the physical changes in the urban landscape, such as densely populated downtown areas, clusters around transportation hubs, and the presence of larger cities. These changes can result in external economies of scale in production, commonly known as agglomeration economies (Marshall 1890, 1920). To neo-classicists, the ‘first nature of geography’ is responsible for the distribution of economic activities being uneven. They stress on the natural endowments in a region. Krugman’s “New Economic Geography” gave another explanation of ‘second nature of geography, related to how actors in the economy organise themselves spatially. It is the spatial agglomeration of economic agents, along with infrastructure investments to support their activities that makes cities productive. Spatial concentration of economic activity, referred as urban increasing returns, has been long discussed by Marshall (1890, 1920), Ohlin (1933) and Hoover (1937). Two concepts that sum

up the advantages of economic concentration or agglomeration externalities are – scale economies and division of labour (Turok and McGranahan 2013).

The works of Marshall (1890) provide a significant reference to the concept of agglomeration economies. Marshall examines external economies related to industrial placement, emphasizing that companies tend to congregate in industrial zones to capitalize on specialization.

> *"When an industry has thus chosen a locality for itself, it is likely to stay there long: so great are the advantages which people following the same skilled trade get from near neighbourhood to one another. The mysteries of the trade become no mysteries; but are as it were in the air, and children learn many of them unconsciously. Good work is rightly appreciated; inventions and improvements in machinery, in processes and the general organization of the business have their merits promptly discussed: if one man starts a new idea, it is taken up by others and combined with suggestions of their own; and thus it becomes the source of further new ideas. And presently subsidiary trades grow up in the neighbourhood, supplying it with implements and materials, organizing its traffic, and in many ways conducing to the economy of its material….."*

> *"….a localized industry gains a great advantage from the fact that it offers a constant market for skill. Employers are apt to resort to any new place where they are likely to find a good choice of workers with special skill which they require; while men seeking employment naturally go to places where there are many employers who need such skills as theirs and where therefore it is likely to find a good market. (Marshall 1920, 224-225)."*

Marshallian externalities encompass three main types: (i) knowledge, (ii) input, and (iii) labor market. The concentration of companies within an industry promotes the sharing of information, enabling producers and workers to gain advantages from knowledge spillovers within the sector. Firms situated in close proximity attract providers of non-traded inputs and supplementary services, resulting in streamlined procurement procedures and diminished transportation expenses. Localization of industries enables sharing of inputs, assets, services, markets, and risks. Furthermore, the aggregation of companies in a specific industry generates a specialized pool of labour in the job market. Urbanist Jane Jacobs, renowned for her work, emphasizes that it is the diversity and variety of economically interconnected activities in close proximity, rather than specialization in a single industry, that drive innovation and economic growth (Jacobs 1969, 1984). She argues that significant knowledge transfers occur between industries, fostering creativity and innovation. Jacobs characterizes

innovation as a process that builds upon existing divisions of labour, giving rise to fresh concepts, methods, and products, and consequently fostering additional specialization.

In his research, Porter (1990) underscores the significance of clustering in the competitive advantage of countries. A cluster signifies a geographical gathering of interconnected companies, specialized suppliers, service providers, related industries, and associated institutions such as universities, standards agencies, and business chambers. These entities compete with each other while also fostering cooperation. Cities play a crucial role in facilitating the aggregation of firms with shared characteristics and complementary capabilities. The close physical proximity of firms results in benefits like resource-sharing and entry into management strategies of the competitors. Competition within clusters stimulates industry excellence and forces firms to innovate in order to thrive.

There has been a large body of research distinguishing between urbanisation and localisation economies. The concept of urbanisation economies is closely linked with the idea of Jacobs (1969) who stresses the importance of benefits of diversity in a region. The benefits of urbanisation get transmitted through three mechanisms- 'learning, sharing and matching' (Duranton and Puga 2004). Sharing of fixed costs, availability of intermediate inputs and easy access to specialised labour pool lead to economies. The experience that keeps on accumulating by diffusion of ideas, ease of learning by doing, acquiring skills to get absorbed in the urban job market makes for learning and adaptability characteristics. Often as in endogenous growth theories of Romer (1990) and Lucas (1988), knowledge diffuses and generates spillover benefits of increasing returns to itself (Andersson and Karlsson 2007). And finally, matching of suppliers and buyers, employers and employees becomes easy, reducing frictions. Localisation economies arise due to local concentration of a particular economic activity, say auto cluster, logistic hub etc. Localisation benefits also occur from provision of local public goods, leading to returns to sharing of benefits and costs.

The theoretical literature on agglomeration externalities refers to effects through total factor productivity. A standard formulation is represented by the following model:

The Urban production function can be represented by:

$$X_u = g(Z,N_u)f_u(N_u) \quad (3.1)$$

here, X_u stands for urban production function, N_u stands for city population and $g(Z, N_u)$ incorporates the agglomeration economies that consist of urban infrastructure/ public good Z (localisation economies) and N_u (urbanisation economies). The production function exhibits increasing returns stemming from external economies of agglomeration. Similary,
The production function of the rural area is represented as:

$$X_r = f_r(N_r) \quad (3.2)$$

here, X_r stands for rural production function and N_r denotes total rural population. The X_r function is taken to experience decreasing returns to scale due to over-crowding in primary sector.
Population endowment is given by:

$$N_u + N_r = N_T \text{ or, } N_r = N_T - N_u \quad (3.3)$$

here, N_T represents the sum total of all population in the economy, which is further assumed to be fixed.

Assuming perfect competition, producers in urban area set the urban real wage w_u equal to marginal productivity (urban) of labour regardless of externalities. The rural producers equalise real rural wage w_r with marginal productivity (rural) of labour. Rural-urban migration occurs until the urban and rural wages are ultimately equated. The competitive equilibrium condition for rural-urban migration is expressed as:

$$w_u = g(Z, N_u)f'_u(N_u) = w_u(Z, N_u) = w_r = f'_r(N_r) = f'_r(N_T - N_u) = w_r(N_u) \quad (3.4)$$

The w_u function exhibits an upward slope in N_u due to agglomeration economies while w_r function shows a negative slope in the N_r consequently, a positive slope in N_u. Infrastructure investments impact Z and N_u, leading to a shift upward in the w_u by engineering agglomeration externalities. Agglomeration leads to productivity gains and hence, higher wages. The assumption of upward-sloping urban wage function is supported by the fact that large cities, ceteris paribus, offer higher wages as productivity premium. The

effects of agglomeration externalities through urbanisation and localisation manifest in ‘agglomeration rent’ in the form of unearned benefits to a lucky few.

Network Externalities

Economies of network, originating from the demand side, yield advantages by fostering greater utilization, integration, and convergence of various networks, including those related to transportation, communication, knowledge, and social interactions. The interplay of these economies make possible the exchange of information and knowledge among varied actors in cities, leading to learning, innovation, and growth. The literature on ICT technology emphasizes the presence of power laws in networks. These principles indicate that networks start reinforcing themselves once they surpass a particular threshold. Network externalities manifest when a member's benefit from a network or the use of a compatible product is affected by the actions of others. With network economies at play, the functional worth of a network rises or the cost of utilizing the network decreases in tandem with the expansion of its user base. The examination of these externalities has resulted in the development of power laws within the field of information and communication technology (ICT) literature. Metcalfe's law, for instance, posits that the potency of a network increases with the square of the quantity of its users. This implies that as a network surpasses a critical value, it becomes self-sustaining and more valuable. Furthermore, network principles propose that the value of a network not only rises with the inclusion of new members but can also undergo a substantial boost through interconnection or amalgamation with other networks. As an example, when a network M comprising m members is interconnected with another network N consisting of n members, the additional value generated for both networks due to this interconnection can be estimated using the following approximation:

$$\Delta V_m = m\,(m + n) - m^2 = mn \tag{3.5}$$

$$\Delta V_n = n\,(m + n) - n^2 = mn \tag{3.6}$$

Consequently, both networks experience advantages when they are interconnected. It follows that the smaller network enjoys a relatively greater benefit when it connects to the larger network. Moreover, when the two networks merge, the resulting combined network M + N generates an additional incremental value:

$$\Delta V_{m+n} = (m + n)(m + n) - m^2 - n^2 = 2mn = 2\Delta V_m = 2\Delta V_n \quad (3.7)$$

The equation mentioned above states that a network can experience significant benefits by incorporating other networks and offering interconnecting services to all its members. Parker, Alstyne and Choudary (2016) explore the notion of the "platform revolution" and elaborate on how interconnected markets are reshaping the economy by giving rise to innovative business models. These models utilize technology to establish connections among individuals, organizations, and resources within a dynamic and interactive ecosystem., resulting in the creation and exchange of substantial value. The authors provide a definition of a platform as:

> *"....a business based on enabling value-creating interactions between external producers and consumers. ....The platform's overarching purpose: to consummate matches among users and facilitate the exchange of goods, services, or social currency, thereby enabling value creation for all participants* (p. 5)*."*

This description implicitly recognizes the influence of network externalities, which may display power-law dynamics. Instances of platform-based enterprises encompass companies such as Amazon, Alibaba, Uber, Ola Cabs, Airbnb, TripAdvisor, eBay, Zomato, and various others. In contrast to the era of the industrial revolution, where the growth of large corporations was primarily propelled by supply side- economies of scale; the present Information and Communication Technology (ICT) revolution is fostering substantial economies of scale on the demand side. This phenomenon is giving rise to the emergence of massive enterprises. Technology is facilitating the functioning of dual kinds of markets that encompass both producers and consumers, thereby generating network effects. Cities, as emphasized by Jacobs, are uniquely poised to reap the advantages of the platform revolution owing to their inherent networking characteristics. Cities naturally attract information-intensive industries, generate concentrated demand, lower transport costs, and promote

network economies, transforming seemingly unviable business models into commercially appealing ones. The network externalities lead to ‘network rents’, which can be considered as a part of externality-based revenue sources. We include network rents under the broader concept of ‘agglomeration rents’.

Infrastructure Externalities: Wider Economic Benefits

Infrastructure creates an environment for enhancing agglomeration and networking benefits and mitigating congestion costs. It connects economic activities, places, workers and entrepreneurs, creating benefits of collaboration and knowledge externalities. Urban infrastructure projects play a crucial role in fostering development by generating local "accessibility" and "serviceability" premiums. These projects also contribute to "wider economic benefits" that extend beyond the local area, as they improve access to the economic core of the complete economy. Transport infrastructure is a discernible example of an infrastructure leading to agglomerating and network externalities. Table 3.1 discusses its key impacts in detail.

Table 3.1

Direct and Externality-induced Impacts of Transport Investments

Market	Key Impact Parameters
Transport Market	• Time-saving benefits in transportation, especially advantageous for business travelers and freight operators. • Enhanced reliability for both travelers and freight handlers. • Streamlined logistical operations and improved supply chain management. • Reduction in accidents and overall enhanced safety.
Goods Market	• Increased efficiency in integrating production inputs. • Broadened market prospects due to lowered input and output expenses, access to fresh markets, and new raw material sources. • Reorganization of production procedures, resulting in a shift in the production capacity frontier, more seamless business interactions, and

	efficient "just-in-time" management. • Agglomeration economies stemming from the dense concentration of firms, workers, and institutions in urban regions. • Encouragement of inward investment, knowledge exchange, innovation, and the spread of technology. • Advantages derived from international trade, such as decreased transportation expenses, transaction costs, tariffs, and time. • Augmented competition, addressing market shortcomings, and fostering inter-market trade.
Labour Market	• Expansion of the labour market catchment area, leading to a reduction in search for labour, recruitment costs, and training expenses. • Enlarged pool of skilled labor with industry-specific and cross-industry expertise. • Benefits from in-person interaction, connection and collaboration, fostering innovation and knowledge sharing. • Improved labor market flexibility, enabling better alignment between employers and workers, job skills and requirements, and facilitating job relocations. • Increased participation in the labor force, particularly among female workers.”
Land Market	• Land value appreciation resulting from improved accessibility. • Creation of opportunities for value-added developments on previously underutilized sites. • Support for urban density and the development of economic agglomerations. • Benefits arising from close proximity, density, and spatial adjacency. • Appreciation in land values because of improved accessibility and serviceability, allowing the utilization of value capture mechanisms to generate resources for infrastructure development.
General	• Stimulating economic growth, leading to a positive feedback loop of further growth. • Improving overall welfare and quality of life. • Promoting social engagement and the acquisition of human and social assets.

	• Providing consumers with a wider range of choices, including access to diverse goods, services, and amenities. • Leveraging changes in geographic and economic prospects linked to globalization, the ICT revolution, innovation, and more, and drawing in globally mobile activities. • Effects on energy consumption and greenhouse gas emissions. • Fostering competitive urban centers as catalysts for economic expansion. • Enhancing connections between rural and urban areas and expanding the influence of the formal economy into rural regions.

Source: Mackie, Graham and Laird 2011; Author

The presence of agglomeration, networking, and infrastructure externalities in cities gives them a central role in the structural and spatial transformation of developing countries like India, which are experiencing an urban transition. In fact, studies conducted across different countries have shown a robust correlation between urban growth and economic growth. A 10 percent increase in a country's level of urbanization leads to a 30 percent rise in its per capita output. Nations where the majority of the population resides in urban areas typically experience per capita incomes that are four times higher than those with a majority living in rural regions. Moreover, in a developed country, when one city is twice the size of another city, it typically demonstrates a productivity advantage ranging from 1 to 5 per cent. In the United States, employees in metropolitan areas that encompass major cities earn 30 percent higher incomes compared to workers in non-metropolitan areas. Typically, individuals in metropolitan areas with populations exceeding one million are over 50 percent more productive than those in smaller metropolitan regions, on average. These associations remain valid even after adjusting for variations in education, experience, intelligence quotient (IQ), and the industry of the workers (Glaeser 2011). The correlation between urban productivity and economic growth appears notably robust in developing countries. Research has indicated that the coefficient, when regressing individual income against area density, stands at approximately 0.05 in the United States, 0.08 in India, and 0.20 in China (Chauvin et al. 2016). Additionally, Williamson's hypothesis suggests that agglomeration plays a significant role in the early stages of economic development, offering a way for developing countries to overcome resource constraints and escape the "development trap." There exists

an inverted-U relationship between urban concentration and economic growth, as posited by Williamson in 1965. Research examining data from 105 countries over the 1960-2000 period consistently upholds Williamson's theory, demonstrating that agglomeration contributes to GDP growth until a specific development threshold is attained. This threshold is estimated to be approximately US$10,000 per capita in 2006 PPP (Purchasing Power Parity) prices, as indicated by Brulhart and Sbergami in 2009. Additionally, research that examined a cross-section of low and middle-income countries revealed that a 1 percent improvement in infrastructure effectiveness has a growth effect that is over 7 times greater than the impact of the same percentage increase in public investment, as highlighted by Hulten in 1996. Hulten et al. (2006) conducted an analysis of data from India and documented substantial external effects stemming from infrastructure development in Indian states on manufacturing output, resulting in a productivity residual of 0.47 percent.

A key impact of interactions between agglomeration, networking and knowledge externalities associated with major infrastructure projects such as urban highways, public transit and water and sanitation networks is that they lead to unearned benefits and rents for being taxed, apart from enabling the levy of user charges. Infrastructure plays a crucial role in creating access, which in turn generates value and financial returns through a process of value generation, capture, and reinvestment. Nevertheless, the connection between infrastructure and externalities is frequently disregarded in developing nations such as India, akin to the oversight of the role of cities in the development conversation. Paradoxically, these countries have not exploited the power of planned urban development to self-finance the urban infrastructure needed, capitalising on spillover effects of urban externalities. The result has been a benign neglect of urban infrastructure striking at the very route of economic growth.

3.4. Agglomeration Rent and Infrastructure Financing

The interactions between core urban infrastructure investments and externalities of agglomeration and networking in city regions catalyse economic growth, unearned benefits to many actors and tax bases of all governments. Transport economics suggests that major urban transport investments lead to enhanced access to the economic mass, agglomeration economies, “accessibility premium” and “wider economic benefits” (WEBs) (Venables 2007, Vickerman 2008, Mackie, Graham and Laird 2011). Venables (2007) examines the impact of infrastructure development on the Central Business District (CBD) and applies the monocentric city model of urban economics to assess the role of transportation improvements in enhancing economic growth and productivity. Through the application of a spatial computable general equilibrium (SCGE) model, he illustrates that transportation investments can yield significant external advantages, quantifiable through the elasticity of productivity concerning employment density. Improved transportation reduces commute costs, leading to increased employment opportunities in the CBD. This, in turn, generates higher productivity among workers due to agglomeration economies. Workers enjoy higher wages, landowners see increased rents, and the government gains from elevated tax revenues. By integrating agglomeration effects into the production framework, the analysis unveils supplementary advantages for commuting trips, ranging from 85 to 147 per cent when compared to conventional benefit-cost analysis.

In Venables' model, it is assumed that all employment is centralized within the Central Business District (CBD), and individuals residing in different areas of the city travel to the CBD for work. Residing in the city involves certain expenditures, and there is a balancing act between housing costs (land rent) and commuting expenditures. To attain spatial equilibrium, workers are deemed to be indifferent between various locations, particularly at the margin. The city continues to grow until the point at which commuting costs reach a level where workers are equally satisfied with either living on the city's periphery and commuting to the CBD or residing and working in non-urban regions. The spatial equilibrium condition, without factoring in taxes on wages, can be expressed as follows:

$$w_u = w_e + \tau d \text{ or, } w_u - w_e = \tau d \tag{3.8}$$

In the spatial equilibrium condition, the variables can be defined as follows:
w_u represents wage in the CBD, w_e implies wage at the city edge, τ denotes the uniform commuting cost per unit distance, and d stands for the distance to the CBD.

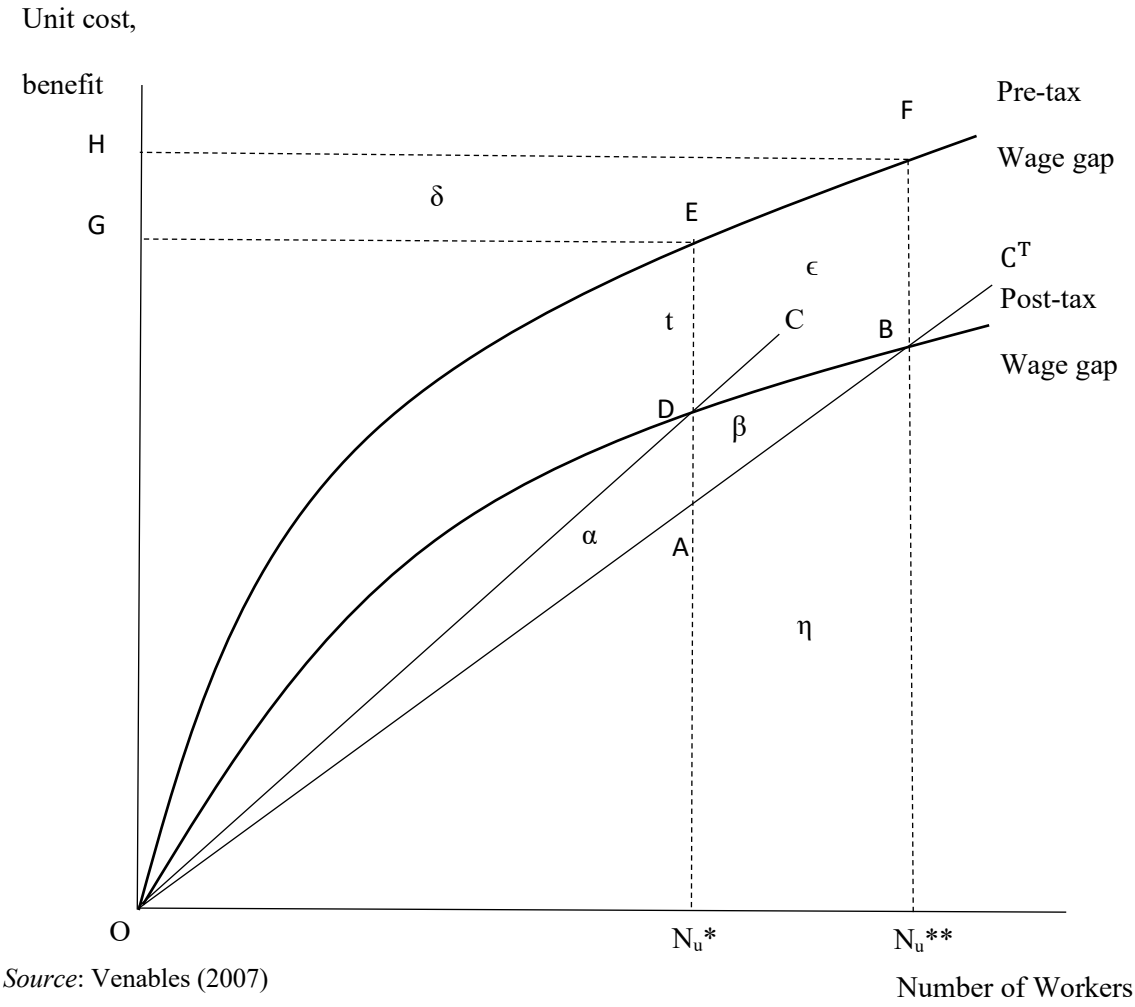
To simplify the analysis, agglomeration economies are assumed to be dependent on the size of the city, represented by its population, N_u. The wage gap between the CBD (w_u) and the city edge (w_e) is assumed to increase as the city's population grows. Additionally, considering that the government imposes a tax rate (t) on the wage at the CBD, the condition for post-tax spatial equilibrium can be expressed as follows:

$$(1 - t)w_u = w_e + \tau d \text{ or, } (1 - t)w_u - w_e = \tau d \quad (3.9)$$

Figure 3.1 illustrates Venable's model, showcasing the pre-tax and post-tax wage gap as increasing functions of the number of workers, N_u, attributed to agglomeration economies. The equilibrium size of the city, denoted as N_u^*, is determined by the point of intersection between the post-tax wage gap curve and the commuting cost curve C. It is assumed that the commuting cost curve C increases as the number of workers, N_u, increases. The equilibrium city size is determined by the point of intersection between the post-tax wage gap curve and the commuting cost curve C. In the scenario where C decreases to C^T due to transportation improvements, the equilibrium shifts to N_u^{**}. Let's denote η as the difference between N_u^* and N_u^{**} α as the length OAD, β as the length ABD, ε as the area AEFB, and δ as the area GHFE. With the increase in the number of workers from N_u^* to N_u^{**},the resource cost of commuting, represented by $\eta - \alpha$, increases. On the other hand, the increase in output is given by $\delta + \varepsilon + \beta + \eta$. Therefore, there is a net gain in real income equal to $\alpha + \beta + \delta + \varepsilon$. The area ε represents the tax wedge effect, while δ captures the impacts of agglomeration externalities on productivity, which can be interpreted as a measure of the elasticity of productivity with respect to city size.

Figure 3.1

Net Gains from Transport Improvement with Endogenous Productivity



Source: Venables (2007)

The Venables model, as illustrated above, aims to elucidate the consequences of a transportation improvement within a city. It demonstrates that such an improvement leads to economic growth, increased productivity, and a net gain in real income within the Central Business District (CBD). This phenomenon can also be extended to an entire economy on a whole with improvement in infrastructure. Infrastructure investment can generate additional employment opportunities by improving living conditions and create competitive forces by improving connectivity. Investing in infrastructure can enhance efficiency and decrease the costs of production inputs. This includes reducing expenses related to skilled labour, material assembly, and other components. Additionally, expanding infrastructure capacity results in improved service quality, benefiting various aspects of production. Importantly, infrastructure

investments impact agglomeration through δ and tax-based effects. These effects are only realized through investments in infrastructure and the presence of agglomeration economies. The positive impacts on costs and quality of service cannot be achieved without the necessary investment in urban infrastructure. To finance such investments, a portion of the financial benefits can be set aside in an escrow fund dedicated to supporting future urban infrastructure projects that contribute to these effects.

3.5. Land Value Tax and Infrastructure Financing

Land values in cities soar due to spatial concentration of economic activity, agglomeration and networking externalities and infrastructure investments. The owner of land in advantageous locations benefits from unearned increases in land values. Therefore, land rent or land value serves as a justifiable means of funding infrastructure development in cities. This fact is emphasized by the Henry George Theorem. A variation of the Henry George Theorem, which supports the taxation of land rent or land value, is outlined below using a simple mathematical model (Stiglitz 1977; Arnott and Stiglitz 1979; Atkinson and Stiglitz 1980).

Proceeding to examine an economy operating under competitive conditions, wherein there is a private good, referred to as X, and a public good, denoted as Z. The distinctive features of this economy can be outlined as follows:

Private Good Production Function: $Y = f(N)$ (3.10)

Y = Output of private good and N = Population or labour force

$\frac{\partial Y}{\partial N} = f'(N)$= Marginal product of labour (3.11)

Endowment Constraint: $Y = f(N) = xN + Z$ (3.12)

x = Consumption of private good and Z = Consumption of public good.

In this scenario, it is assumed that every individual within the economy consumes an equal quantity of the private good, denoted as x. Additionally, it is assumed that land rents are evenly distributed among all individuals.

Utility Function of the Representative Individual: $U = U(x, Z)$ (3.13)

Social Welfare Maximization Problem: Maximise $U = U(x, Z)$ subject to $f(N) = xN + Z$.
Figure 3.2 depicts the determination of the socially optimal level of public goods.

Combining (3.13), (3.12) and (3.10), the problem can be reduced to the unconstrained optimization problem:

Maximise $U = U(\frac{f(N) - Z}{N}, Z)$ (3.14)

First order conditions:

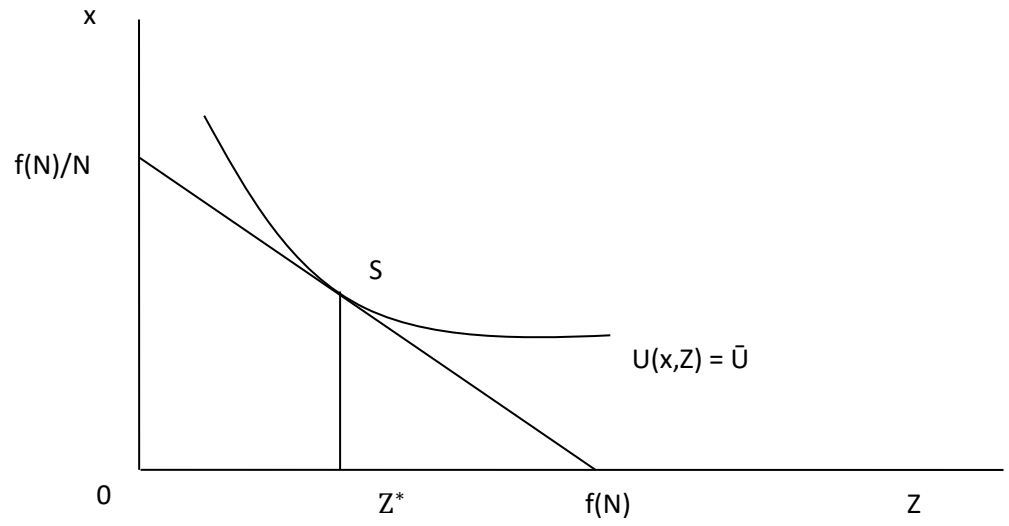
$$\frac{\partial U}{\partial x}[Nf'(N) - f(N) + Z]\frac{1}{N^2} = 0 \text{ or, } Z = f(N) - Nf'(N) \quad (3.15)$$

$$\frac{\partial U}{\partial x}\left(-\frac{1}{N}\right) + \frac{\partial U}{\partial Z} = 0 \text{ or, } \frac{\partial U}{\partial x} = N\frac{\partial U}{\partial Z} \quad (3.16)$$

Condition 3.16 introduces the Samuelsonian rule, which outlines the efficient provision of public goods. According to this rule, the marginal product of labour in a competitive setting is equal to the real wage, indicating that the wage payment equals $Nf'(N)$. Consequently, equation (3.15) implies that the optimal level of public goods is equivalent to aggregate land rents (total production minus wage payment), aligning with the principles of the Henry George theorem. It is essential to note that the aforementioned outcome relies on the simplified framework have adopted above. Nevertheless, the implication regarding the utilization of land rent taxation (or land value taxation - LVT) as a potent tool for financing public expenditures is unmistakable.

Figure 3.2

Henry George Theorem: Utility Maximization



3.6. Congestion Charging and Infrastructure Financing

Cities create congestion externalities due to high density and traffic. They present a legitimate case congestion charging to mitigate the externality effects and also generate resources for capacity expansion. The Mohring-Harwitz Theorem in the field of transport economics proposes that congestion charging achieves a break-even point, meaning it generates sufficient funds to finance an optimal capacity infrastructure investment. A simplified rendition of the Mohring-Harwitz Theorem is presented below, drawing upon the works of Mohring and Harwitz (1962) and Mohring (1972).

Consider a congestible public good, such as a highway, which accommodates a certain number of users denoted as x, with a capacity represented by c. In this context, the capacity utilization ratio can be calculated as $\frac{x}{c}$. Now, the cost of congestion for an individual user or private trip cost (PTC) is as follows:

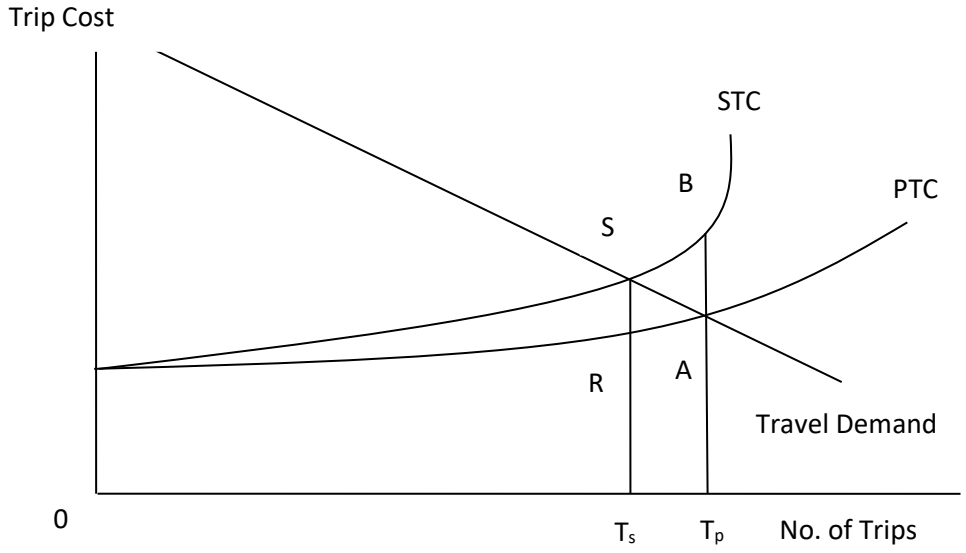
$g = g(\frac{x}{c})$ where $g'(\frac{x}{c}) > 0$ due to congestion externalities (3.17)

The total cost of congestion, denoted as aggregate congestion cost, can be represented as $xg(\frac{x}{c})$, where g(x/c) captures the relationship between congestion and the capacity utilization ratio. The marginal social cost of travel on the highway, known as the social trip cost (STC), can be expressed as $g(\frac{x}{c}) + xg'(\frac{x}{c})$. It is worth noting that the STC curve will be positioned above the private trip cost (PTC) curve due to the positive nature of $g'(\frac{x}{c}) > 0$, indicating that as the capacity utilization ratio increases, the marginal social cost of travel also rises.

Figure 3.3 displays both the private trip cost (PTC) and social trip cost (STC) functions, both of which exhibit upward slopes. The travel demand function, on the other hand, is represented by a downward-sloping curve. At the equilibrium point, denoted as T_p, under free market conditions, the number of trips is balanced. Conversely, the socially optimal number of trips is indicated as T_S. Given that T_S is less than T_p ($T_S < T_P$), implementing a Pigovian congestion toll equivalent to SR would result in achieving the socially optimal outcome.

Figure 3.3

Congestion Pricing



Assume that K represents the construction cost per unit capacity, resulting in the total construction cost being equal to cK, where c represents the capacity. The overall cost to society is the sum of the construction cost and the aggregate congestion cost.

$$C = cK + xg(\frac{x}{c}) \quad (3.18)$$

The optimization problem faced by society is to determine the capacity, denoted as c, that minimizes the total cost, represented as C. The first-order condition for this optimization problem is:

$$\frac{\partial C}{\partial c} = K - (\frac{x^2}{c^2})g'(\frac{x}{c}) = 0 \text{ or, } K - (\frac{x^2}{c^2})g'(\frac{x}{c}) = 0 \text{ or, } cK = \text{Construction cost} = (\frac{x^2}{c})g(\frac{x}{c}) \quad (3.19)$$

After implementing optimal capacity on the highway, consider the congestion pricing strategy. With each additional road user, the congestion cost for all other users increases by $\frac{\partial g}{\partial x} = (\frac{1}{c})g'(\frac{x}{c})$. Since there are x users affected by this external cost, each user will be responsible for paying a Pigovian toll of $x(\frac{1}{c})g'(\frac{x}{c})$ under the congestion pricing scheme. Consequently, the total revenue generated from congestion charging will be equal to:

$$R = x(\frac{x}{c})g'(\frac{x}{c}) = (\frac{x^2}{c})g'(\frac{x}{c}) \quad (3.20)$$

By comparing equations (3.19) and (3.20), the observation is that the total construction cost of the highway is equal to the revenue generated from the aggregate congestion toll. This suggests that congestion pricing achieves a break-even point. It is important to note that the aforementioned Mohring-Harwitz theorem is contingent upon the simplified assumptions made in its formulation. Nevertheless, the theoretical foundation supporting the implementation of congestion charging schemes, as seen in cities like Singapore, London, and Stockholm, remains robust and clear.

3.7. A Model for Urban Infrastructure Financing

In this proposed framework for financing infrastructure in smart cities, the present study integrates the theories of wider economic benefits (Venable's Model), land value taxation (Henry George Theorem), and congestion charging (Mohring-Harwitz Theorem). By combining these concepts, the aim is to develop a comprehensive and robust model that can effectively support infrastructure funding in smart cities.

Urban Production Function with Agglomeration externalities:

$$X = f(N) = g(Z, N)f(N) \tag{3.21}$$

$$\frac{\partial g}{\partial Z} > 0 ; \frac{\partial g}{\partial N} > 0; \frac{\partial f}{\partial N} > 0$$

$$\frac{\partial^2 g}{\partial Z^2} < 0 ; \frac{\partial^2 g}{\partial N^2} < 0 ; \frac{\partial^2 f}{\partial N^2} < 0$$

X is urban production function

g is agglomeration function

N is urban population

Z is urban infrastructure (Congestible local public good)

Infrastructure Cost Function:

$$C = C(Z, N) \tag{3.22}$$

$$\frac{\partial C}{\partial Z} > 0; \frac{\partial C}{\partial N} > 0$$

Representative City Household's utility function

$$u = u(x, h, Z) \tag{3.23}$$

$$\frac{\partial u}{\partial x} > 0 ; \frac{\partial u}{\partial h} > 0 ; \frac{\partial u}{\partial z} > 0$$

x is a private good assumed to be a numeraire

h is housing (assuming, 1 unit of housing equals 1 unit of land)

Z is public good/urban infrastructure

Society's Budget Constraints:

Endowment Constraint: $g(Z,N)\mathrm{f(N)} = \mathrm{Nx+C(Z,\ N)}$ (3.24)

Urban Land Constraint: $T = Nh$ (3.25)

Society's Optimisation Problem:

$Max\ u = u(x,h,z)\ subject\ to$

$g(Z,N)\mathrm{f(N)}\ =\ \mathrm{Nx + C(Z,N)}\ \ and\ T = Nh$

Forming Lagrangean, $\int = u(x,h,z) + \lambda[g(Z,N)\mathrm{f(N)} - \mathrm{Nx} - \mathrm{C(Z,N)}] + \mu(\mathrm{T} - \mathrm{Nh})$ (3.26)

First Order Conditions,

$\frac{\partial \int}{\partial \mathrm{x}} = \frac{\partial \mathrm{u}}{\partial \mathrm{x}} - \lambda N = 0$ or, $u_x = \lambda N$ (3.27)

$\frac{\partial \int}{\partial \mathrm{h}} = \frac{\partial \mathrm{u}}{\partial \mathrm{h}} - \mu N = 0$ or, $u_h = \mu N$ (3.28)

$\frac{\partial \int}{\partial \mathrm{z}} = \frac{\partial \mathrm{u}}{\partial \mathrm{z}} + \lambda[f(N)\frac{\partial \mathrm{g}}{\partial \mathrm{z}} - \frac{\partial \mathrm{C}}{\partial \mathrm{z}}] = 0$ or, $U_z + \lambda f(N)\frac{\partial \mathrm{g}}{\partial \mathrm{z}} = C_z$ (3.29)

$\frac{\partial \int}{\partial \mathrm{N}} = \lambda\left[g\frac{\partial \mathrm{f}}{\partial \mathrm{N}} + f\ \frac{\partial \mathrm{g}}{\partial \mathrm{N}} - x - \frac{\partial \mathrm{C}}{\partial \mathrm{N}}\right] - \mu h = 0$ or, $g\frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f}\frac{\partial \mathrm{g}}{\partial \mathrm{N}} - \mathrm{x} - \mathrm{C_N} = \frac{\mu}{\lambda}\mathrm{h}$ (3.30)

$\frac{\partial \int}{\partial \lambda} = \mathrm{g(Z,N)f(N)} - \mathrm{Nx} - \mathrm{C(Z,N)} = 0$ or, $C(Z,N) = g(Z,N)f(N) - Nx$ (3.31)

$\frac{\partial \int}{\partial \mu} = \mathrm{T} - \mathrm{Nh} = 0$ or, $T = Nh$ (3.32)

From (3.27) and (3.28) we get,

$\frac{\mu}{\lambda} = \frac{u_h}{u_x}$ (3.33)

From (3.29), substituting for $\lambda = \frac{u_x}{N}$ from (3.27):

$u_z + \frac{u_x}{N}f(N)\frac{\partial g}{\partial z} = \frac{u_x}{N}C_z$ or, $N\frac{u_z}{u_x} + f(N)\frac{\partial g}{\partial z} = C_z$ (3.34)

(3.34) implies that at the margin, the benefits of increase in investment in Z, taking both consumption and production side equal the cost increase due to such investment.

From (3.30) using (3.33) i.e., $\frac{\mu}{\lambda} = \frac{u_h}{u_x}$

$$g\frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f}\frac{\partial \mathrm{g}}{\partial \mathrm{N}} - \mathrm{x} - \mathrm{C_N} = \frac{u_h}{u_x}\mathrm{h} \tag{3.30}$$

Multiplying both sides by N,

$N[g\frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f}\frac{\partial \mathrm{g}}{\partial \mathrm{N}}] - \mathrm{Nx} - \mathrm{NC_N} = \frac{u_h}{u_x}\mathrm{Nh}$ or,

Using (3.32):

$N\left[g\frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f}\frac{\partial \mathrm{g}}{\partial \mathrm{N}}\right] - \mathrm{Nx} - \mathrm{NC_N} = \frac{u_h}{u_x}\mathrm{T}$ or,

$$Nx = N\left[g\frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f}\frac{\partial \mathrm{g}}{\partial \mathrm{N}}\right] - \mathrm{NC_N} = \frac{u_h}{u_x}\mathrm{T} \tag{3.35}$$

Using (3.35), (3.31) yields:

$$C(Z,N) = g(Z,N)f(N) - N\left[g\frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f}\frac{\partial \mathrm{g}}{\partial \mathrm{N}}\right] + \mathrm{NC_N} + \frac{u_h}{u_x}\mathrm{T}. \tag{3.36}$$

Note:

$g\frac{\partial f}{\partial N}$ is the wage under competitive conditions

$g\frac{\partial f}{\partial N} + f\frac{\partial g}{\partial N}$ is the wage recognised by the society taking into account agglomeration externalities.

The ratio $\frac{u_h}{u_x}$ represents the marginal rate of transformation between housing (land) and the numeraire private good. This ratio also corresponds to the price ratios at equilibrium or the land rent when the price of the private good is equal to one.

$\frac{u_h}{u_x}\mathrm{T}$ is the rent to land or under competitive conditions is the aggregate residual rent.

C_N is the Pigovian Toll for Congestible Public Good

NC_N is the Aggregate Pigovian Congestion Toll

Therefore, equation (3.36) states that the cost of providing public infrastructure is equal to the combined sum of revenues derived from agglomeration rent, congestion tolls, and land rent Panda et.al (2020).

$$C(Z,N) = Agglomeration\ Rent + Congestion\ Toll + Land\ Rent$$

This result is powerful and provides theoretically elegant and practically attractive ways to financing urban infrastructure in smart cities of developing countries.

3.8. A Tool-box of Financing Instruments

The discussions in the previous sections suggest that smart cities need to be empowered with (i) taxes on agglomeration rents, (ii) taxes on land rents/land value tax/land value increment tax and (iii) congestion charges/taxes. Based on the theoretical model, Table 3.2 provides a toolbox of instruments aimed at financing urban infrastructure in developing countries, with a particular focus on smart cities.

Table 3.2

A Tool-box of Financing Infrastructure in Smart Cities

Category	Instruments
Beneficiary Pay Charges	
User charges	Water supply charges; Park entrance fees; Charges for public transportation services, etc.
Benefit charges	Sewerage and storm drainage charges hooked onto water charges; Access or connectivity charges to water, sewerage, drainage and road networks; Charges for roads, street lighting, solid waste management, fire and other services linked to property characteristics such as plinth area or unit area value, capital value, plot frontage, road width, etc.
Special assessments	The financing of costs associated with internal and external infrastructure and services in designated areas can be facilitated through various charges imposed on residents. These charges encompass a range of facilities, including roads, public transport, street lighting, water supply, sewerage, drainage, fire protection, and more. Additionally, betterment charges may also be implemented as part of the financing mechanism.
Land-based Taxes	
Planning-related charges	Land use conversion charges, development charges, external

	development charges, and impact fees are examples of mechanisms used to manage the financial aspects of land development and infrastructure. These charges are imposed to cover the costs associated with converting land use, undertaking development projects, facilitating external infrastructure development, and addressing the impact of new developments on the surrounding area.
Land-based benefit taxes	Property tax, land value tax, vacant land tax, land value increment tax, land hoarding tax, and stamp duty/property registration tax are various forms of taxes and fees related to real estate and property transactions. These mechanisms are implemented to generate revenue, capture the value of land, discourage land speculation or hoarding, and ensure fair taxation based on property values and transactions.
Agglomeration-related taxes	
Local agglomeration taxes	Entertainment tax; advertisement tax; profession tax; payroll tax; business licensing tax.
General taxes	Local option taxes, also known as piggyback taxes, refer to the additional taxes imposed by cities or local authorities on various sources of revenue. These can include income tax, business tax, excise tax, sales tax, value-added tax (VAT), goods and services tax (GST), and other similar taxes. Local governments may opt to levy surcharges on these taxes or receive a share of the revenue generated, particularly in the case of the GST. This enables local authorities to supplement their funding and support infrastructure development and services at the local level.
Congestion Charging Instruments	
Congestion charges	Road toll (Pigovian)
Congestion-related taxes	Motor vehicle tax; motor fuel tax; tax on registration of vehicles, etc

Source: Mohanty (2016); Panda et.al (2020) Author

3.9. Conclusion

The concept of 'smart city' initiatives is gaining increasing traction in developing regions around the world. Nevertheless, cities must be established upon fundamental pillars of planning, financing, and governance prior to attaining smart status. Put simply, the implementation of smart tools and techniques relies on the current condition of urban infrastructure and how it is financed. In this context, the theories of agglomeration rents, as expounded by the Henry George Theorem and the Mohring-Harwitz Theorem, offer valuable theoretical insights and practical principles for designing strategies to finance city infrastructure and services in developing countries. These theories propose two fundamental paradigms: "beneficiaries pay" and "congesters pay." These principles serve as the essential cornerstones for a resilient urban public finance system. The Henry George theorem acknowledges landowners as the primary beneficiaries of intentional urban development and growth. Nonetheless, urban economics and the research on new economic geography (NEG) propose that the advantages of agglomeration externalities in cities go beyond just land. These benefits materialize in the form of "agglomeration rents" that accrue to both immobile and mobile factors of production through the mechanisms of agglomeration economies. New economic geography (NEG) theorists contend that when potent agglomeration forces are present, mobile factors in cities also gain substantial advantages in the form of rents, which can be taxed without diminishing the tax base. The discussion between Stiglitz and Piketty underscores different types of rents, such as monopoly rents, rents from natural resources, and returns to capital. Ironically, the approach to funding urban infrastructure and services in developing nations such as India often fails to sufficiently take into account the notion of agglomeration rents or the principles drawn from the Henry George Theorem and the literature on new economic geography (NEG). Likewise, the formulation of urban financing mechanisms neglects to incorporate the insights offered by the Mohring-Harwitz theory, which recommends pricing congestible local public goods at a level that adequately addresses the societal expenses associated with congestion. The models proposed by Venables, the Henry George Theorem, and the Mohring-Harwitz Theorem have garnered limited consideration from scholars and policymakers in developing nations like India. This chapter strives to help bridge this research gap by addressing two key aspects: (i)

emphasizing the significance of cities and their various externalities and (ii) proposing a theoretically sound model for city financing that incorporates the taxation of agglomeration rent, land taxation, and the use of payment mechanisms such as "users pay," "beneficiaries pay," "congesters pay," "polluters pay," "exacerbaters pay," and "growth pay. Future research endeavours could focus on exploring empirical evidence regarding the externalities generated by cities and the rents they generate. The existing theoretical framework and empirical evidence from developed countries suggest that adopting taxation measures targeting "agglomeration rents," "land rents," and various payment instruments can potentially enable self-financing during the course of deliberate urban development in countries such as India. The fundamental assumption is that cities generate substantial agglomeration and congestion externalities, and any urban financing approach must explicitly take these aspects into account. By recognizing externalities as a valuable resource for urban development, cities can pursue a win-win strategy that benefits all participants in the urban economy.

Chapter 4

Role of Infrastructure and Urbanization on Economic Growth in Indian States: A Panel Study (2005-19)

4.1. Introduction

The Commission on Population and Development's 2018 report foresees a predominantly urban world in the future. The global arrangement of people is heavily impacted by urbanization, given that over 50 per cent of the world's population currently lives in urban regions. At present, the population living in urban environments exceeds those living in rural settings. According to the results of the 2018 World Urbanization Prospects report, urban areas accommodated 55 per cent of the total global population. Urbanization process, with its direct and indirect consequences, influences the sustainability of economic growth and overall development. Urban areas create and enhance agglomeration economies by constituting a large knowledge pool by the creation and diffusion of ideas, innovation, and technology (Glaeser 2011). Cities have the potential to create wider economic benefits (WEBs). Moreover, urbanization has a pivotal role in fostering economic growth. This is substantiated by the idea that investing in urban infrastructure generates substantial multiplier effects due to network externalities. The growth of urban regions functions as a primary catalyst for economic advancement. By leveraging urbanization externalities, particularly in conjunction with core infrastructure advancements, it becomes possible to generate financial resources for additional investments.

As countries undergo economic development, urbanization tends to occur as a natural progression. This progression entails a structural shift from an economy rooted in agriculture to one propelled by industry and services (Henderson 2003).The concentration of firms and labor in cities is influenced by agglomeration and network externalities (Henderson 1974; Quigley 1998; Duranton and Puga 2004; Glaeser 2011). According to Marshall (1890), a firm's production costs decline as its industry size grows, owing to improved access to local infrastructure and the sharing of knowledge within the industry. Such localization economies arise due to knowledge spillovers among firms in a single industry as emphasized by

Marshall (1890), Arrow (1962) and Romer (1986), popularly referred as MAR spillovers. There also exists Jane Jacobs externalities. Such externalities arise as cities attract industries to co-locate and create inter-industry linkages. Porter externalities arise as industries compete (Gleaser et. al. 1992). All these lead to localization and urbanization economies that create growth with the diversity of economic activity, labour pooling, input sharing and knowledge spillovers. Zheng (2010) talks about network dynamic externality, which refers to knowledge spillovers from an agglomeration. All these make cities special and distinctive.

The existing literature on urbanization has mainly focused on urban concentration, optimal city size, infrastructure led externalities and core-periphery models. However, only a limited number of models have attempted to examine the interconnectedness of economic growth, urbanization, and, specifically, the development of "agglomerating and networking" infrastructure. Urbanization provides the breeding ground on which infrastructure compounds the benefits leading to economic growth.

The current chapter hinges upon twin objectives: first to analyse the effect of “agglomerating and networking” infrastructural services and urbanization on economic expansion for a panel data set from 2005-2019 on 20 major Indian states. The research also delves into exploring the causal connections between infrastructure, urbanization, and economic growth in both the short-run and long-run contexts. Second, is to present an analytical case for, how infrastructure propelled by urbanization can be self-financing. This study stands apart from prior research due to its distinctive approach in constructing a multidimensional infrastructure index and its utilization of advanced econometric tools for estimation. The novelty of this chapter is two-fold, departing from the existing previous literature, the chapter supplements the construction of the infrastructure index by considering four dimensions apart from applying Principal Component Analysis. Secondly, a state level analysis of India has been done by basing on this dimensional index.

The following chapter is structured as follows: Section 4.2 offers a comprehensive analysis of the urbanization status within Indian states. In Section 4.3, an overview of the existing empirical literature concerning economic growth, urbanization, and infrastructure is presented. The data employed in this study is thoroughly described, along with the methodology used, in Section 4.4. The outcomes of the empirical analysis are delineated in Section 4.5. Lastly, the chapter concludes with Section 4.6.

4.2. Urbanization in Indian States

India is positioned as the 6th largest economy globally, based on its total GDP, among the leading economies (World Bank 2020). The growth rate of India is gaining momentum, with cities playing a significant role in driving this growth. This fact is substantiated by the statistic that urban areas contribute 65 per cent to India's GDP (Planning Commission 2011). The proportion of the urban population in India is 31.1 per cent of the total population, and this urban population is experiencing an annual growth rate of 2.76 per cent, as reported by the Census of India in 2011. Table 4.1 showcases the trends in urban population and population growth rates, as observed in the respective censuses conducted in India. It illustrates that the urban population has witnessed nearly a five-fold increase during the last five decades, spanning from 1961 to 2011.

Table 4.1

Trends of Indian Urbanization

Census year	Urban population (in million)	Urbanization Rate	Annual exponential urban growth rate
1961	78.94	17.97	-
1971	109.11	19.91	3.23
1981	159.46	23.34	3.79
1991	217.18	25.72	3.09
2001	286.12	27.86	2.75
2011	377.10	31.16	2.76

Source: Respective year Census of India

The Indian urbanization definition is characterized by certain restrictions, which subsequently lead to lower figures in the aforementioned table. Since 1961, the census report has followed specific criteria to define urban areas, which include:

- Locations featuring a municipality, corporation, cantonment board, or a designated town area committee, among other designations.
- Other locations that fulfil the following criteria:
    (i) Having a minimum population of 5000.

(ii) With a minimum 75 per cent of the male working population engaged in non-agricultural pursuits

(iii) Possessing a population density of at least 400 persons per square kilo-meter.

Despite this stringent definition, India is expected to witness a significant increase in its urban population, projected to reach 43.2 per cent by 2035, as per the World Cities Report 2022. At the state level, the patterns of urbanization display great diversity. States with higher per capita income tend to experience higher rates of urban growth and/or possess a larger urban population. Table 4.2 below presents a summary of the complete urban population, the urbanization percentage, and the urban population growth rate, along with the per capita net state domestic product in constant prices (Rs.). Remarkably, states such as Delhi, Goa, Puducherry, Tamil Nadu, Gujarat, Karnataka, Kerala, and Maharashtra, which showcase the most substantial levels of urbanization, also possess the highest per capita net state domestic product among all Indian states. Therefore, urbanization presents a compelling case for fostering economic growth within India's states.

Table 4.2

Urban Population and Per Capita Net State Domestic Product for Indian States

Sl. No.	States	Per capita net state domestic product Rs. (2011-12)	Per capita net state domestic product Rs.(2020-21)	Urban Population (in million) in 2011	% Urban in 2011	Average annual urban growth rate in 2011
1	Andhra Pradesh	69000	114324	28.35	33.4	3.09
2	Arunachal Pradesh	73540	108706	0.31	22.6	3.18
3	Assam	41142	57227	4.38	14	2.43
4	Bihar	21750	28127	11.72	11.3	3.01
5	Chhattisgarh	55177	72236	5.93	23.2	3.49

6	Delhi	185001	243110	16.33	97.5	2.35
7	Goa	259444	298527	0.9	62.01	3.01
8	Gujarat	87481	160321	25.71	42.5	3.06
9	Haryana	106085	165617	8.82	34.7	3.66
10	Himachal Pradesh	87721	133079	0.68	10	1.45
11	Jharkhand	41254	51365	7.92	24	2.79
12	Karnataka	90263	154123	23.56	38.5	2.72
13	Kerala	97912	134878	15.93	47.5	6.56
14	Madhya Pradesh	38497	58334	20.05	27.6	2.28
15	Maharashtra	99597	133356	50.82	45.2	2.12
16	Odisha	48387	71622	6.99	16.6	2.37
17	Puducherry	119649	147483	0.85	68.3	2.71
18	Punjab	85577	112119	10.38	37.4	2.28
19	Rajasthan	57192	74009	17.08	22.8	2.56
20	Tamil Nadu	93112	143528	34.94	48.4	2.4
21	Uttar Pradesh	32002	39371	44.7	22.2	2.52
22	Uttarakhand	100314	138191	3.09	30.5	3.49
23	West Bengal	51543	72202	29.13	31.8	2.61

Source: RBI Handbook of Statistics for Indian States

Furthermore, the McKinsey Global Institute (2010) contended that urbanization ought to be employed as a strategy to realize a seven-fold rise in per capita income within India. The report predicts that by 2030, more than 70 percent of India's GDP and the creation of new employment opportunities will originate from urban centres. Additionally, it proposes that an escalation in urbanization could result in a quadruple rise in per capita income. According to the report, India's urban population is projected to reach around 590 million by 2030, marking a significant rise from the 290 million recorded in 2001. In order to achieve the envisaged prosperity, the report suggests a set of measures, which encompasses an

additional investment of approximately $1.2 trillion by 2030. This investment is intended to tackle urban challenges and alleviate infrastructure bottlenecks.

It is crucial to note that, India's urbanization has displayed a significant concentration of both population and economic activities in major cities, leading to a 'top-heavy' urbanization pattern. As of 2001, metropolitan cities (cities boasting a population of one million or more) accommodated 37.8 per cent of the total urban population, in contrast to a mere 6 per cent in 1901. India stands out with a higher proportion of its urban population residing in metropolitan cities compared to most other countries. Notably, India is home to five out of the 33 mega cities worldwide, namely Delhi, Mumbai, Kolkata, Bangalore, and Hyderabad. Among these, Delhi holds the position of the world's second-largest city with a population of 29 million, as indicated by the World Urbanization Prospects 2018.

4.3. Literature Review

Urban economies serve as the driving force behind a nation's wealth. (Jacobs 1984). They are strongly connected with the growth generating forces in an economy (Henderson 1988; Rahman et al., 2006). According to Nakamura's study in 1985, it was demonstrated that multiplying the urban population by a factor of 2 in Japan could lead to a productivity increase of 3.4 per cent. Findings of Ciccone and Hall (1996), implementing the same approach in the United States can lead to a notable 6 per cent rise in productivity. Henderson (2003) and various other studies propose a robust positive correlation between urbanization and per capita GDP, demonstrated by a straightforward correlation coefficient of 0.85. This seemingly arises from the fact that economic development necessarily structurally transforms any economy from an agrarian to an “industry-service” based economy (Todaro 1997). Pandey (1977) conducted an empirical study on urbanization using Indian state-level census data. The objective of the study was to investigate the association between urbanization rates and several factors, encompassing population density, industrialization (quantified through non-agricultural employment), cropping intensity (used as a proxy for agricultural development), per worker income, literacy rate, and population growth. The findings of Pandey's study revealed several noteworthy insights. industrialization exerted a notable and positive impact on urbanization rates. Secondly, there was a negative effect of cropping

intensity on urbanization, indicating that higher agricultural development was associated with lower urbanization rates. However, the study did not find any significant effect of average worker income on urbanization. Pandey's estimates were based on simple cross-section OLS and hence faced endogeneity issues.

Moomaw and Shatter (1996) conducted a comprehensive study that examined a broader range of determinants associated with urbanization. They explored the interconnections between these determinants, considering their influence not only on the overall urbanization rate but also on metropolitan concentration (the proportion of the urban residents in cities with populations greater than 100,000) and urban primacy (the proportion of the urban population located in the largest city). The study considered several factors including GDP per capita, industrial development, export orientation, external aid, and political forces. The findings of Moomaw and Shatter's research indicated that certain factors were positively associated with the urban population percentage. These factors included higher GDP per capita, increased industrialization, greater export orientation, and higher levels of foreign assistance. By examining the link between these determinants and different measures of urbanization (overall urbanization rate, metropolitan concentration, and urban primacy), Moomaw and Shatter provided a more nuanced understanding of the relationship between various factors and urbanization dynamics. Black and Henderson (1999) conducted a study focusing on individual city sizes in the United States and their relationship with human capital accumulation. The study assessed the accumulation of human capital by analysing the proportion of workers in the labour force with college education. The findings of Black and Henderson revealed a positive association between city sizes and human capital accumulation. In other words, cities with a higher percentage of college-educated workers tended to experience growth in terms of their population and size. This study illuminates the significance of human capital, particularly educational attainment, for propelling urban development within the United States. It suggests that cities with a higher concentration of educated workers tend to attract more residents and experience economic expansion.

Henderson (2003) tries to quantitatively analyse the causal relationships that connect both urban and GDP growth through instrumental variable (IV)/generalized method of moments (GMM) approach. Employing a cross-country panel data, the researcher gauges the influence of both urbanization and urban primacy on growth of productivity, specifically focusing on the increase in output per worker. Instrumental variables are employed to address

the existence of potential endogeneity issues. The findings of the study indicate a significant effect of urban primacy on productivity enhancements. This indicates that a greater degree of urban concentration, represented by the percentage of the urban population residing in the largest city, is linked to enhanced productivity. The study provides empirical evidence of the inter-relationships between urban primacy and productivity enhancements, offering insights into the importance of urban development and concentration for economic performance.

Anett Hofmann and Guanghua Wan (2013) estimate that for every 1 per cent increase in economic growth, there is a corresponding 0.9 per cent rise in urbanization. This implies a favourable correlation between economic growth and urbanization. Additionally, the study establishes a significant causal impact of education on the urbanization rate. Based on their discoveries, a rise of one year in average schooling is linked to a two-percentage-point upturn in urbanization. This implies that education plays a crucial role in driving urbanization processes. These findings highlight the importance of economic growth and education as factors influencing urbanization. Economic growth appears to be positively associated with urbanization, while education demonstrates a causal effect on urbanization rates. Tripathi's (2017) study focused on examining India's Class I cities has discovered that enhancing infrastructure facilities might not lead to a significant rise in population concentration (measured by factors such as size, density, and population growth) within these major cities. However, it can considerably enhance the cities' potential contribution to India's national economic growth. This improvement is achieved by enhancing the quality of living conditions and facilitating business activities. Lewis (2014) conducted a study on Indonesia, utilizing data spanning from 1960 to 2009, and established a positive link between urbanization and economic expansion. However, the study stated that the rate at which urbanization changes negatively correlates with economic output. The conclusion drawn from this observation is that a lack of adequate local infrastructure financing is connected to this adverse relationship. In a paper of Wang et al. (2019), it was revealed that a bidirectional causality exists between urban growth and road transportation sector energy consumption. The findings revealed that economic growth has a Granger causality effect on energy consumption of the road sector, as well as urban growth and road infrastructure. In other words, economic growth influences the consumption of energy in the roadways transport sector, and urbanization and road infrastructure are also affected by economic growth. Timilsina et. al 2022 comprehensively establish a link between infrastructure, urbanisation

and economic growth. Backed by strong empirical estimation results, they state that urbanisation and economic growth are the major determinants of infrastructure development for Indian states. These inter-linkage between urbanization, infrastructure and economic growth need a further literature support as stated below.

Urbanisation and Economic Growth

Cities with greater population density yield elevated rates of economic growth (Jedwab & Vollrath 2015). In a study conducted by Moomaw and Shatter (1996), various measures of urbanization and urban concentration were regressed against growth, revealing that concentration in metropolitan regions have a positive impact on growth. This indicates that regions characterized by elevated levels of urban concentration encounter more rapid rates of economic growth. Similarly, McCoskey and Kao (1998) employed panel cointegration techniques to examine the long-run effects of urbanization on growth. Their findings suggest that the long-term impacts of urbanization on growth cannot be dismissed. This implies that urbanization has enduring effects on economic growth, further highlighting its significance as a determinant of economic development.

There are several studies that have analysed role of urban expansion on economic growth (Fay and Opal 2000; Henderson 2002; Turok and McGranahan 2013; Chen et al. 2014; Bao and Chen 2015; Liddle and Messinis 2015; Mohanty and Mishra 2015; Li 2017). Studies are divided among urbanisation having a positive impact on growth (Henderson 2003; Hansen 1990; Zi 2017; Nguyen and Nguyen 2017) to having a negative impact on growth as well (Piano et al. 2020; Etokakpan et al. 2021; and Philip et al. 2021). Empirical literature on the direction of causality also runs from urbanisation causing economic growth (Gallup et al.1999; Cheng 2013; Liu, Su and Jiang 2015; Zi 2017; Song et al. 2018; Gross and Ouyang 2020) to economic growth causing urbanization (Hofmann and Wan 2013; Pradhan et. al 2014; Zhao and Wang 2015; Arvin et. al 2015; Shaban, Kourtit, Nijkamp 2022) and also a feedback effect existing between the two (Solarin and Shahbaz 2013). Ades and Glaeser (1995), Junius (1999), Davis and Henderson (2003) and Arouri et al. (2014). Studies have found that urbanization has an inverted U-shaped correlation among GDP and the economic structure of an economy. This relationship is observed in the form of a

curvilinear pattern between the share of urban population and per capita GDP. As the urban population share increases, per capita GDP tends to rise initially, indicating a direct impact of levels of urbanization on economic output. However, beyond a certain point, further urbanization can lead to diminishing returns, resulting in a decline or slower growth in per capita GDP. This inverted U-shaped relationship suggests that there is an optimal level of urbanization beyond which the benefits start to diminish. It highlights the importance of finding a balance between urbanization and other factors for sustaining economic growth effectively. To Davis and Henderson (2003), urban population growth rate is a concave increasing pattern of level of income.

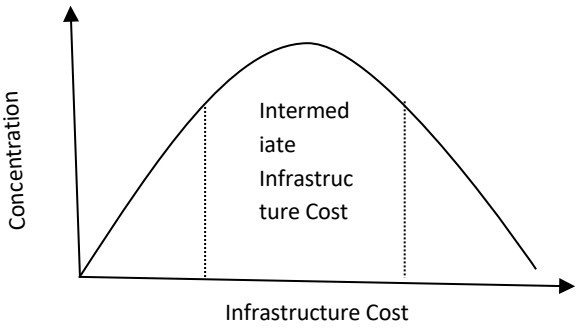
In the Indian context, an empirical analysis conducted by Cali (2008) on Indian states, the investigation revealed a temporal correlation between urbanization and economic development, indicating that they tend to coexist. However, this relationship was not particularly strong. Adding to it, the analysis revealed a clear negative correlation among the rate of urbanization (the speed at which a state urbanizes) and the rate of economic growth. This suggests that as the rate of urbanization increases, the rate of economic growth tends to decrease. Tripathi and Mahey (2017) identified a positive association between urbanization and economic growth, particularly within the context of Punjab. Ghosh and Kanjilal (2014) and Shaban et al. (2022) identified a unidirectional causality in which economic growth influences urbanization. Megeri and Kengnel (2016) investigated the connection between urbanization and economic growth in Indian states, utilizing their Human Development Index (HDI) as a basis for analysis. Their findings revealed that states with an HDI surpassing 0.5 displayed a causal relationship from growth to urbanization, whereas states with an HDI below 0.5 exhibited causality from urbanization to growth. Certain states, irrespective of their HDI levels, demonstrated bidirectional causality between urbanization and economic growth. Shaban (2019) employed cross-sectional data for Indian states in 2013 and utilized the Ordinary Least Squares (OLS) method. The study illustrated that a 1 per cent increase in the urbanization rate led to an approximate per capita income rise of Rs. 935. Furthermore, the study unveiled that the population growth of the largest million-plus city had a more pronounced effect on per capita income. Specifically, a 1 per cent increase in the population of million-plus cities resulted in a per capita income rise of Rs. 745, whereas a 1 per cent increase in the population of the largest million-plus city led to a per capita income increase of Rs. 1843 among the states.

Urbanisation and Infrastructure

Infrastructure costs hold a pivotal role in influencing the extent of urbanization. When the costs associated with infrastructure are excessively high, economic activity tends to disperse. Conversely, in situations where infrastructure costs are minimal, firms could be distributed randomly, as factors like proximity to markets or suppliers become less relevant. Optimal agglomeration, however, occurs at intermediate infrastructure costs, especially when labour mobility is limited. This pattern of spatial concentration in relation to infrastructure costs is typically represented by a bell-shaped or inverted U-shaped curve, as shown in Figure 4.1.

Figure 4.1

Concentration of Economic Activity and Infrastructure Cost



Source: Lall, Shalizi and Deichmann (2004), Author

Pradhan, Arvin, and Nair (2021) undertook a comprehensive analysis utilizing a substantial and lengthy panel database, along with an extended application of the Granger test within a panel framework. Their study centered on the G-20 countries and aimed to discern the temporal causality between urbanization, transportation infrastructure, ICT infrastructure, and economic growth. The analysis unveiled that the sustained economic growth trajectory of these economies is reliant on urbanization, transportation infrastructure, and ICT infrastructure. Rice et al. (2006) established a connection between the pace of urbanization and the commuting time from less developed regions to core city centres in Great Britain. Their results highlighted that the urbanization rate peaks when the commuting time is under 40 minutes. Furthermore, they unearthed that the influence of agglomeration is fourfold more

pronounced when the commute time is 30 minutes in comparison to 60 minutes. Alam et al. (2007) contend that swift urbanization can result in diseconomies due to heightened strain on infrastructure. Elevated levels of urbanization generate an increased need for infrastructure amenities, including transportation, power, electricity, water supply, telecommunications networks, schools, and hospitals. Consequently, this calls for escalated infrastructure development (Démurger 2001; Li 2017; Maparu and Mazumder 2021).

Economic Growth and Infrastructure Nexus

The significance of infrastructural development as a pre-condition for economic growth and its positive impact on growth has been widely acknowledged in various studies Barro (1991), Barro & Sala-i-Martin (1992, 1995), Hirschman (1958), Khadaroo and Seetanah (2008), and Timilsina et al. (2021) are some of the researchers who emphasize the positive correlation between infrastructure and economic growth. Furthermore, research suggests that infrastructure not only fosters economic growth but is also impacted by it. Aschauer (1990), Khadaroo and Seetanah (2008), Tripathi and Gautam (2010), Pradhan and Bagchi (2013), and Mohmand et al. (2017) underscore the influence of economic growth on infrastructure development. Moreover, Mohmand et al. (2017) identified a bidirectional causality between infrastructure and economic growth in developed provinces of Pakistan. The literature examining the relationship between infrastructure and growth in the Indian context is extensive and encompasses studies by Ghani et al. (2013), Maparu & Mazumder (2017), Pradhan & Bagchi (2013), Sahoo & Dash (2009), and Tripathi & Gautam (2010), among others. Numerous studies underscore the pivotal role of a well-functioning infrastructure system in guaranteeing sustainable growth in India. Scholars including Pradhan & Bagchi (2013), Sanchez-Robles (1998), Shah (1992), Short & Kopp (2005), and Tripathi & Goutam (2010) accentuate the significance of infrastructure for economic development. Tripathi and Gautam (2010) and Pradhan and Bagchi (2013) specifically identify a substantial and positive long-term relationship between infrastructure and economic growth in India. Maparu and Mazumder (2017) investigate the causal connections between various sub-sectors of transport infrastructure (road, rail, air, and port infrastructure), economic development, and urbanization in India spanning the period from 1990 to 2011.

Their findings suggest that over the long term, transport infrastructure and economic development are cointegrated, with the causality typically flowing from economic development to the distinct sub-sectors of transport infrastructure. These outcomes provide support for Wagner's law. Ghosh and Dinda (2022) re-examine the correlation between transport infrastructure and economic growth in post-liberalization India. Their research uncovers bidirectional causality between overall transport infrastructure and economic growth across Indian states.

The present study centres on examining the impact of infrastructure and urbanization on economic growth in 20 prominent states of India, setting itself apart from preceding research in various aspects. Firstly, this study constructs a multidimensional infrastructure index to thoroughly assess its influence on economic growth. This approach facilitates a more nuanced comprehension of the interplay between infrastructure and economic development. Secondly, the study examines the interlinkages among urbanization, infrastructure, and economic growth by utilizing the latest available data. By incorporating up-to-date information, the study provides a current and relevant analysis of these factors. Thirdly, the study enriches the empirical framework by deepening our comprehension of the interaction among urbanization, infrastructure, and economic growth, specifically within the framework of Indian states. It introduces an analytical framework customized to the distinct attributes of these states. Fourthly, the analysis employs various econometric techniques to ensure the robustness of its findings. By utilizing different methods, the study enhances the credibility and reliability of its results. Moreover, the study offers valuable insights into the short-term and long-term effects of infrastructure and urbanization on economic growth across the 20 prominent Indian states. By considering the temporal aspects, the study offers a comprehensive understanding of the dynamics between these variables.

4.4. Methods

4.4.1 Variable Description and Data

Using available literature and data, this study investigates the correlation between economic growth, infrastructure development, and urbanization in 20 major Indian states. For the purpose, a panel data set of yearly observations of the variables is taken from the RBI Handbook of Statistics for Indian States database over the period 2005-19. Table 4.3 describes the variables used in the study. Sarma's (2008) methodology and formula is used to form an infrastructure index using available data on Agglomerating and Networking Infrastructure: Roads, National Highway, Railway and Power.

Table 4.3

List of Variables for Panel Data Analysis.

1.	$SDPPC_{it}$	Natural Log of Per capita Net State Domestic Product (Constant Rs.)
2.	UR_{it}	$Natural \log of\ \ Urbanization = \frac{Urban\ Population\ (in\ Thousands)}{Total\ Population\ (in\ Thousands)} \times 100$
3.	$Infraindex_{it}$	• The ratio of the State's total length of Roads to land area (in sq. kms) • The ratio of the State's total length of National Highways to land area (in sq. kms) • The ratio of the State's total Rail Route to land area (in sq. kms) • State-wise per capita availability of power (in kilowatt-hour)

Source: Author

This research makes use of panel data to capture the dynamic behavior of the variables and to offer stringent estimation. The regression of panel data combines cross-sectional and time series data, where that particular cross-sectional unit is observed at several points in time. In other words, the panel analysis of data consists of data from the same entities observed over a specific time period. If we have T time periods (t = 1, 2, ..., T) and N individuals (i = 1, 2, ..., N), then the total number of observation units in panel data is N x T.

If each individual has the same number of observations over time, it is referred to as a balanced panel. Conversely, if the number of time periods varies across individuals, it is considered an unbalanced panel.

In this study, the focus is on 20 major Indian states, resulting in N = 20, and the time period covers 2005-2019, resulting in T = 15. Therefore, the total observations in this study are 300. This underlying panel data is balanced. The dependent/response variable used in this framework is the natural logarithm of Net State Domestic Product per capita (SDPPC). The independent variables include the Infrastructure Index (Infraindex) and the natural logarithm of the Urbanization Rate (UR). Table 4.4 offers descriptive statistics of all the variables employed in the analysis, drawing from a balanced panel dataset encompassing the period from 2005 to 2019 and including data for 20 Indian states. The mean values for SDPPC, Infraindex, and UR are 93675.83, 0.2577823, and 37.35652, respectively. The skewness statistics for all variables fall within the range of 1-2, indicating a moderate level of skewness. Moreover, the kurtosis statistics for all variables exceed 3, indicating a heavier tail in the dataset being leptokurtic. This follows that neither of the variables are normally distributed.

Table 4.4

Descriptive Statistics

Statistics	SDPPC	Infraindex	UR
Mean	93675.83	0.21	37.36
Median	77719.5	0.17	34.77
Standard Deviation	58492.61	0.14	21.18
Maximum	313973	0.67	100.97
Minimum	11734.55	0.05	9.89
Sum	2.81e+07	63.38	11206.96
Skewness	1.38	1.73	1.12
Kurtosis	5.08	5.45	4.21
Observations	300	300	300

Source: Author's estimation

Table 4.5

Correlation Matrix

Variables	SDPPC	Infraindex	UR
SDPPC	1		
Infraindex	0.57***	1	
	(0.00)		
UR	0.59***	0.85***	1
	(0.00)	(0.00)	

Source: Author's estimation

Table 4.5 depicts the cross-correlation among all variables under consideration. The results indicate a significant positive linear association between SDPPC and UR at the significance level of 1 per cent. Similarly, a positive correlation is observed between SDPPC and Infraindex, also significant at the 1 per cent level. Furthermore, a positive and significant correlation is found between UR and Infraindex. However, it is important to note that the degree of correlation between infrastructure and urbanisation is higher (0.85) than any other pair. Prior to conducting the analysis, a unit root test is performed on the data, and the results are stated in Table 4.6. The Levin-Lin-Chu unit root test, including a time trend, indicates that all variables are stationary at the level at one per cent significance level.

Table 4.6

Unit Root Test

Variables	At level with time trend
SDPPC	-3.87***
Infraindex	-2.20**
UR	-29.59***

Source: Author's estimation

*** Stationary at significance level of 1 per cent.

** Stationary at significance level of 5 per cent.

4.4.2 Econometric Specification

Panel data models are utilized to analyse the effects of group (individual-specific) and time on the variables of interest, accounting for potential heterogeneity or unobserved individual effects. These effects can be classified as either fixed effects or random effects. The former model investigates whether intercepts differ among groups or time periods, while the later model explores variations in the components of error variance across individuals or time periods. The F-test is utilized to assess fixed effects, while the Lagrange multiplier (LM) test is applied to investigate random effects. If the null hypothesis isn't rejected in either test, the pooled ordinary least squares (OLS) regression is favoured. Thus, this study has conducted regression model estimations using panel data through three distinct approaches. Additionally, to verify the stability of the multidimensional infrastructure index, the study goes further to construct another index of Infrastructure using Principal Component Analysis (PCA).

Model 1: Pooled Ordinary Least Square Regression

Pooled OLS regression is used as a baseline model. This model pools all observations into one regression and doesn't consider time and individual dimensions.

$$SDPPC_{it} = \alpha + \beta_1 Infraindex_{it} + \beta_2 UR_{it} + \varepsilon_{it} \quad (4.1)$$

for i = 1,2, ..., N and t = 1,2, ..., T.

where:

N = number of individuals or cross section

T = the number of time periods.

Model 2: Fixed Effect Model

Fixed Effect Models deviate from the pooled model, retaining the ordinary least squares principle. The pooled model assumes a consistent intercept for each cross section and time, which is seen as less accurate. Conversely, the Fixed Effect model accommodates individual variations (cross section) by introducing distinct intercepts.

$$SDPPC_{it} = \alpha_i + \beta_1 Infraindex_{it} + \beta_2 UR_{it} + \varepsilon_{it} \quad (4.2)$$

for i = 1,2, ..., N and t = 1,2, ..., T.

where:

N = number of individuals or cross section

T = the number of time periods.

Model 3: Random Effect Model

The study employs a panel data model to address potential interconnections between variables across time and individuals. In the Random Effects model, variations in intercepts are captured by the error terms linked to each entity. This model offers the benefit of reducing heteroscedasticity and is also known as the Error Component Model (ECM) or Generalized Least Squares (GLS) technique. It is important to highlight that the random effects model differs from both the fixed effects and pooled models. Unlike the ordinary least squares (OLS) approach, the random effects model is commonly estimated using the principle of maximum likelihood or generalized least squares.

$$SDPPC_{it} = \alpha + \beta_1 Infraindex_{it} + \beta_2 UR_{it} + u_i + \varepsilon_{it} \quad (4.3)$$

for i = 1,2, ..., N and t = 1,2, ..., T.

where:

N = number of individuals or cross section

T = the number of time periods.

ε_{it} = is the residual as a whole where the residual is a combination of cross section and time series.

u_i= individual residual which is a random characteristic of the i^{th} unit observation and remains at all times.

The study explores the interrelation among economic growth, infrastructural development, and urban growth through the subsequent models. The anticipated sign of the coefficients for the independent variables is positive. To empirically validate the models, diverse econometric techniques are employed. The construction of the infrastructure index follows the methodology outlined by Sarma (2008). The presence of cross-sectional dependence across the units is assessed using the LM adjusted test introduced by Pesaran, Ullah, and Yamagata (2008). Within the panel regression analysis, Breusch-Pagan tests are employed to choose between random and fixed effects estimation approaches. To address the

concern of autocorrelation in fixed-effect models, the standard error procedure advanced by Driscoll and Kraay (1998) is implemented. Lastly, the panel causality test introduced by Dumitrescu and Hurlin (2012) is utilized as a diagnostic check for the long-run equilibrium relationship. Finally, scatter plots of the multidimensional infrastructure index (formed from Sarma's 2008 methodology) is compared with the scatter plots of PCA Infrastructure Index.

4.5. Empirical Findings

4.5.1 Infrastructure Index

To create the infrastructure index, four dimensions were considered: roads, national highways, railways, and power. The empirical data for these variables in the Indian states from 2005 to 2019 were utilized. Sarma's (2008) methodology was employed to construct the index. By applying the formula mentioned in Equation (4.4), a multidimensional infrastructure index was computed for all the dimensions. This index denotes a point within the four-dimensional Cartesian space.

$$d_i = w_i\ [(A_i - m_i)/(\ M_i - m_i)] \tag{4.4}$$

In Equation (4.4), the weight associated with dimension i is denoted as w_i, with a range of $0 \leq w_i \leq 1$; A_i represents the true value of dimension i, while m_i refers to minimum value and M_i stands for maximum value of dimension i, respectively. The value d_i corresponds to the dimension of the infrastructure index i. This equation is derived from empirical observations. The weights assigned to each dimension always fall within the range of 0 to 1, indicating that $0 \leq w_i \leq 1$. A higher value of d_i signifies greater achievement in dimension i. The present situation encompasses four aspects of the infrastructure index, with each state denoted as a coordinate in the four-dimensional Cartesian space. Within this space, the point O = (0, 0, 0, 0) signifies the least favourable state, whereas the point W = (1, 1, 1, 1) represents the pinnacle achievement across all dimensions.

To gauge the infrastructure index, it's crucial to examine the placement of the achievement point X relative to both the ideal point W and the worst point O. An elevated

level of infrastructure attainment occurs as X moves farther from O and nearer to W. To compute the present index, the measurement entails calculating a basic average of two elements: the Euclidean distance between X and O (designated as X_1) and the reciprocal Euclidean distance between X and W (denoted as X_2). Both distances are then normalized by dividing them by the distance between O and W, ensuring that they fall within the range of 0 to 1. The construction of the indices involves computing the values of X_1 and X_2, and then calculating the index by taking a simple average of these two components. The specific formulae for these calculations are provided below.

$$X_1 = \frac{\sqrt{d_1^2+d_2^2+d_3^2+d_4^2}}{\sqrt{w_1^2+w_2^2+w_3^2+w_4^4}} \tag{4.5}$$

$$X_2 = 1 - \frac{\sqrt{(w_1-d_1)^2+(w_2-d_2)^2+(w_3-d_3)^2+(w_4-d_4)^2}}{\sqrt{w_1^2+w_2^2+w_3^2+w_4^4}} \tag{4.6}$$

$$Infraindex = (X_1 + X_2)/2 \tag{4.7}$$

Equation (4.5) quantifies the separation between X and O, whereas Equation (4.6) assesses the separation between X and W. Subsequent to computing the values of X_1 and X_2, the infrastructure index for distinct states can be computed using Equation (4.7). The infrastructure index is computed for 20 prominent Indian states spanning the years 2005 to 2019. A greater index value signifies an elevated degree of infrastructure advancement.

These Indian states can be classified into tiers of infrastructure development—namely, low, medium, and high levels—based on previous categorizations by Sarma (2008) and Yadav et al. (2020). If Index ranges from $0 \leq \text{Index} < 0.25$, it falls under low infrastructure development, $0.25 \leq \text{Index} < 0.5$ range indicates medium infrastructure development and a range of $0.5 \leq \text{Index} \leq 1$ may be considered as high infrastructure development.

The critical objective involves assigning suitable weights to individual dimension indexes. Given that each dimension holds equal significance for overall infrastructure, thus study has allocated uniform weights to all four dimensions. In the present analysis, a weight 1 is assigned for roads (d_1), 1 for national highways (d_2), 1 for railways (d_3), and 1 for power (d_4). By using equations 4.1. 4.2, 4.3 and 4.4, the Infrastructure Index (Infraindex) for the Indian States has been computed.

4.5.2 Infrastructure Index and Analysis for Indian States

Table 4.7 furnishes an overview of infrastructure development across Indian states for the year 2019. Delhi stands as the leading state in terms of infrastructure advancement. Out of the 20 states under consideration, 7 fall into the medium infrastructure development category, namely Goa, Gujarat, Haryana, Maharashtra, Puducherry, Punjab, and Tamil Nadu. The remaining states, including Andhra Pradesh, Assam, Bihar, Chhattisgarh, Himachal Pradesh, Karnataka, Kerala, Madhya Pradesh, Odisha, Rajasthan, Uttar Pradesh, and West Bengal, are classified as having low infrastructure development. Figures 4.2, 4.3, 4.4, 4.5, 4.6 and 4.7 depict scatter plots that complement the core discoveries of the study. These plots visually demonstrate that states with elevated levels of infrastructure and urbanization also exhibit heightened economic growth.

Table 4.7

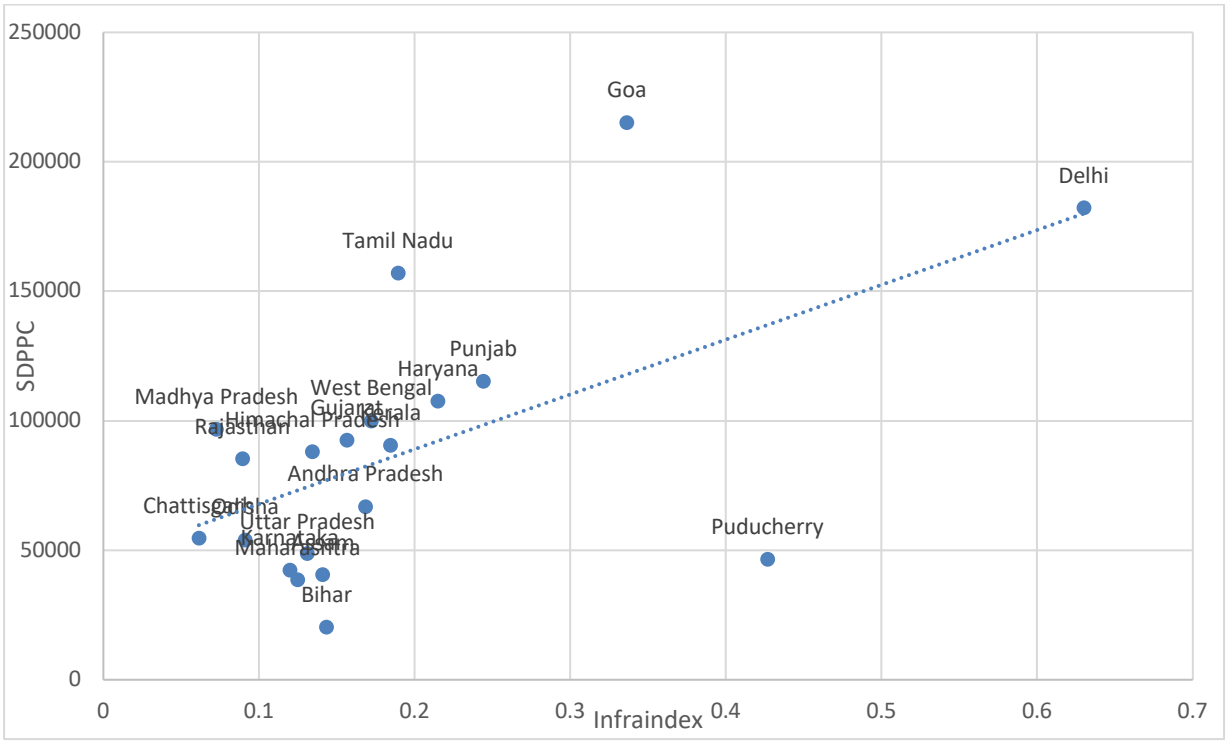
State of Infrastructure Development in Indian States (2019)

Sl. No.	State	Infraindex	low/medium/high
1	Andhra Pradesh	0.21	low
2	Assam	0.2	low
3	Bihar	0.21	low
4	Delhi	0.67	high
5	Goa	0.44	medium
6	Chattisgarh	0.13	low
7	Gujarat	0.25	medium
8	Haryana	0.36	medium
9	Himachal Pradesh	0.21	low
10	Karnataka	0.18	low
11	Kerala	0.24	low
12	Madhya Pradesh	0.14	low
13	Maharashtra	0.25	medium
14	Odisha	0.14	low
15	Puducherry	0.43	medium
16	Punjab	0.36	medium
17	Rajasthan	0.16	low
18	Tamil Nadu	0.26	medium
19	Uttar Pradesh	0.19	low
20	West Bengal	0.21	low

Source: Author's estimation

Figure 4.2

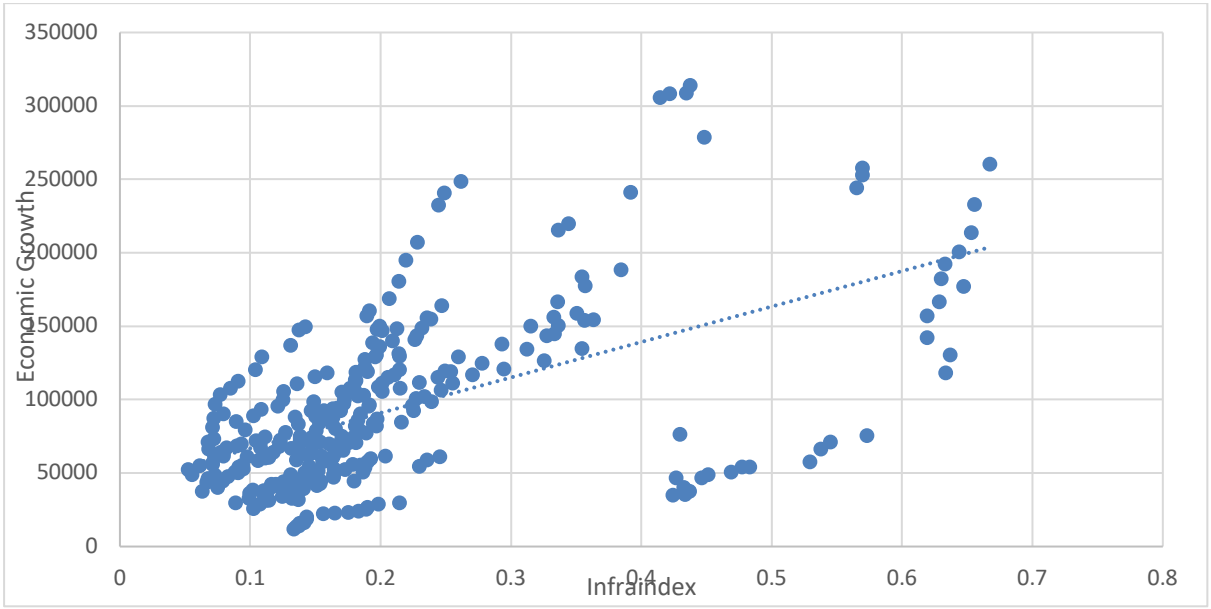
Scatter Plot for Economic Growth and Infrastructure (2011)



Source: Author's estimation

Figure 4.3

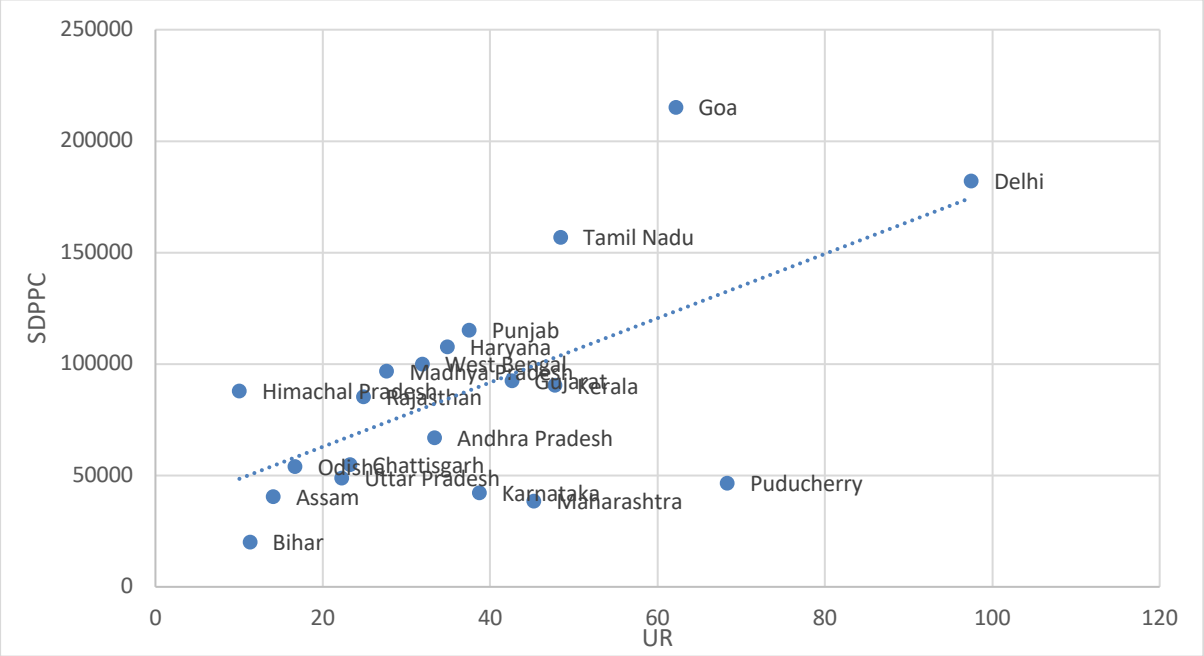
Scatter Plot for Economic Growth and Infrastructure (2005-2019)



Source: Author's estimation

Figure 4.4

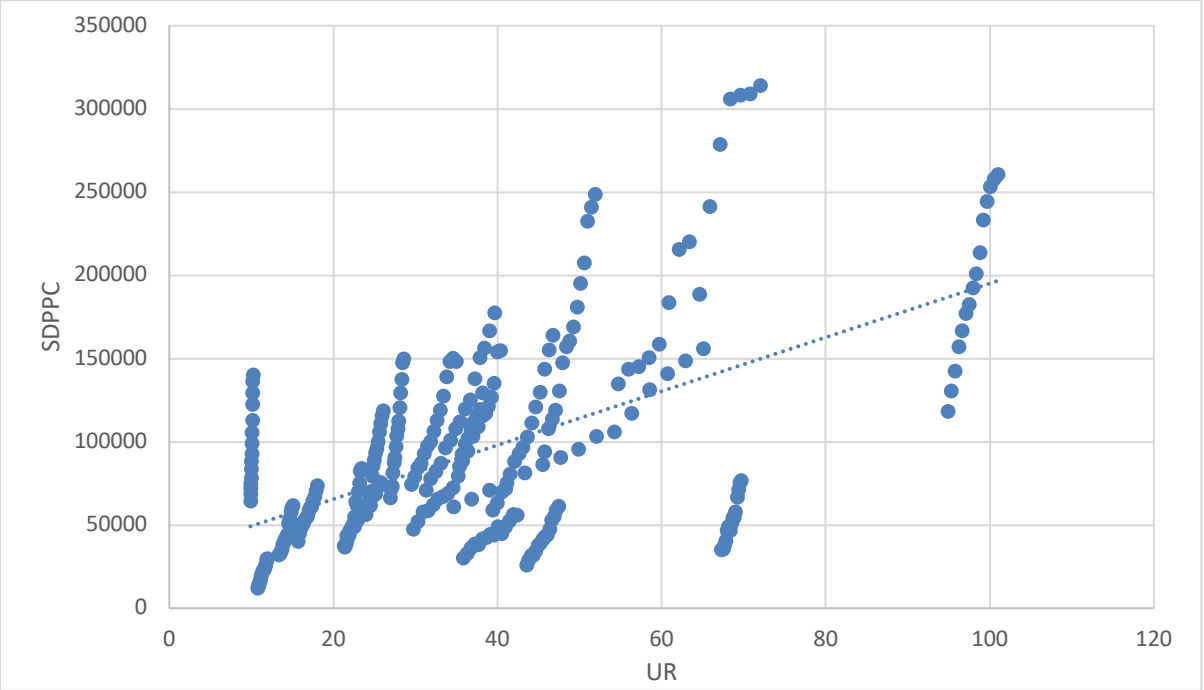
Scatter Plot for Economic Growth and Urbanization (2011)



Source: Author's estimation

Figure 4.5

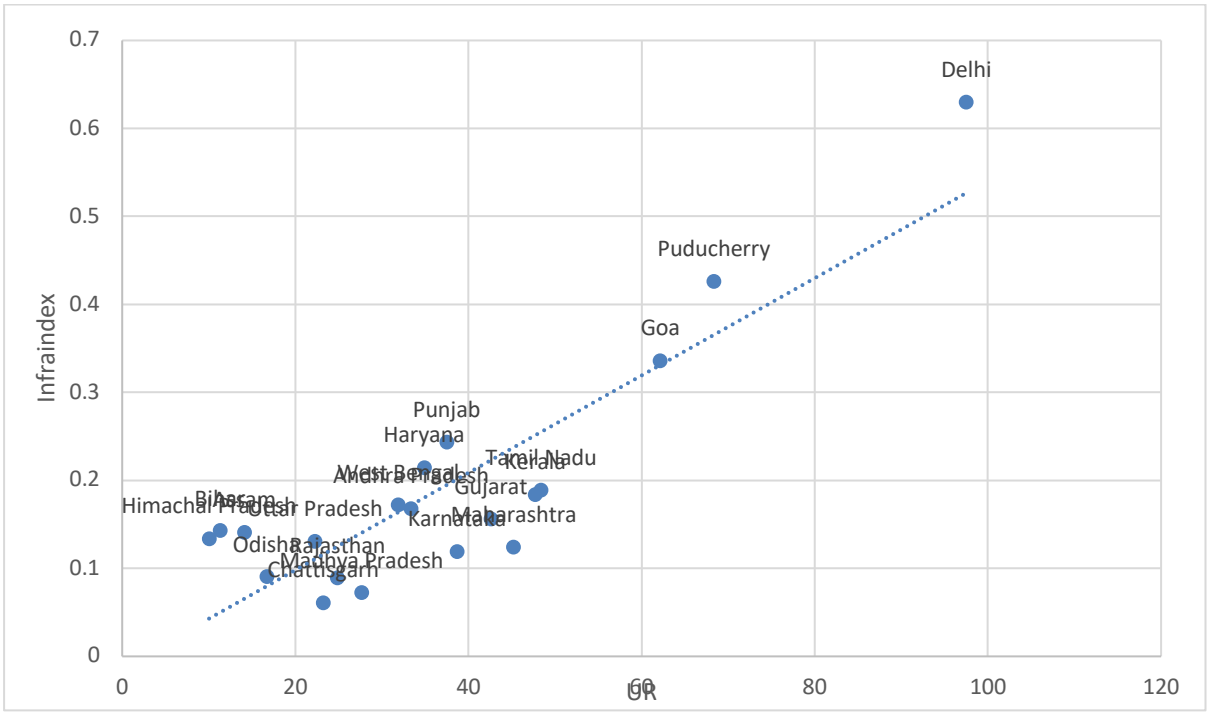
Scatter Plot for Economic Growth and Urbanization (2005-2019)



Source: Author's estimation

Figure 4.6

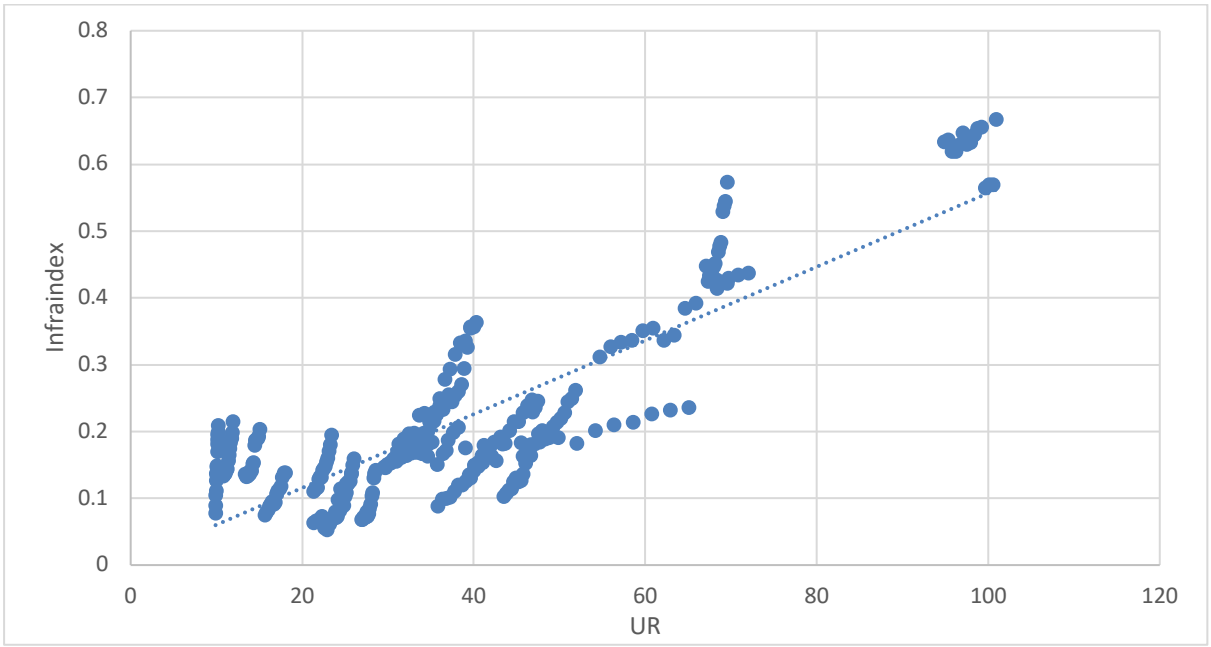
Scatter Plot for Infrastructure and Urbanization (2011)



Source: Author's estimation

Figure 4.7

Scatter Plot for Infrastructure and Urbanization (2005-2019)



Source: Author's estimation

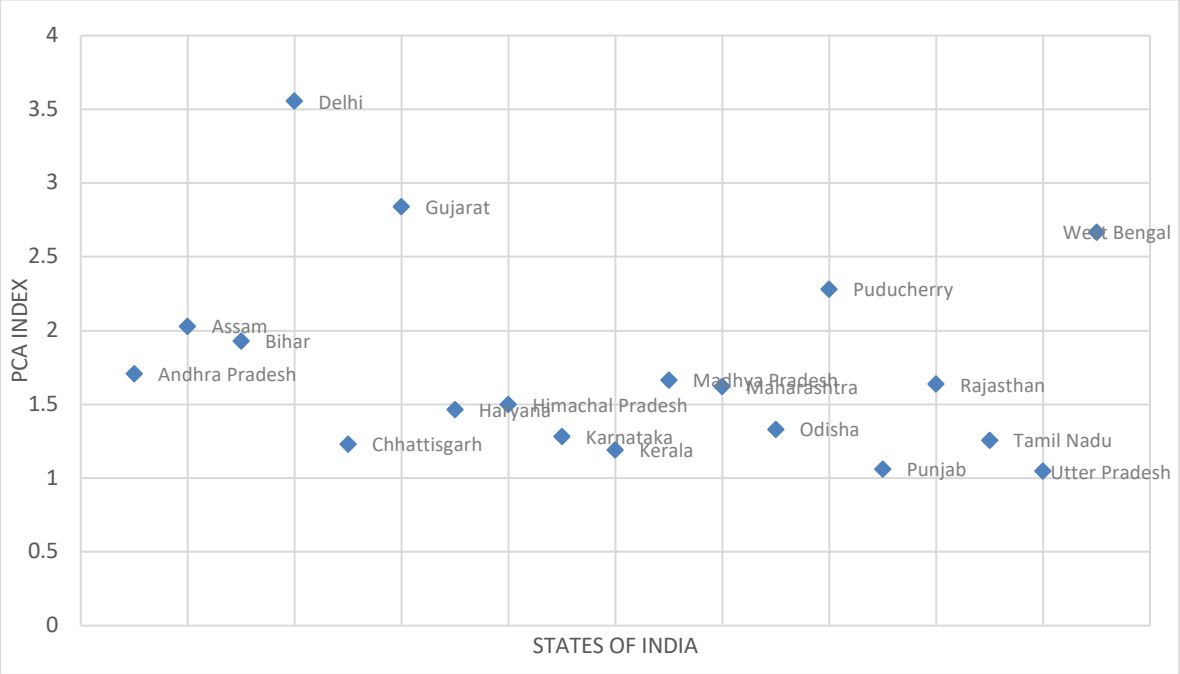
4.5.3 Principal Component Analysis

Another infrastructure index is constructed using the available infrastructure data on 19 states of India. Due to data limitations, Goa was dropped from the list of 20 states. Principal component analysis is used to construct the infrastructure index using data on Length of Roads (in sq. kms), National Highways (in sq. kms), Length of Rail-route (in sq. kms), and Power (in kilowatt-hour). This exercise was done to verify the stability of my results found from my previous Infraindex (constructed using Sarma's 2008 methodology).

The study has achieved similar outcomes when comparing them to the infrastructure index developed using the Sarma (2008) methodology in the past. This confirms the consistency and reliability of the previous index. Figure 4.8 below plots the state of infrastructure for 19 Indian States using the PCA index. Notably, states such as Delhi, Gujarat, West Bengal, and Puducherry stand out with high rankings in the PCA infrastructure index. Additionally, in Figure 4.9, the analysis generated a scatter plot illustrating the relationship between Economic growth and the PCA Infrastructure Index, revealing a positive trend line across all 19 Indian states. Furthermore, Figure 4.10 presents a scatter plot for Urbanization and the Infrastructure PCA Index, affirming the anticipated and previously established positive connection. The correlation coefficients indicate a correlation of 0.32 between economic growth and infrastructure (PCA index) and a correlation of 0.49 between urbanization and infrastructure (PCA index) for all 19 Indian States.

Figure 4.8

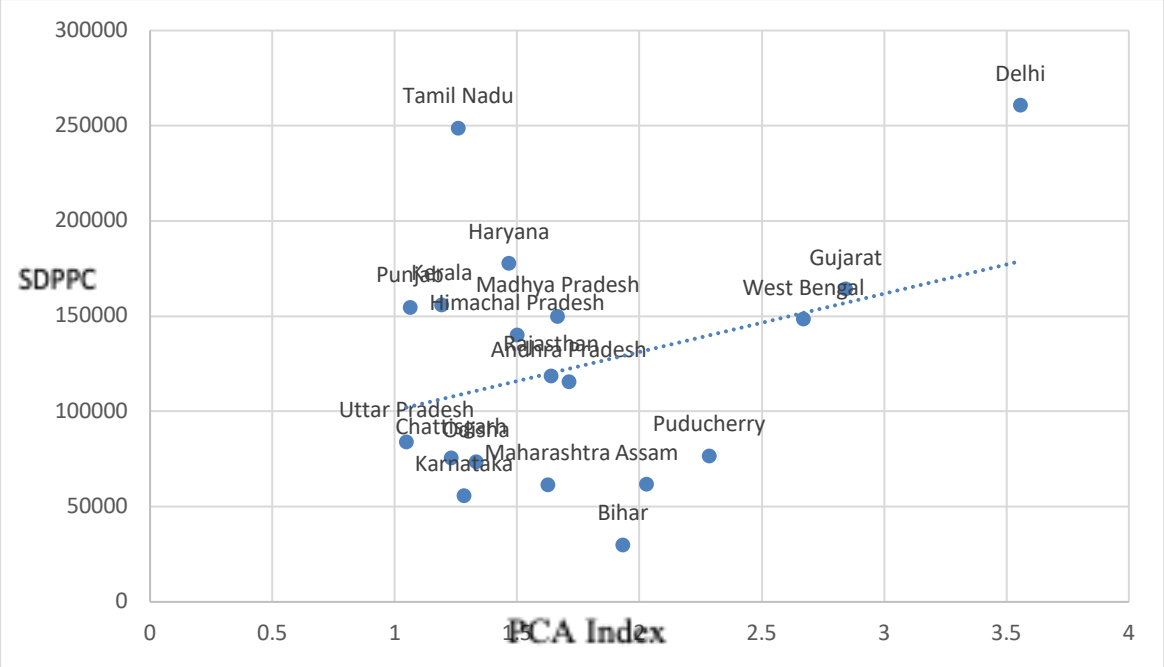
Scatter Plot for Infrastructure (PCA Index) for the States of India



Source: Author's estimation

Figure 4.9

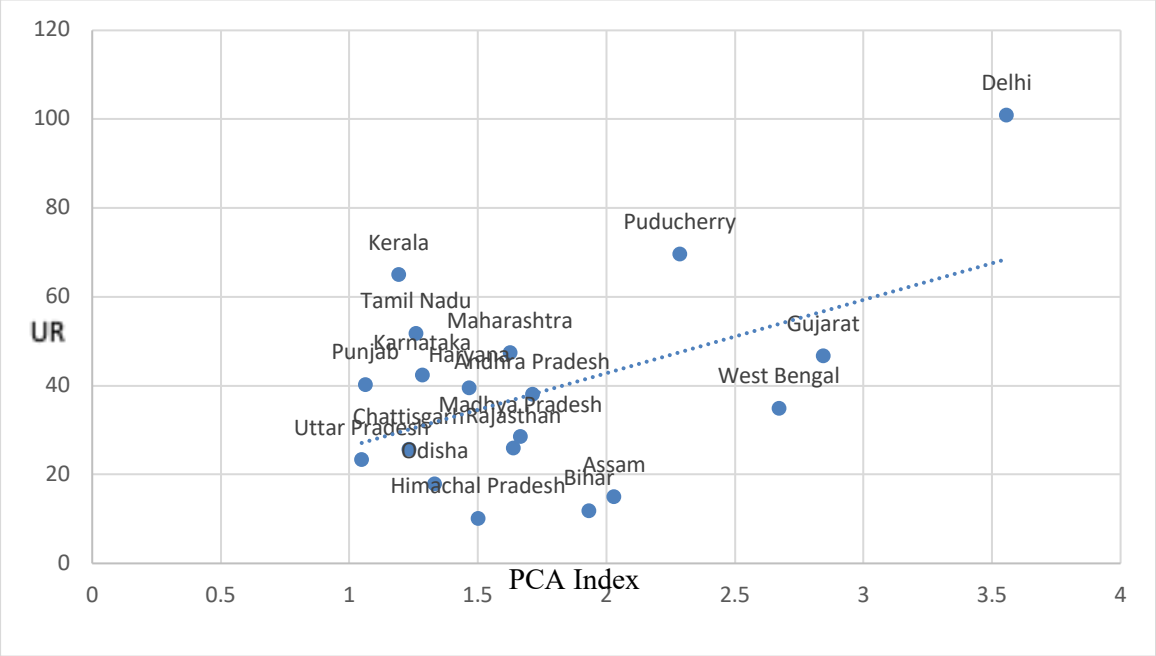
Scatter Plot for Economic Growth and Infrastructure (PCA Index) for the States of India



Source: Author's estimation

Figure 4.10

Scatter Plot for Urbanisation and Infrastructure (PCA Index) for the States of India



Source: Author's estimation

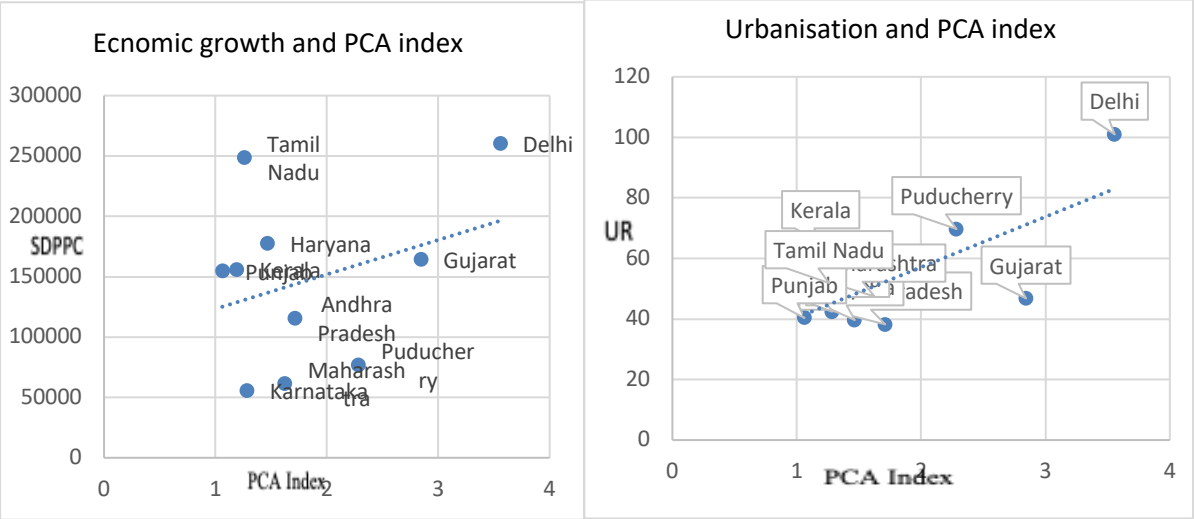
To further bolster the analysis, the study divided the 19 states into two distinct categories based on their urbanization levels. States with urbanization rates exceeding 31.1 percent, as per the Census of India 2011, were classified as "high-urbanization," while the remaining states fell into the "low-urbanization" category. Figures 4.11 illustrates that among the 10 high-urbanized states, Delhi emerged as a leader in terms of infrastructure, economic growth, and urbanization. Maharashtra, Tamil Nadu, Gujarat, Karnataka, and Andhra Pradesh showcased notable economic growth, but only Gujarat demonstrated a relatively stronger infrastructure index. In contrast, Haryana, Punjab, and Kerala, despite high levels of urbanization, faced limitations in their infrastructural development, which hindered their growth prospects. Notably, the correlation between economic growth and infrastructure (PCA index) stood at 0.32, while the correlation between urbanization and infrastructure (PCA index) was notably stronger at 0.69 for these 10 high-urbanized states in India.

Additionally, Figure 4.12 sheds light on the 9 low-urbanized states, namely Assam, Bihar, Odisha, and Himachal Pradesh, which not only exhibited low urbanization levels but also experienced moderate to low economic growth alongside inadequate infrastructural development. On the other hand, West Bengal, Uttar Pradesh, Rajasthan, Chhattisgarh, and

Madhya Pradesh possessed the potential to enhance their economic growth by investing in well-planned urban development initiatives. Within this group of 9 low-urbanized states, the correlation between economic growth and infrastructure (PCA index) registered at 0.22, while the correlation between urbanization and infrastructure (PCA index) was 0.26.

Figure 4.11

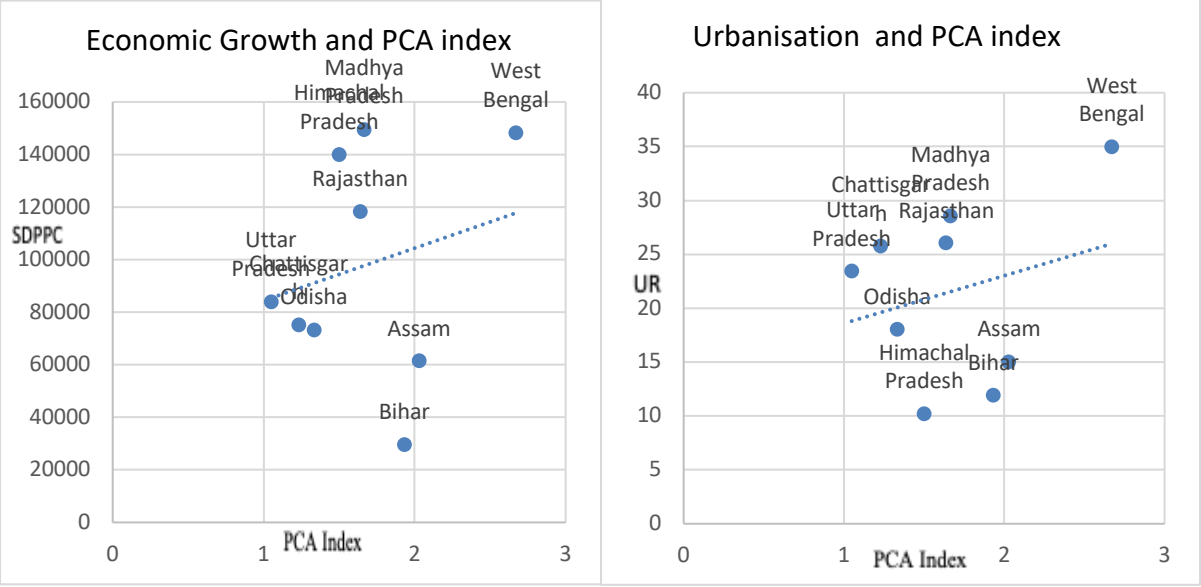
Scatter Plot for High Urban States of India



Source: Author's estimation

Figure 4.12

Scatter Plot for Low Urban States of India



Source: Author's estimation

From the above analysis made my employing the PCA econometric technique, we find that states with high urbanisation and infrastructural development seem to have high economic growth. For urbanisation to reap its benefits, states need coextensive infrastructural development to avoid diseconomies like congestion and sprawl as a case with Maharashtra.

4.5.4 Results Panel Regression

Table 4.8 exhibits the results derived from three regression models: Pooled OLS Model, Fixed Effects Model, and Random Effects Model. In the pooled regression model, all variables demonstrate significance at the 1 per cent level. Both the coefficient of Infraindex and the coefficient of UR are positively oriented. Likewise, within both the Fixed Effects model and the Random Effects model, all variables demonstrate significance at the 1 per cent level. The coefficients of Infraindex and UR remain positive, mirroring the findings of the Pooled OLS results.

Table 4.8

Results of pooled OLS, Fixed effects and Random Effects Models

Variables	Pooled OLS	Fixed Effects Model	Random Effects Model
Infraindex	0.95***	0.27***	4.12***
UR	0.41***	0.15***	1.25***
Constant	9.63***	0.48***	6.06***
R-Square	0.31	R^2= 0.77	R^2= 0.77
F Statistic	F (2,297)= 66.34	F(2,278)=478.48	Wald chi2(2) = 711.39
Prob>F	0.0000	0.0000	0.0000
DF	299	299	299
N	300	300	300

Source: Author's estimation

*** 1 per cent level of significance.

4.5.5 Results of Postestimation Diagnostics

Cross-sectional Dependence

Panel data models frequently demonstrate cross-sectional dependency, particularly when interconnected states within a country are influenced by shared shocks and latent factors that contribute to the error terms. In order to assess the presence of cross-sectional dependency in my dataset, the study performed the Cross Sectional Independence test proposed by Pesaran (2004). The outcomes of this test are presented in Table 4.9. The null hypothesis of cross-sectional independence is rejected for all variables at the 1 per cent significance level. This implies the presence of cross-sectional dependency among the entities within the cross-sections.

Table 4.9

Results of Pesaran (2004) Cross Sectional Independence Test

Pesaran's (2004) test of cross sectional independence = 10.51, Pr = 0.00
Average absolute value of the off-diagonal elements = 0.56

Source: Author's estimation

Diagnostic Tests

To gauge the robustness of the regression models, a series of diagnostic tests were performed. These tests encompass the Breusch-Pagan/Cook-Weisberg test to identify heteroskedasticity, the Ramsey RESET test to detect omitted variable bias, the Variance Inflation Factor (VIF) test to assess multicollinearity, and the Jarque-Bera Goodness of Fit test. The findings of these tests are presented in Tables 4.10, 4.11, 4.12, and 4.13. The heteroskedasticity test outlined in Table 4.10 reveals that there is no substantial heteroskedasticity issue, as the p-values are not significant at the 1 per cent level. However, the regression models do exhibit signs of omitted variable bias and autocorrelation, as indicated by the noteworthy p-values at the 1 per cent level in Tables 4.11 and 4.13, respectively. Moreover, the VIF values presented in Table 4.12 are all below 10, indicating the absence of significant multicollinearity problems in the models.

Table 4.10

Breusch-Pagan / Cook-Weisberg test for Heteroskedasticity

Ho: Constant variance Variables: fitted values of SDPPC
chi2(1) = 0.69 Prob > chi2= 0.41

Source: Author's estimation

Table 4.11

Ramsey RESET Test

Ho: Model has no omitted variables Using powers of the fitted values of SDPPC
F(3, 294) = 9.38 Prob > F = 0.0000

Source: Author's estimation

Table 4.12

Variance Inflation Factor test for Multicollinearity

Variable	VIF	1/VIF
Infraindex	1.90	0.53
UR	1.90	0.53
Mean VIF		1.90

Source: Author's estimation

Table 4.13

Skewness/Kurtosis Tests for Normality

Variable				------joint-------	
	Observation	Pr(Skewness)	Pr (Kurtosis)	Adj chi2(2)	Prob>chi2
Residuals	300	0.00	0.43	16.14	0.00

Source: Author's estimation

The Breusch-Pagan Lagrangian Multiplier Test for Random Effects was executed to ascertain whether a random effects model offers better suitability than a pooled regression model. The outcomes of this test are documented in Table 4.14. The test outcome suggests the existence of a panel effect, favouring the utilization of a random effects model, as evidenced by the statistically significant probability value at the 1 per cent level.

Table 4.14

Breusch and Pagan Lagrangian Multiplier Test

	Var	sd= sqrt(Var)
SDPPC	0.38	0.62
e	0.15	0.12
u	0.26	0.51
Test: Var(u) = 0 chibar2(01) = 1439.28 Prob > chibar2 = 0.0000		

Source: Author's estimation

The application of the Hausman Test aimed to establish the better fit between the fixed effects model and the random effects model for the analysis. The findings of the Hausman test are documented in Table 4.15. The test outcome indicates the rejection of the null hypothesis associated with the random effects model at the 1 per cent significance level. Consequently, the fixed effects model is selected as the more suitable choice. Opting for the fixed effects model is grounded in its superiority over the pooled OLS regression model for this analysis, as it tackles the previously identified issue of omitted variable bias.

Table 4.15

Hausman Specification Test Results

Variables	Fixed Effects Model (b)	Random Effects Model (B)	Difference (b-B)	S.E.
Infraindex	3.80	4.12	-0.32	.
UR	1.83	1.25	0.58	0.05
b = consistent under Ho and Ha; obtained from xtreg B = inconsistent under Ha, efficient under Ho; obtained from xtreg Test: Ho: difference in coefficients not systematic $Chi^2(2) = (b-B)'[(V\_b-V\_B)^{(-1)}](b-B) = 139.95$ Prob>chi2 = 0.00 (V_b-V_B is not positive definite)				

Source: Author's estimation

To proceed with an assessment of the robustness of the fixed effects regression model, the study investigated the presence of time fixed effects, and the results are depicted in Table 4.16. The significance level indicated by Prob>F is 1 per cent, suggesting the inclusion of a time fixed effect factor in the model. Subsequently, Wooldridge Test for Autocorrelation (Table 4.17) and the Modified Wald Test for Groupwise Heteroskedasticity in the fixed effect regression model (Table 4.18) has been tested. Both tests yielded notable probabilities at the 1 per cent level, signalling the existence of heteroskedasticity and autocorrelation issues within the model.

Table 4.16

Time Fixed Effect Results

Variables and Year	Coefficient
Infraindex	0.14
UR	0.27***
2006	0.08***
2007	0.14***
2008	0.19***
2009	0.24***
2010	0.31***
2011	0.36***
2012	0.40***
2013	0.43***
2014	0.48***
2015	0.54***
2016	0.61***
2017	0.67***
2018	0.72***
2019	0.75***
Constant	9.89***
R-Square	R^2 = 0.95 rho = 0.98
F Statistic	F (16,264) = 343.45*** F (14, 264) = 73.75***
N	300

Source: Author's estimation

Table 4.17

Wooldridge Test for Autocorrelation

H_0: No first-order Autocorrelation
F(1, 19) = 52.44 Prob > F = 0.00

Source: Author's estimation

Table 4.18

Modified Wald test for groupwise heteroskedasticity in fixed effect regression model

H_0: sigma(i)^2 = sigma^2 for all i
chi2 (20) = 975.96
Prob>chi2 = 0.00

Source: Author's estimation

Based on the aforementioned findings, the study utilizes the Driscoll and Kraay (1998) standard errors to address the concerns of autocorrelation and dependence. This approach is known for its autocorrelation consistency and robustness against various forms of cross-sectional and temporal dependence, as highlighted by Hoechle (2007). The outcomes of the fixed-effect panel regression with the Driscoll and Kraay (1998) standard errors adjustment for the model are outlined in Table 4.19.

Table 4.19

Fixed Effects Model with Driscoll and Kraay Standard Errors

Variables	Coefficient	Drisc/Kraay Std. Err.	p-value
Infraindex	3.80	0.64	0.00
UR	1.83	0.19	0.00
Constant	4.11	0.51	0.00
R^2	0.77		
F-stat	F(2, 19) = 2325.74		0.00
Observations	300		

Source: Author's estimation

The fixed-effects regression model yields the most substantial influence on economic growth, infrastructure, and urbanization. The findings reveal a positive and statistically significant correlation between economic growth and all the variables, signified by a significance level of 1 per cent.

4.5.6 Fully Modified OLS (FMOLS)

The findings from the fixed-effect regression models align with the expected outcomes. In order to evaluate the stability of the parameters with respect to their signs, significance levels, and magnitudes, the Fully Modified Least Square (FMOLS) estimation method, as proposed by Christopoulos and Tsionas (2004), is utilized. FMOLS is particularly useful when addressing serial correlation issues and provides more reliable results. The outcomes of the FMOLS analysis for the model are shown in Table 4.20. The results are indicative of the fact that, there are no significant changes in the signs, significance levels, or magnitudes of the coefficients. Furthermore, the FMOLS results confirm that infrastructure provision and urbanization have a strong impact on economic outcome or growth.

Table 4.20

FMOLS Results

Variables	Coefficient	p-value
Infraindex	4.25	0.00
UR	1.67	0.00
R-squared	0.97	
Adjusted R-squared	0.96	

Source: Author's estimation

4.5.7 Panel Causality

To examine the presence of a long-run equilibrium relationship among the variables of economic growth, infrastructure, and urbanization, as investigated through fixed-effect regression, the Dumitrescu and Hurlin (2012) Panel Causality Test is employed as a diagnostic tool. This test is derived from the original Granger (1969) causality test, which was initially designed for analyzing causal relationships among time series variables and later extended to panel data analysis by Dumitrescu and Hurlin (2012). The outcome of the panel causality test is depicted in Table 4.21.

Table 4.21

Dumitrescu & Hurlin (2012) Granger non-causality Test

Sl. No.	Null Variable	W-stat	Z-bar stat	p-value
1.	H_0: SDPPC does not Granger-cause Infraindex H_1: SDPPC does Granger-cause Infraindex for at least one panel (code).	2.90	5.99	0.00
2.	H_0: Infraindex does not Granger-cause SDPPC. H_1: Infraindex does Granger-cause SDPPC for at least one panel (code).	2.69	5.35	0.00
3.	H_0: SDPPC does not Granger-cause UR. H_1: SDPPC does Granger-cause UR for at least one panel (code).	6.39	17.06	0.00
4.	H_0: UR does not Granger-cause SDPPC. H_1: UR does Granger-cause SDPPC for at least one panel (code).	6.80	18.33	0.00
5.	H_0: Infraindex does not Granger-cause UR H_1: Infraindex does Granger-cause UR for at least one panel (code).	4.18	10.05	0.00
6.	H_0: UR does not Granger-cause Infraindex. H_1: UR does Granger-cause Infraindex for at least one panel (code).	12.51	36.41	0.00

Source: Author's estimation

Based on the findings presented in Table 4.21, a significant bi-directional causal relationship is observed between SDPPC and Infraindex in Indian States. At a 1 per cent significance level, the alternative hypothesis is accepted, indicating that SDPPC causes Infraindex and vice versa. Similarly, a bi-directional relationship is also identified between SDPPC and UR for the States of India. With SDPPC causing UR and UR also causing SDPPC at a 1 per cent significance level. Furthermore, at a 1 per cent level of significance, the null hypotheses stating that Infraindex doesn't cause UR and UR doesn't cause Infraindex are rejected. These findings indicate the presence of a bi-directional causality between UR and Infraindex in Indian States. Overall, the empirical results obtained from the fixed-effect regression and

FMOLS analysis demonstrate the long-run dynamics among economic growth, infrastructure, and urbanization for the states of India. The findings suggest that both infrastructure and urbanization exert a positive influence on economic growth in the Indian states.

4.6. Conclusion

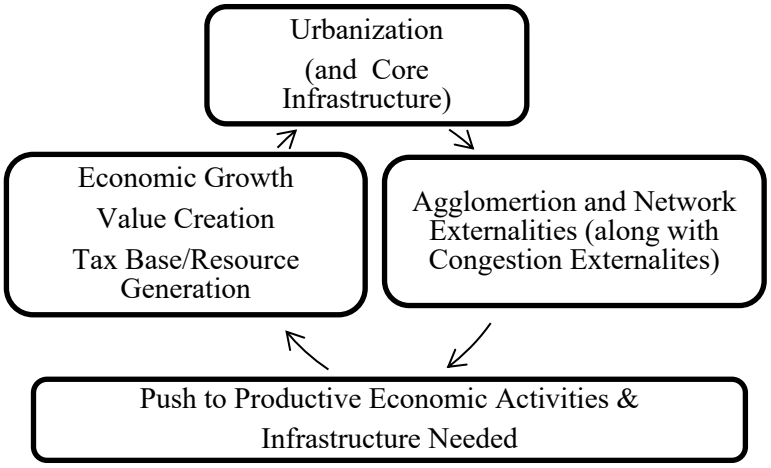
The chapter offers an empirical analysis of the impact of infrastructure and urbanization on economic performance across 20 prominent Indian states spanning the years 2005 to 2019. It employed four agglomerating and networking infrastructure dimensions to construct a multidimensional infrastructure index using Sarma (2008) methodology. The research employs fixed-effects and FMOLS techniques to explore the enduring equilibrium association among infrastructure, urbanization, and economic growth. Furthermore, the Dumitrescu-Hurlin (2012) causality test is utilized for short-term diagnostic assessment of the panel data. The empirical outcomes reveal a positive and statistically significant effect of both infrastructure development and urbanization on both long-term and short-term economic growth. Moreover, the analysis reveals a bi-directional relationship between urbanization and economic growth in the Indian states examined. Similarly, a bi-directional relationship is observed between infrastructure development and economic growth. Also, there is bi-directional relational between urbanisation and infrastructure as well. The results lend support to the paradigm that "growth pays its way". To further verify the stability of the results derived from using the Infrastructure index, constructed from Sarma (2008)methodology, the study constructs another infrastructure index using Principal Component Analysis. This exercise also yields similar results as the previous index.

Economic growth, supported by planned urbanization and urban infrastructure development creates values that can be captured to make infrastructure self-financing, leading to cumulative and circular causation processes fuelling growth. In the theoretical model of Chapter 3, the thesis argued for three broad categories of instruments: land rents/value taxation, 'congesters pay' charges and agglomeration rent-based taxes or charges. Unfortunately, through most of the Indian states fall under low level infrastructure development, they have not attempted to exploit these revenue instruments – first best or surrogate ones. This chapter empirically establishes that urbanisation together with

agglomerating and networking infrastructure is a growth generating force for Indian states. Such a force can be harnessed to finance further infrastructure development. Urbanization is anticipated to have a pivotal role in propelling India's forthcoming economic growth. It brings about positive externalities such as agglomeration and networking, which contribute to economic growth. However, it is important to address negative externalities like congestion, which can hinder growth. This highlights the significance of infrastructural development, which is essential to support urbanization and accelerate economic prosperity. The interrelationship between urbanization, infrastructure, and economic growth is illustrated in Figure 4.13, showcasing the analytical linkage between these factors.

Figure 4.13

Analytical Linkage between Infrastructure, Urbanization and Economic Growth



Source: Author

In the long run, Indian states should harness the growth potential of productive urbanization through the implementation of inventive financing mechanisms. Cities hold a pivotal role in generating economic growth, which in turn generates revenue that can be earmarked for investment in infrastructure that supports urban agglomeration and networking. This investment in infrastructure further enhances the productivity of cities, leading to sustained growth and increased tax revenues derived from various sources such as income, goods and services, and land-based taxes. Establishing self-financing city infrastructure requires effective partnerships between the central, state, and local governments. The efficacy of

urbanization as a driver of growth is greatly contingent on the presence of enabling infrastructure and institutional frameworks, as highlighted by Turok and McGranahan (2019).

It is worth noting that India was more urbanized than China in 1950; however, China strategically accelerated its urbanization process, which was instrumental in its industrialization and economic growth (Ravallion 2009; World Bank 2009). During the early 2000s, China directed 12.6 per cent of its GDP toward infrastructure investments, which was over twice the amount allocated by India (Bardhan 2010). Recent observations have highlighted the stark difference in investment between India and China, with Chinese authorities spending seven times more on urban infrastructure compared to their Indian counterparts (Observer 2012). China's significant commitment to investing in urban infrastructure has resulted in productive urbanization, leading to improved living standards. Future research may intend to analyse the revenue-generating capacity of urbanization in a more detailed and disaggregated manner.

Chapter 5
Summary and Directions for Reforms

5.1. Summary

Urban areas have consistently attracted people from smaller towns and rural regions, lured by the prospect of a more promising and prosperous future. The appeal of cities lies in their diverse range of sizes and opportunities, as they host a plethora of establishments and functions, offering a multitude of jobs and superior amenities. Cities foster resource sharing, provide ample learning prospects, encourage innovation, attract and retain talented individuals and financial capital, and facilitate effective job-worker matching, thereby boosting productivity and enhancing the well-being of their residents. However, these advantages come at a price. The influx of individuals into cities leads to increased population density, which in turn causes issues like congestion, emissions, pollution, and housing problems. Despite that, No nation has progressed to a middle-income status without undergoing industrialization and urbanization. Likewise, no nation has achieved high-income status without the presence of dynamic cities. The apparent frenzy of urban migration in developing nations might appear disorderly, yet it is imperative - World Bank (2009). According to a report published in the Economic and Political Weekly in 2005, the global urban population is expanding by approximately 60 million individuals annually. This rate of growth is three times faster compared to the increase in the rural population.

At present, almost half of the worldwide population lives in urban regions. However, urbanization in India is characterized by lack of proper planning and relatively gradual progress (Ahluwalia, Kanbur, and Mohanty 2014). Despite a low urbanisation rate, India's extensive mega-cities indicate a scope of growing urban population in future. However, in order to fully harness the potential of cities for job creation, productivity gains, and improvements in the quality of life, it is imperative to enhance urban infrastructure, as highlighted in the OECD Economic Survey India 2017. Regrettably, cities in India have been overlooked in this aspect. By 2025, it is estimated that India will be home to 69 cities, each

accommodating a population surpassing one million. These cities will serve as centers of economic growth, attracting significant infrastructure development.

However, the challenge associated with rapid urbanization is the strain it places on existing infrastructure. Effective infrastructure planning becomes pivotal in managing urban growth. The demand for infrastructure investments is expected to outpace output and tax revenues, necessitating the need for a higher share of total infrastructure financing in the Gross Domestic Product (GDP) from 3 per cent to 5.6 per cent by 2020 on a global scale, as reported by the McKinsey Global Institute in 2012.

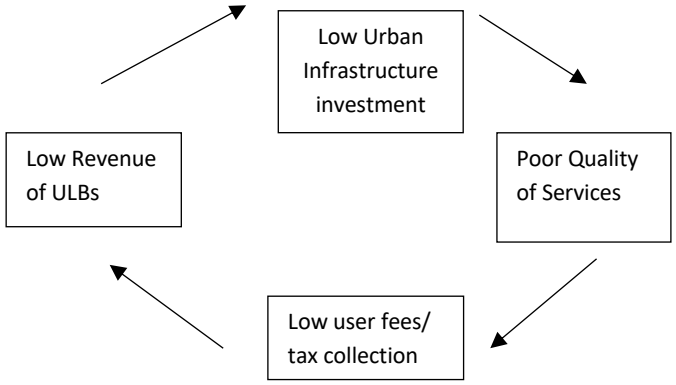
According to Mohanty (2016), cities in India presently make up approximately 60 -65 per cent of total GDP. Projections suggest that by 2030, this percentage is expected to soar to 75 per cent. Cities in India account for around 70 per cent of new job creation and 80 per cent of the total tax revenue, emphasizing the pivotal role that municipalities and city administrations play in ensuring vital urban infrastructure for land-use, transportation, affordable housing, and natural resource sustainability. Nevertheless, the current situation falls short of being ideal, considering that urban local bodies (ULBs) struggle to meet the demands placed upon them. These bodies face various challenges such as limited revenue sources, insufficient fiscal transfers, and restricted fiscal autonomy. In India, the urban infrastructure needs amount to approximately 2 per cent of GDP, whereas the total municipal revenue merely represents 1 per cent of GDP, as reported by Mohanty (2016).

ULBs have various revenue sources at their disposal, including local taxes such as land and property taxes, trade taxes, profession taxes, vehicle taxes, user charges for services, tolls, and benefit charges. However, the actual revenue potential of ULBs is limited. For instance, the main revenue source, octroi duty, was abolished without a suitable replacement, and other revenue sources like profession tax and motor vehicle tax accrue to state governments. ULBs also lack access to goods and services tax or formula-based sharing of national and state taxes. As a result, many ULBs rely on state governments to cover even basic operational expenses, including essential public services and employee salaries. This weak fiscal condition of ULBs creates a cycle of low investment and inadequate infrastructure services, as depicted in Figure 5.1. The detrimental cycle mentioned above is further intensified by budgetary limitations faced by state governments, restricting their ability to finance ULBs. Additionally, insufficient transfers of sharable tax revenues through central and state finance commissions, the limited capacity of banks to support long-term

urban projects, and the financial weaknesses of municipalities in accessing capital markets all contribute to exacerbating the situation.

Figure 5.1

Vicious Circle of Low Urban Infrastructure Investment



Source: Author

Abundant evidence exists illustrating the impact of infrastructure investment on the economic performance of urban regions. Such investment bolsters both labor and capital productivity, consequently enhancing household welfare. Given India's urbanization needs, infrastructure investment plays a crucial role in addressing current and future demands. Infrastructural investment acts as a tool to tackle unfulfilled needs and obstacles that hinder economic performance and the potential for growth. By ensuring the availability of crucial infrastructure services, individuals can actively participate in significant economic activities, leading to heightened productivity and broader avenues for growth (Seethepalli et al. 2008). By making smart investments and implementing efficient travel demand management strategies, it is possible to alleviate congestion and mitigate the accompanying expenses. A notable illustration of this can be found in China, specifically in Shanghai. Despite allocating only 10 per cent of its urban space for roads, the city successfully revitalized its downtown region by prioritizing investments in public transportation and essential supporting infrastructure such as bridges and tunnels. Notably, international lending agencies played a significant role in providing assistance for these initiatives. As a result, the city has managed to evade the traffic congestion frequently seen in other major Chinese urban centres (Wu 2007). A study by the Guangzhou Academy of Social Sciences underscores that traffic

congestion incurs an annual cost of up to 12 billion RMB for Guangzhou, equivalent to around 7 per cent of its GDP (Beijing Wrestles with Urban Traffic Congestion 2006).

Additionally, public infrastructure financing plays a crucial role in anticipating future development and promoting investments in other sectors, thereby fostering long-term economic growth (ADB 2002). The medium-term impacts of such investments have been substantiated through numerous analyses. The development of infrastructure facilities simplifies the adoption of new technologies by entrepreneurs, consequently driving technological advancements and economic proliferation (Démürger 2001). In the present knowledge-driven economy, the necessity for sophisticated telecommunication cable networks, energy-efficient buildings, and dependable backup power and communication lines holds significant significance (Bird 2004).

This thesis studied the nexus of cities, infrastructure, externalities and growth linkage for India. It is an attempt to draw lessons for policies for urban infrastructure financing. Cities contain all the pre-conditions for growth such as capital, infrastructure, surplus and skilled labour pool called human capital, innovation, technology, etc. Paradoxically, cities have not found their place in development strategy. The high-end infrastructure led urban development is yet to happen. Recently, there has been an effort to plan cities. The political influence of cities in India is growing with effect of 74th Constitutional Amendment Act, 1992. There have been a lot of projects focusing on urban development and renewal such as JNNURM, AMRUT, Smart Cities Mission, HRIDAY etc. A lot of recent research has focused on studying the impact of urban India in its growth trajectory. This thesis portrays infrastructure as a potent force in a city. It is no longer just a public good but rather a congestible local public good with network and agglomeration externalities. Infrastructure generates significant positive externalities and high degree of cumulative and reinforcing spillover effects to the urban development, detailed in the chapters. The power of infrastructure in conjunction with urban development to drive economic growth is an established fact. A large body of literature talk of agglomeration externalities. Such as Krugman's New Economic Geography depict agglomeration rent to mobile and immobile factors, Henry-George Theorem on land values and Mohring-Harwitz theorem on revenues from congestion tolls. It's a paradox that rents that can be tapped from agglomeration, congestion and land have not been synchronised. The thesis is an attempt to abridge this gap, making a study for India.

Chapter 1 explores the interconnections between economic growth, infrastructure, and cities. Economic growth is a crucial prerequisite for achieving inclusive development. This expansion demands a fundamental shift from an economy rooted in agriculture to one driven by industry and services (Henderson 2003). Cities attract firms and labour due to the presence of agglomeration and network externalities (Henderson 1974; Quigley 2013; Duranton and Puga 2004). Currently, urban areas house a greater population than rural areas worldwide. As per the World Urbanization Prospects in 2018, urban areas were home to 55 per cent of the global population. Urbanisation has growth benefits which hinges upon infrastructure planning. This chapter also presents the genesis of economic growth in India along with its gradual shift towards industry-service sectors. The dwindling share of agriculture in GDP is noted with a service sector contribution to GDP marking an impressively upward trend. Where growth occurs, scale economies, agglomeration economies and network externalities matter. Cities being the reservoirs of capital, new technology, innovation, skilled labour pool and infrastructure have the potential to drive that growth. However, in order to fully capitalise on the capacity of cities for job creation, productivity gains, and improving the quality of life, it is imperative to enhance urban infrastructure, as emphasized in the OECD Economic Survey India 2017. The economic activity in a city and its spatial configuration depends on the availability of public infrastructure. The World Economic Forum ranks India 70th of 141 countries for its infrastructure, in the Global Competitiveness Report 2019. Therefore, the infrastructure gap in Indian scenario is undeniable. This chapter sets the foundation for the thesis by discussing the prevailing context of economic growth in India, which is shifting away from agrarian sources and increasingly relying on non-agrarian sectors. As a result, cities are becoming prominent drivers of this growth. However, in order for cities to effectively contribute to economic development, it is imperative to have sufficient infrastructure in place. Indian Urban Local Bodies (ULBs) encounter significant financial constraints, posing a challenge in their operations, while the demand for urban infrastructure financing remains substantial. This necessitates the exploration of innovative financing mechanisms to bridge the gap and meet the funding requirements for urban infrastructure projects.

Chapter 2 reviews the literature in a comprehensive manner. It identifies the distinctiveness of ‘urban infrastructure’ from infrastructure from a theoretical perspective. Financing of ‘urban infrastructure’ stands out differently from financing of infrastructure. By

drawing lessons from theory, this chapter discusses the 'urban infrastructure' financing practices and infrastructure financing practices internationally and in Indian context. The city infrastructure investment requirements are huge. The chapter elaborates on the traditional sources financing urban infrastructure and marks that there are two-fold challenges of ULBs. Firstly cities need to find resources to meet the huge 'backlog' and 'current' needs of existing urban population. Second, they also have to generate resources to accommodate the 'growth' needs of urbanization. Several initiatives, such as the Smart City Mission, AMRUT, JNNURM, and the HRIDAY, have been implemented to address the inherent weaknesses of ULBs and promote urban infrastructure investment. However, there are still gaps that need to be addressed. While relying solely on public resources to bridge infrastructure financing gaps may be unrealistic, yet public sector spending continues to be vital, particularly in developing countries. This expenditure holds a vital role in upkeeping current infrastructure and addressing the growing investment requirements essential to sustain economic growth. However, it is imperative to explore innovative financing tools and mechanisms for urban infrastructure funding. India requires a well-defined financing strategy to address its urban infrastructure needs.

Chapter 3 builds upon the existing theory and evidence on agglomeration, network externalities and congestion to demonstrate their linkages which can be tapped to generate revenue. This chapter revisits the Venables (2007) model to highlight how agglomeration economies in cities impact GDP by enhancing tax bases of all levels of government. The chapter also studies the Henry George Theorem advocating land rent or land value taxation and finally the Mohring-Harwitz model of congestion charging. Here, the thesis proposes a comprehensive framework for financing urban infrastructure in India by integrating theories such as the wider economic benefits (Venable's Model) leading to agglomeration rents, land value taxation model and congestion charging model. This combined approach allows for a robust model. Theoretically, the chapter establishes that the cost of providing public infrastructure is offset by the revenues generated through agglomeration rent, congestion tolls, and land rent. Finally, a tool-box of innovative urban infrastructure financing instruments has been described. The model in this chapter hinges on two ideas:

(i) Infrastructure improvements enhance productivity through agglomeration and network externalities. Moreover, in cities they are often congested due to density;

(ii) These benefits and costs can be tapped to finance urban infrastructure

The externalities generated by cities create diverse tax bases for the Central, State, and Local governments, resulting in financial resources that support various socio-economic activities. The tax bases that contribute to government revenue include income tax, which encompasses capital gains tax as well. The central government also collects revenue through the central GST and corporation tax, while the state governments collect revenue through state GST, state excise, corporation tax, stamp duty or property transfer tax, motor vehicle tax, and other similar sources. Furthermore, local governments derive revenue from land and property taxes. These diverse tax sources contribute to the overall revenue pool for different levels of government in the country.

In Chapter 4, an empirical analysis is presented. This chapter has twin objectives: first to analyse the influence of "agglomerating and networking" infrastructure and urbanization on economic performance by making use of a panel data set spanning from 2005 to 2019, encompassing 20 prominent states in India. In addition, the research focuses on analysing how infrastructure and urbanization contribute to both short-term and long-term economic growth. Second, is to present an analytical case for, how infrastructure propelled by urbanization can be self-financing. Most cities in India have experienced unplanned urbanization and have grown as disconnected centres of growth. Municipal bodies face significant challenges due to the constraints of limited fiscal resources and the absence of collaborative planning. City governments are confronted with the task of addressing urban sprawl, managing increasing congestion, and simultaneously providing quality public services while maintaining fiscal health. On the other hand, cities enjoy the benefits of “agglomeration effects, network externalities, and economies of scale”, which give them a competitive advantage. They have the potential to drive economic growth by harnessing economic opportunities, fostering innovation and technology, and serving as major financial, technology, or export hubs. Throughout history, cities have played a pivotal role in determining industrial locations, allocating national resources, establishing transportation networks, and influencing international trade dynamics. In order for India to emerge as a leading economic power, it is crucial to develop its cities as vibrant hubs of growth. This development holds immense promise for the country. Flourishing urban centres are characterized by the presence of advanced technology companies, research institutions, top-notch educational facilities, a diverse array of employment opportunities, and favourable living conditions. To achieve this, cities must avoid becoming mired in inefficient urban

sprawl, harness the economic potential of surrounding towns and villages, and ensure the provision of high-quality public services to their residents.

The following chapter is organised as follows. The preceding Section 5.1 detailed the complete summary of the thesis. In Section 5.2, the contribution of the thesis is outlined. Lessons for Financing Urban Infrastructure in India is discussed in Section 5.3. This chapter ends with Section 5.4 highlighting the limitations of the study and scope for further research.

5.2. Contribution of the Thesis

The thesis looks into theoretical issues of financing urban infrastructure in India. It aims at arguing for the paradigm "growth pays its way" when urbanisation and infrastructure reinforce each other and create value. Through the analysis, that chapters not only combine infrastructure and cities but also the associated agglomeration and network externalities. The study basically tries to highlight that urban infrastructure is not only a public good but a congested and networked public good, that creates externalities and wider economic impacts. It is urban infrastructure that generates an 'urban productivity premium' and capturing that premium is a venture of this thesis. In an attempt to do so, the thesis covers areas such as:

a) Exploring the Indian growth scenario, city scenario, urban infrastructure scenario and urban infrastructure financing scenario.
b) Establishing a link between cities and externalities and subsequent implications to growth.
c) Building a theoretical model to tap rents generated from externalities in cities using first best and second best solutions.
d) Econometrically, analysing the impacts of infrastructure and urbanisation in Indian States by applying econometric tools.
e) Looking at the derived results' implications towards public policy.

The thesis is compiled in the idea that cities are India's future. There is a need for two-pronged strategy- to augment growth and to address the issues of distribution. Cities have the power to drive economic growth through employment generation, innovation, reduction of poverty, inclusive development, and hence can serve the hopes of millions. City development strategy is the need of the hour as the wealth of cities is the wealth of the nation.

Urban infrastructure financing is gaining importance. In 2015, SEBI released guidelines pertaining to municipal bonds. Further, in June 2019, it introduced amendments to the SEBI (Issue and Listing of Debt Securities by Municipalities) Regulations, 2015. This aimed at enhancing the efficiency and transparency of the bond market of Indian municipalities. Infrastructure is established through borrowing, but it must be repaid over time. No meaningful strategy for infrastructure financing can be worked out if externalities cannot be tapped.

5.3. Lessons for Financing Urban Infrastructure in India

Numerous studies (Kessides 1993; Ingram and Kessides 1994; Azizi 1995; Estache and Fay 2007) have highlighted the critical and beneficial function of infrastructure, particularly urban infrastructure, in development. Infrastructure not only boosts the efficiency of labor and capital as an "uncompensated factor of production" but also adds to the well-being of households (Kessides 1993). Research underscores a robust positive correlation between indicators of urban infrastructure and per capita gross domestic product (GDP) (World Bank 1999). Moreover, studies indicate that regions or subnational units that allocate resources to infrastructure tend to witness elevated productivity, augmented private investment, and enhanced employment growth (Munnell 1990; Cutanda and Paricio 1994).

The development and progress of a nation rely heavily on the presence of a robust infrastructure system. In the case of India, as the population continues to grow, there is an increasing strain on public transportation services and overall public infrastructure. To ensure uninterrupted provision of services to India's expanding population, it is crucial to establish a reliable, long-term funding mechanism for planned investments in infrastructure. In this thesis, an exploration is conducted on different funding tools utilized in various cities, states, and countries across the globe. The objective is to present a diverse array of potential revenue sources. Every mechanism possesses unique advantages and disadvantages, requiring thorough evaluation within the framework of particular projects or jurisdictions. Nonetheless, it is apparent that the current strategy adopted by Indian administrations to fund public infrastructure is unsustainable, inappropriate and grossly deficient in relation to growth. The entire country has the potential to gain from a comprehensive urban infrastructure system that

effectively addresses the population's requirements. By broadening the financing resources for infrastructure through innovative funding mechanisms that generate dedicated funds for such services, the strain on urban local bodies (ULBs) can be reduced, leading to advantages at a national level.

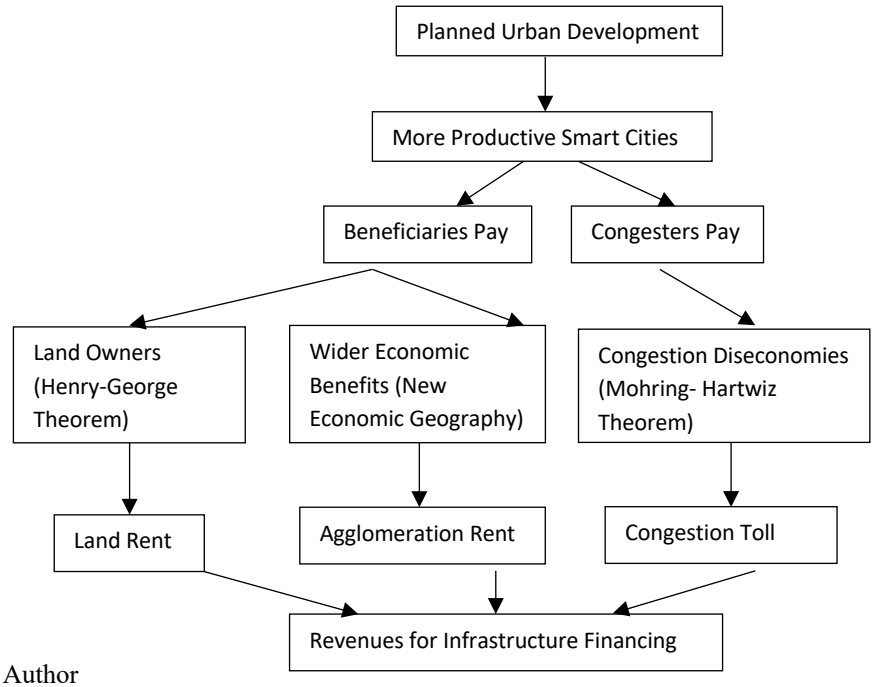
Cities generate public financial resources based on the principles of “users pay”, “beneficiaries pay”, “polluters pay”, “congesters pay”, “exacerbaters pay” and “growth pays”. The discussions in the thesis suggest that smart cities need to be empowered with (i) taxes on agglomeration rents, (ii) land related taxes and (iii) congestion charges/taxes. The thesis recommends a tool box of instruments such as:

i. Beneficiaries Contribute: User Fees, Benefit Charges, and Special Assessments.
ii. Land-Based Levies: Property Tax; Land Value Tax; Vacant Land Tax; Land Value Increment Tax; Property Registration Tax (portion); Land Use Conversion Charges; Development Charges; External Development Charges; Impact Fees.
iii. Agglomeration Levies: Local Choice (Piggyback) Levies - Municipal Surcharge on Income Tax, Business Tax, Excise Tax, Sales Tax, Value Added Tax, etc,.
iv. Congestion Fees: Road Tolls, Motor Vehicle Tax; Motor Fuel Tax; Vehicle Registration Tax; Truck Weight Fees, etc.

The research derives a model from theory and suggest tools to put into practice. Figure 5.2 below describes our model of breaking even the financing of urban infrastructure. It describes the planned urban development process, including financing. Smart cities need to be managed in a way that users contribute financially; both the beneficiaries and congesters must pay. Drawing lessons from urban theory, it points towards innovative revenue sources for urban infrastructure financing.

Figure 5.2

Urban Infrastructure Financing: Theory to Practice



Source: Author

A robust infrastructure system is the foundation of a nation's development. With India's population on the rise, there is a corresponding increase in the demand and strain on public transport systems and overall infrastructure. Securing sustainable and consistent funding for planned public infrastructure investments is crucial to guarantee the ongoing delivery of services to India's expanding population. Although investments in inter-regional infrastructure and regulatory changes are essential for boosting productivity, it's important to acknowledge the significance of enhancing urban infrastructure as well. Insufficient progress in urban infrastructure would curtail the potential productivity benefits stemming from economies of scale. Therefore, a comprehensive approach that addresses both inter-regional and urban infrastructure development is necessary to drive productivity and meet the needs of India's expanding population.

5.4. Limitations of the Study and Scope for Further Research

This thesis emphasizes the significance and benefits of urbanization, recognizing cities as catalysts for growth and transformative forces in India. Drawing upon theories of urban finance and public finance, the thesis proposes innovative financing tools and reform measures that encompass economic development and infrastructure services. The suggested alternative financing mechanisms include municipal bonds, private sector partnerships, special purpose vehicles, land finance, and externality finance.

The contribution of urbanization to India's GDP surpasses its demographic proportion. According to the 2011 census data, although urban regions are home to only 31 per cent of India's population, they contribute to more than 65 per cent of the nation's gross domestic product (GDP). Forecasts suggest that by 2030, urban regions in India will house approximately 40 per cent of the total population and contribute to about 75 per cent of the country's GDP (Census of India 2011). But the Indian municipal finances face significant challenges. However, with suitable policies, urban India can enhance its infrastructure levels. Further research could explore empirical evidence on the externalities generated by cities and the associated benefits they yield.

Theoretical frameworks and empirical evidence from developed nations suggest that implementing taxation mechanisms such as "agglomeration rents," "land rents," and instruments like "user pays," "beneficiary pays," "congestion charges," "pollution levies," "negative externality charges," and "growth-oriented fees" will lead to self-financing of planned urban growth of India. The underlying concept is that cities produce significant agglomeration and congestion externalities, and urban financial strategies should explicitly take these factors into account. Cities ought to uncover the latent potential of externalities as a resource for their growth, promoting a mutually beneficial approach for all participants within the urban economy. This necessitates collaborative partnerships between the central government, states, and local authorities, exemplifying the essence of "cooperative federalism.

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EXTERNALITIES AND URBAN INFRASTRUCTURE FINANCING: A NEW THEORETICAL MODEL AND LESSONS FOR SMART CITIES IN INDIA

PRERNA PANDA* · ALOK KUMAR MISHRA** · SHIBANI MISHRA***

ABSTRACT · Developing countries, including India are embarking on 'smart city' programs to position their cities as 'engines of growth',using smart technology solutions and management innovations. However, they are not adopting 'smart' ways of financing urban infrastructure based on coherent theories. In particular, they have not harnessed unearned benefits accruing to various actors in the urban economy due to agglomeration and network externalities and urban infrastructure investments. This paper combines the theoretical literature dealing with Wider Economic Benefits (WEB) of urban infrastructure investments, leading to agglomeration benefits and rents; Henry George Theorem (HGT), advocating taxation of land value increments; and Mohring-Harwitz Theorem (MHT), suggesting charging of congestion externalities. This paper brings out that if the principles of 'beneficiaries pay' and 'congesters pay' are combined then cities in developing economies like India can mobilise ample resources to service long-tenor debt to finance infrastructure needs. In other words, urban infrastructure can be self-financing.

KEYWORDS · Agglomeration Externalities, Network Externalities, Wider Economic Benefits, Agglomeration Rents, Henry George Theorem,Mohring-Harwitz Theorem, Beneficiaries Pay, Congesters Pay, Debt Financing.

JEL CODE: O18, R31, R51.

1. THE SMART CITIES MISSION

DEVELOPING countries around the world are resorting to 'Smart City' programs to position their cities as engines of growth. India is no exception. The country has launched the Smart Cities Mission in 2015 to develop 100 smart cities. The primary objective of the Mission is to enable cities to improve infrastructure and services by using 'smart' solutions, including those based on Information and

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Communication Technology (ICT). The Mission also seeks convergence and synergy with other national missions and schemes such as Atal Mission for Rejuvenation and Urban Transformation (AMRUT), Swachh Bharat Mission (SBM), Pradhan Mantri Aawas Yojana (PMAY), state government schemes, etc. The duration of the Mission is slated to be five years – financial year (FY) 2015-16 to 2019-20. The Government of India (GoI) committed a total investment of Rs. 48,000 crores in 100 cities during five years with each smart city getting Rs.100 crores annually for five years; states/urban local bodies will mobilise additional resources amounting to Rs.48,000 crores as per 50:50 funding pattern. The GoI and state government funds are expected to 'catalyse' funding from internal and external sources of Urban Local Bodies (ULBs), including borrowing through instruments such as municipal bonds.

The Smart City Mission is focused on creating robust models of planned urban development and financing for replication in other cities. In this regard, four models have been envisaged (MoUD2015):

i. City improvement (retrofitting): Developing an existing built area of more than 500 acres to make it more efficient and livable.
ii. City renewal (redevelopment): Replacing the existing built-environment in an area with more than 50 acres and enabling co-creation of a new layout, especially enhanced infrastructure, mixed land use and increased density.
iii. City extension (green-field development): Developing a green-field area of more than 250 acres, using innovative planning, plan financing and plan implementation tools with provision for affordable housing, especially for the poor.
iv. Pan-city initiative: An initiative in which at least one smart solution is applied covering larger parts of the city.

It is expected that these projects will lead to area-specific, city-wide and regional benefits, contributing to productivity and growth. How to 'leverage' central and state funds with locally mobilized revenues and external resources to finance innovative development programs is a key challenge for smart cities. However, the experience with implementation of the Smart Cities Mission suggests that cities in India are struggling to raise resources for core infrastructure projects and plans. Ironically, no city or state in India has embarked on a 'smart' strategy to finance planned urban development.

The earlier national initiative of Jawaharlal Nehru National Urban Renewal Mission (JNNURM), launched in 2005, also had the objective of leveraging central and state funds with municipal share and external resources. The Mission envisaged central grant to the tune of Rs.100,000 crore for projects involving core urban infrastructure and basic services to the poor, including affordable housing and slum redevelopment. As against this amount, the Planning Commission allocated a sum of Rs.66,085 crore during the mission period: 2005-06–2011-12. However, the actual allocation made based on progress of JNNURM achieved by cities over the period was Rs.45,066 crore. Against this amount, Rs.40,584 crore could be released by the end of 2011-12. A key problem under JNNURM was that many ULBs could not mobilize their share in time and failed to raise resources as envisaged. The 23 reforms that JNNURM stipulated included major efforts for resource mobilization through

user charges and property tax. These reforms were carried out only partially. Moreover, due to central and state grants being made available through the JNNURM route, there was very little 'own' effort by municipalities to raise funds from the market using instruments such as municipal bonds. Only three municipal bonds were issued during the 7-years mission period, mobilizing a meagre Rs.1500 crore from the market. The lack of a robust strategy to finance core urban infrastructure in tune with the demands of urbanization and growth continues to plague Indian cities.

While smart cities need smart ways to finance them, research on urbanisation in developing countries, including India has grossly neglected urban public finance. This is a paradox as cities are the engines of economic dynamism and generators of tax bases due to their powerful externalities. These externalities are associated with the clustering of firms, households and institutions in cities. Growth and innovation localize in city regions. Large cities create agglomeration and networking benefits, leading to what Harvard economist Edward Glaeser calls their "collaborative brilliance" (Glaeser 2011). The externalities of cities reduce the cost of moving goods, people, information, ideas and knowledge. They manifest in benefits of specialization, diversity and competition (Marshall 1890, Jacobs 1970, Porter 1990). They lead to learning, matching and sharing economies (Duranton & Puga 2004). The externalities of cities are closely linked with the density and mix of productive economic activities. Investments in infrastructure play a key role in augmenting the positive effects of density and minimizing its negative effects. The powerful externalities of cities, in conjunction with infrastructure investments, lead to unearned gains to many actors in the spatial economy. Raicu *et al.* (2019) stated that during assessment of infrastructure projects negative externalities must be included in the minimisation of total social costs of infrastructure construction.Thus, well-designed taxation and user charging regimes that take the benefits and costs induced by externalities of cities into account can, in principle, generate adequate resources [Bahl & Linn (1992), Mohanty *et al.* (2007), Peterson (2009), HPEC (2011), Lincoln Institute of Land Policy (2013), McKinsey (2010), MoUD & World Bank (2013), Ahluwalia, Kanbur & Mohanty (2014), World Bank (2014), Mohanty & Mishra (2015), and Mohanty (2014, 2016, 2019)].

Smart cities in developing countries, including India must adopt smart ways of financing planned urban development by harnessing externalities as a resource. Smart technology solutions will not be adequate. In this background, this research aims at enhancing local resources through externality-based revenues to facilitate sustained investments in infrastructure in cities that are expected to create growth, benefits, values, rents and tax bases. In this regard, 'beneficiaries', 'exacerbators', 'congesters'and 'polluters' must pay. Growth must pay its impacts. We combine the theoretical literature on Wider Economic Benefits (WEB) of key urban infrastructure investments leading to agglomeration rents, Henry George Theorem (HGT) advocating land value taxation and Mohring-Harwitz Theorem (MHT) suggesting congestion charging for designing a robust strategy to finance urban infrastructure. This paper brings out that, if the principles of 'beneficiaries pay' and 'congesters pay' are combined then cities in developing economies like India can mobilise

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adequate resources to service long-tenor debt incurred to finance infrastructure through instruments like municipal bonds. In other words, urban infrastructure can be self-financing.

The paper is organised as follows. Section 2 presents agglomeration and network externalities of cities and how infrastructure investments impact such externalities, leading to'wider economic benefits', tax wedge and agglomeration rents. Section 3 presents a case for taxation of agglomeration-induced benefits or rent to meet the cost of urban infrastructure, especially public transport. We draw lessons from the model presented by Venables (2007). Section 4 makes a case for using urban land as a resource, especially land value tax to finance urban infrastructure. We refer to the Henry George Theorem in urban economics and local public finance. Section 5 dwells on congestion charging to finance optimal capacity infrastructure. We refer to the Mohring-Harwitz Theorem in transport economics. Section 6 presents a new theoretical model of financing urban infrastructure, combining the theories of wider economic benefits, land taxation and congestion pricing. Section 7 presents a tool-box of instruments that smart cities in India can adopt based on the theoretical model and international practices. Section 8 gives direction for future research and concludes.

2. Externalities of Cities

Cities are homes to two powerful externalities: (i) agglomeration and (ii) networking. These externalities carve out a unique role for cities as the drivers of knowledge-led growth. They facilitate knowledge externalities, with faster generation, transmission, diffusion and accumulation of knowledge, catalysing innovation. They magnify the effects of growth drivers outside the market mechanism. Agglomeration externalities, arising from the collection of firms, households and institutions in cities lead to productivity gains and reduced costs. They occur on the supply side. Network externalities arise on the demand side. They are associated with a rise in the number of network users, reducing the average cost of use and increasing benefits to network suppliers and firms. Agglomeration and network externalities reinforce each other. They, in conjunction with market forces and public policies benefit many actors in the spatial economy. The endogenous growth theories suggest infrastructure can act as a powerful driver of growth by impacting knowledge externalities.

Agglomeration Externalities

The clustering of economic activities in areas such as dense downtown districts, transit hubs, cities and metropolitan regions gives rise to external economies of scale, known as agglomeration economies (Marshall 1890, 1920). To neo-classicists, the 'first nature of geography' is responsible for the distribution of economic activities being uneven. They stress on the natural endowments in a region. Krugman's "New Economic Geography (NEG)" gave another explanation of 'second nature of geography, related to how actors in the economy organise themselves spatially.

It is the spatial agglomeration of economic agents, along with infrastructure investments to support their activities that make cities productive. The concentration of economic activities spatially, referred as urban increasing returns, has been long discussed by Marshall (1890, 1920), Ohlin (1933) and Hoover (1937). Two concepts that sum up the advantages of economic concentration or agglomeration externalities are – scale economies and division of labour (Turok & McGranahan 2013).

Marshall refers to the externalities industrial clustering related to: (i) knowledge, (ii) input and (iii) labor market. Co-location of firms in an industry facilitates the exchange of information; producers and workers benefit from intra-industry knowledge spillovers. When firms agglomerate, they attract suppliers of non-traded inputs and ancillary services to locate nearby. Producers buy requirements more efficiently and save transport costs. The localization of industry leads to benefits from the sharing of inputs, assets, services, markets and risks. Further, the location of many firms in a single industry leads to specialized labour market pooling. The great urbanist, Jane Jacobs argues that diversity of geographically clustered economic activities, rather than single industry specialization that make urban externalities the drivers of innovation and growth (Jacobs 1970, 1984). Porter (1990) highlights the role of clustering in the 'competitive advantage' of nations. A cluster is "a geographic concentration of inter-connected companies, specialized suppliers, service providers, firms in related industries and associated institutions (e.g. universities, standards agencies, chambers of business, etc.) in a particular field that compete, but also cooperate".

Urban economists refer to localisation and urbanisation economies. Localisation economies arise due to the local concentration of a particular economic activity, say auto cluster, logistic hub etc. Localisation benefits also occur from provision of local public goods, leading to returns to sharing of benefits and costs. The concept of urbanisation economies is closely linked with the idea of Jacobs (1970) who stresses the benefits of diversity in an urban region. The benefits of urbanisation get transmitted through three mechanisms- learning, sharing and matching (Duranton & Puga 2004). The sharing of fixed costs, availability of intermediate inputs and easy access to specialised labour pool lead to these economies. The experience that keeps on accumulating by diffusion of ideas, ease of learning by doing, acquiring skills to get absorbed in the urban job market makes for learning and adaptability characteristics. Endogenous growth theories of Romer (1990) and Lucas (1988) suggest that knowledge diffuses and generates spillover benefits, leading to increasing returns. And finally, matching of suppliers and buyers, employers and employees, trainers and trainees becomes easy, reducing transaction costs.

The theoretical literature on agglomeration externalities refers to effects through total factor productivity. The following model represents a standard formulation:

$$\text{Urban production function: } X_u = g(Z,N_u)f_u(N_u) \qquad (1)$$

where, X_u is urban production, N_u is urban population and $g(Z,N_u)$ represents the agglomeration function that incorporates urban public good/infrastructure Z (lo-

calisation economies) and N_u(urbanisation economies). The production function is subject to increasing returns due to external economies of agglomeration.

$$\text{Rural production function: } X_r = f_r(N_r) \quad (2)$$

where, X_r is rural production and N_r is rural population.The function X_r is assumed to exhibit decreasing returns to scale because of over-crowding in agriculture.

$$\text{Population endowment: } N_u + N_r = N_T \text{ or, } N_r = N_T - N_u \quad (3)$$

where, N_T is total population in the economy, assumed to be fixed.

Assuming perfect competition, the urban producers set urban real wages w_u equal to urban marginal labour productivity oblivious of externalities. The rural producers equate rural real wage w_r with rural marginal productivity of labour. Rural-urban migration occurs till the urban and rural wages are equal. The competitive rural-urban migration equilibrium condition is:

$$w_u = g(Z, N_u)f'_u(N_u) = W_u(Z, N_u) = w_r = f'_r(N_r) = f'_r(N_T - N_u) = w_r(N_u) \quad (4)$$

The w_u function is upward-sloping in N_u due to agglomeration externalities; the w_u function is downward-sloping in N_r and therefore upward-sloping in N_u. Infrastructure investments shift up w_u function by engineering agglomeration externalities and impacting Z and N_u. Agglomeration economies lead to productivity gains and hence, higher wages.The assumption of upward-sloping urban wage function is supported by the fact that large cities, ceteris paribus, offer higher wages as productivity premium. The effects of agglomeration externalities through urbanisation and localisation manifest in 'agglomeration rent' in the form of skill premiums and unearned benefits. The NEG literature suggests that such rents accrue to both immobile factors like land and mobile factors like high-end labour (Krugman 1979, 1991).

Network Externalities

Network economies, arising on demand side create benefits from the increased use, integration and merger of networks, including transportation, communication, knowledge and social networks (Mohanty 2019). The interplay between externalities facilitates the exchange of information and knowledge between diverse actors in cities, catalysing learning, innovation and growth. The ICT literature refers to the power laws of networks. These laws suggest that networks power themselves after reaching a threshold. Network externalities occur when the benefit from a network or the use of a compatible product to a member is influenced by its use by others. When network economies are present, the functional value of a network rises or the cost of its usage falls with rise in the number of users. As per Metcalfe's law, a network's power scales up with the square of the number of users. It suggests

that when a network crosses the critical value, it begins to power itself. The more valuable a network is the more valuable it becomes to users and providers.

Network laws also suggest that while the value of a network rises with the addition of users, it can jump by inter-connecting or merging with other networks. For example, if a network M of m members is inter-connected with another network N of n members, the incremental values to the two networks due to inter-connection, following Metcalfe's law, can be approximated by:

$$\Delta V_m = m\,(m + n) - m^2 = mn \tag{5}$$

$$\Delta V_n = n\,(m + n) - n^2 = mn \tag{6}$$

Thus, each network gains by connecting to the other. An implication of this is that the smaller network benefits relatively more by linking to the larger network. Further, when the two networks merge, the incremental value generated by the combined network M + N is:

$$\Delta V_{m+n} = (m + n)(m + n) - m^2 - n^2 = 2mn = 2\Delta V_m = 2\Delta V_n \tag{7}$$

This equation implies that a network can gain considerably by merging other networks and providing inter-connecting services to all members.

Parker, Alstyne & Choudary (2016) refer to the 'platform revolution'. They explain the way networked markets are revolutionising the economy by endorsing new business models. These models are using technology to connect resources, people and organisations in an interactive ecosystem that is creating and exchanging an enormous amount of value. The authors define a platform as "a business based on enabling value-creating interactions between external producers and consumers. ….The platform's overarching purpose: to consummate matches among users and facilitate the exchange of goods, services, or social currency, thereby enabling value creation for all participants" (p. 5). This definition implicitly refers to the role of network externalities which may be subject to power laws. Platform businesses include Amazon, Uber, Ola Cabs, Airbnb, TripAdviser, eBay, Swiggy, Zomato, etc.

Infrastructure Externalities: Wider Economic Benefits

Infrastructure creates an environment for enhancing agglomeration and networking benefits and mitigating congestion costs. It connects economic activities, places, workers, entrepreneurs and traders, creating benefits of collaboration and knowledge externalities. Urban infrastructure projects lead development by generating 'accessibility' and 'serviceability' premiums locally and 'wider economic benefits' to the whole economy by enhancing access to the economic mass. Transport infrastructure is a discernible example of an infrastructure leading to agglomeration and network economies while mitigating congestion diseconomies. Table 1 discusses its key impacts in detail.

TABLE 1. Direct and Externality-induced Impacts of Transport Investments.

Market	Key Impact Parameters
Transport Market	• Travel time savings, especially for business travellers and freight operators. • Increased reliability for travellers and freighters. • Efficient logistic operations and supply chain management. • Reduced accidents and increased safety.
Goods Market	• Increased efficiency in combining inputs in production. • Expansion of markets through reduced input and output prices, access to not only new markets but also new sources of raw materials. • Reorganisation of production, shifting the production possibility frontier;smoother business interaction; and'just-in-time' management. • Agglomeration economies due to collocation and clustering of firms, workers and institutions in cities. • Stimulation of inward investment, knowledge transfer, innovation and technology diffusion. • Gains from trade: reduction in costs of transport, transaction, tariff and time (4 T's). • Enhanced competition; alleviation of market failure and promotion of cross-trading between markets.
Labour Market	• Increase in labour market catchment area, reducing labour search, recruitment and training costs. • Expanded pool of specialised labour with industry-specific and cross-industry skills. • Economies of face-to-face interaction and collaboration. • Increased labour market flexibility; better matching of employers and workers, jobs and skills; and job relocation benefits. • Enhanced labour force participation, especially female workers.
Land Market	• Accessibility premium to land. • Unlocking sites for value-adding developments. • Supporting densification and formation of economic agglomerations. • Benefits of density, proximity and spatial contiguity. • Increase in land values due to enhanced accessibility and serviceability of locations, leading to resource mobilization for infrastructure through value capture instruments.
General	• Triggering growth, which in turn stimulates further growth. • Enhancing welfare. • Promoting social interactions and accumulation of human and social capital. • More consumer choices – access to a variety of goods, services and amenities. • Taking advantage of shifts in geographic and economic opportunities associated with globalisation, ICT revolution, innovation, etc.; attracting globally mobile activities. • Impacts on energy use and emission of Greenhouse Gases. • Developing competitive cities as engines of economic growth. • Enhancing rural-urban linkages; extending money economy to rural areas.

Source: Mackie, Graham & Laird 2011, Mohanty (2019).

The presence of agglomeration, networking and infrastructure externalities in cities accord them a pivotal place in the structural and spatial transformation of a developing country like India undergoing urban transition. In fact, cross-country studies find a near perfect correlation between urbanization and economic development. As the level of urbanization of a country goes up by 10 percent, its per capita output rises by 30 percent. Per capita incomes are 4 times higher in countries with the majority of population in cities compared to those in which the majority reside in rural areas. A city in a developed country twice the size of another has a productivity premium higher by 1-5 percent. Within the United States, workers in metropolitan areas containing large cities earn 30 percent more than workers in non-metro areas. Persons in a metropolitan region having population one million or above are, on an average, more than 50 percent productive than those in smaller metro areas. These relationships do not alter even after correcting for heterogeneity with regard to education, experience, Intelligence Quotient (IQ) and industry of workers (Glaeser 2011).

The urban productivity-economic growth relationship appears to be much stronger in developing countries. When individual income is regressed on area density, the coefficient is around 0.05 in the United States, 0.08 in India and 0.20 in China (Chauvin *et al.* 2016). Furthermore, Williamson's hypothesis states that the role of agglomeration is significant at the lower stages of economic development; it serves as a means to an emerging economy to address the resource constraints and overcome the 'development trap'. The relationship between urban concentration and economic growth takes an inverted-U shape (Williamson 1965). An important research using cross-country data for 105 countries for the period 1960-2000, finds evidence in the support of Williamson's hypothesis that agglomeration economies boost up GDP growth to a threshold of development. The level is around US$10,000 per capita in 2006 PPP prices (Brulhart & Sbergami 2009). Hulten (1996) find that a 1 per cent increase in infrastructure effectiveness has an impact on growth that is more than 7 times larger than the impact of same percentage increase in public investment for a cross-section of low and middle income countries. Hulten *et al.* (2006) did an analysis of Indian data and noticed significant externality effects arising from infrastructure provisioning in Indian States to manufacturing output, with a productivity residual of 0.47 percent. Other studies such as Elburz *et al.* (2017) synthesized the literature on infrastructure and growth by employing a meta-analysis to determine the sources of variation in empirical relations between public infrastructure and regional growth with regard to the probability of obtaining a positive, negative or insignificant impact. Their study reveals that in all the countries the most effective infrastructure seems to be telecommunication. They make a strong case for taking the emergence of negative spillovers on neighbouring areas into account. Aschauer (1989) advocates for public investment in highways, airports, water and sewerage systems and other non-military structures. He accords significant weight to such investments while evaluating the role of government in enhancing productivity and economic growth. In another study Aschauer (1989) stated that public infrastructure capital "crowds in" private investment. Caragliu *et*

al. (2011) find a positive correlation between multimodal accessibility, high quality urban transport network, diffusion of ICTs and urban wealth in their study on the European cities.

A key impact of interactions between agglomeration, networking and knowledge externalities associated with major infrastructure projects such as urban highways, public transit and water, sewer and drainage networks is that they lead to unearned benefits and rents for taxing, apart from enabling the levy of user charges. Pauser (2013) examines the optimal policies for provisioning and funding of congestible transport infrastructure. The results of which stress on the role of user charges. Infrastructure creates access and access creates value, which can, in turn, generate finances through a value creation, capture and recycling process. However, the role of urban externalities is a grossly neglected subject in developing economies like India. Paradoxically, these countries have not exploited the power of planned urban development to self-finance the needed infrastructure. The result has been a benign neglect of urban infrastructure striking at the very root of economic growth.

3. Agglomeration Rent and Infrastructure Financing

The interactions between core urban infrastructure investments and externalities of agglomeration and networking in city regions catalyse economic growth, unearned benefits to many actors and tax bases of all governments. Transport economics suggests that major urban transport investments lead to enhanced access to the economic mass, agglomeration economies, 'accessibility premium' and 'wider economic benefits' (WEBs) (Venables 2007, Vickerman 2008, Mackie, Graham & Laird 2011).

Venables (2007) discusses the effect of infrastructure development on a Central Business District. He adopts the monocentric city model of urban economics to analyse the contribution of transport improvements to economic productivity. Using a spatial computable general equilibrium (SCGE) model, he shows that the transport investment benefits can be substantial and these external benefits can be measured from the elasticity of productivity with respect to employment density. Transport improvements reduce commuting costs, which in turn facilitates the expansion of employment at the Central Business District (CBD). This results in increased productivity of workers through agglomeration economies. Workers benefit from higher wages. Landowners gain from higher rents, and government from income tax wedge. The incorporation of agglomeration effects on production gives rise to 85-147 percent additional benefits for commuting journeys compared to standard benefit-cost analysis.

The basic assumption of the Venable's model is that all jobs are located in the CBD. Workers commute to the CBD for work from different parts of the city. City living imposes costs. There is a trade-off between land rent or housing cost and commuting cost. Spatial equilibrium warrants that workers are indifferent between locations, at the margin. The city expands to the point, where commuting cost is high enough to make workers indifferent between living at city edge and working in CBD and living in a non-city location and working there. The spatial equilibrium

condition with no tax on wages is:

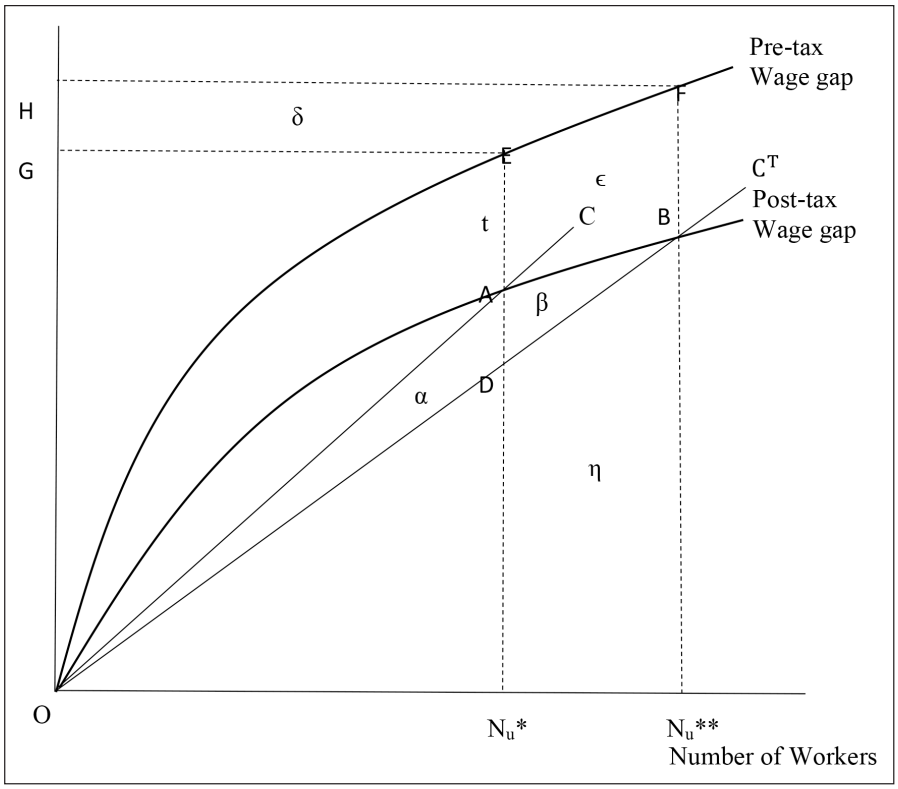
$$w_u = w_e + \tau d \text{ or, } w_u - w_e = \tau d \quad (8)$$

where, w_u is the wage at the CBD, w_e is the wage at the city edge, τ is the commuting cost per unit distance, assumed to be uniform, and d is the distance to the CBD.

For simplicity, agglomeration economies are assumed to be related to city size; the wage gap $w_u - w_e$ is an increasing function of city population, N_u. Assuming further that the government taxes w_u at the rate t, the condition of post-tax spatial equilibrium is as follows:

$$(1 - t)w_u = w_e + \tau d \text{ or, } (1 - t)w_u - w_e = \tau d \quad (9)$$

FIGURE 1 presents Venables' model with pre-tax and post-tax wage gap depicted as increasing functions of the number of workers, N_u due to agglomeration economies. The equilibrium city size is determined at N_u^* where the post-tax wage gap curve intersects the commuting cost curve C, assumed to be increasing in N_u. When C falls to C^T due to improvements in transportation, the equilibrium moves to N_u^{**}. Denoting $\eta = N_u^*DBN_u^{**}$, α = OAD, β = ABD, ε = AEFB and δ = GHFE, the increase in the resource cost of commuting with N_u rising from N_u^* to N_u^{**} is $\eta - \alpha$, the increase in output is $\delta + \varepsilon + \beta + \eta$. Thus, there is net real income gain of $\alpha + \beta + \delta + \varepsilon$. The area ε is the tax wedge effect; δ captures the impacts of agglomeration externalities on productivity; it is similar to the measure of elasticity of productivity with respect to city size. The area ε captures income or wage tax benefits to government due to agglomeration externalities induced by public transport investment. The area δ captures productivity benefits to firms arising due to such externalities, leading to taxable 'agglomeration rents'.



Source: Venables (2007).

FIGURE 1. Net Benefit of Transport Improvement with Endogenous Productivity, Unit cost, Benefit.

The Venables model, depicted above, tries to explain key impacts of transportation improvements in a city. It shows that as economic activity in a city grows, there is an increase in productivity and gain in net real income in the CBD due to externalities. Infrastructure investment can also generate additional employment and strengthen competitive forces. By improving connectivity, its leads to widening and deepening of labour markets. Transportation infrastructure is critical for enhancing productive efficiency and lowering input costs. It leads to a reduction in the costs of skilled labour and material assembly. With the rise in the capacity of infrastructure,the quality of services to firms and households also improves. Importantly, infrastructure investments lead to agglomeration-induced benefits through δ,which can be taxed and wage or income tax through ε. These effects do not exist without investment in infrastructure and agglomeration externalities in cities. A part of the pecuniary benefits can be escrowed to facilitate debt-financing of urban infrastructure investments that lead to such benefits. Susanne A. Frick and Andrés Rodríguez-Pose

(2016) in a robust econometric analysis showed a positive and significant link between city size and economic growth for developed countries. The results turn out to be either negative or insignificant for developing countries. This is mainly due to unharnessed benefits of externalities by these economies.

4. Land Value Tax and Infrastructure Financing

Land values in cities soar due to the spatial concentration of economic activity, agglomeration and networking externalities and infrastructure investments. Owners of land at vantage locations gain by way of unearned increments in land values. Thus, land rent or land value is a legitimate source of financing infrastructure facilities in cities. This is amply highlighted by the Henry George Theorem (George 1897). A version of the Henry George Theorem advocating land rent or land value taxation is presented below with simple mathematical model (Stiglitz 1977; Arnott & Stiglitz 1979; Atkinson & Stiglitz 1980; Mishra 2019).

Consider a simple competitive economy with private good Y and public good Z subject to the underlying specifications:

$$\text{Production Function of the private good: } Y = f(L) \quad (10)$$

Y = Output of private good and L = Population or labour force

$$\frac{\partial Y}{\partial L} = f'(L) = \text{ Marginal productivity of labour} \quad (11)$$

$$\text{Endowment Constraint: } Y = f(L) = yL + Z \quad (12)$$

y = Private good consumption and Z = Public good consumption.

We assume that private good is consumed by each individual in equal amount and land rents are uniformly distributed among all individuals.

$$\text{Utility Function of the Representative Individual: } U = U(y, Z) \quad (13)$$

Conditions maximising social welfare:

$$\text{Maximise } U = U(y, Z) \text{ subject to } f(L) = yL + Z.$$

The determination of the socially optimal level of public goods is depicted diagrammatically in Figure 2.

Reducing the problem to the unconstrained optimization framework by combining (13), (12) and (10):

$$\text{Maximise } U = U\left(\frac{f(L) - Z}{L}, Z\right) \quad (14)$$

First order conditions:

$$\frac{\partial U}{\partial y}[Lf'(L) - f(L) + Z]\frac{1}{L^2} = 0 \text{ or, } Z = f(L) - Lf'(L) \quad (15)$$

$$\frac{\partial U}{\partial y}\left(-\frac{1}{L}\right) + \frac{\partial U}{\partial Z} = 0 \text{ or, } \frac{\partial U}{\partial y} = L\frac{\partial U}{\partial Z} \tag{16}$$

Condition 16 states the Samuelsonian Condition for efficient public good provision. The marginal labour productivity under competitive conditions equals real wage so that wage payment = $Lf'(L)$. Thus, (15) implies that the optimal level of public goods equals aggregate land rents (total production – wage payment), the Henry-George theorem. The model presented is simplistic, but the message is clear. The taxation of land rent can be a powerful instrument to finance the expenditures of public goods provisioning. This will be particularly the case in large cities where land values are high due to investment in public goods which, in turn, attracts productive firms and workers.

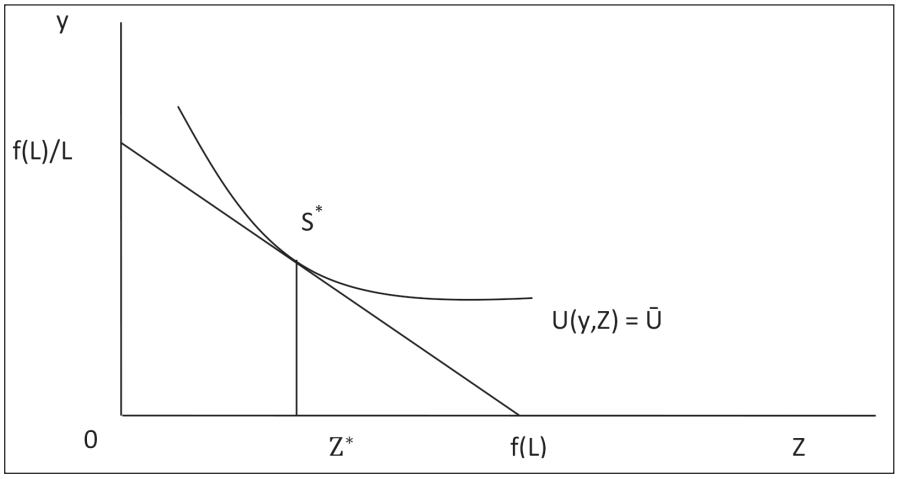


Figure 2. Henry George Theorem: UtiliyMaximisation.

5. Congestion Charging and Infrastructure Financing

Cities create congestion externalities due to high density and traffic. They present a legitimate case for congestion charging to mitigate the externality effects and also generate resources for capacity expansion. Congestion affects fuel consumption. Rizzi (2014) models that fuel taxes can act as perfect substitutes for road toll as a funding scheme for road infrastructure financing. The Mohring-Harwitz Theorem in transportation economics suggests that congestion charging breaks even, i.e. is adequate to finance an optimal capacity infrastructure investment. A simple model of the Mohring-Harwitz Theorem is outlined as follows (Mohring & Harwitz 1962; Mohring 1972; Mishra 2019).

Consider a public good which is by nature congestible, such as a highway, with the number of users = n and capacity = x, then the capacity utilization ratio = $\frac{n}{x}$.

Congestion in the public good imposes a cost– time, money, etc. to an individual user or private trip cost (PTC) which is represented by:

$$c = c(\frac{n}{x}) \text{ where } c'(\frac{n}{x}) > 0 \text{ due to congestion externalities} \quad (17)$$

Aggregate cost of congestion = $nc(\frac{n}{x})$ and marginal social cost of travel on the highway or social trip cost (STC) = $c(\frac{n}{x}) + nc'(\frac{n}{x})$. From this expression it is noted that STC curve will lie above PTC curve as $c'(\frac{n}{x}) > 0$.

FIGURE 3 depicts PTC and STC curves as upward-sloping. The downward-sloping line in the figure is the travel demand function. Travel demand is assumed to be negatively related to trip cost. T_m is the equilibrium number of trips under free market conditions.T_s is the socially optimal number of trips. $T_s < T_m$, a Pigovian congestion toll equal to CD will lead to the socially optimal outcome.

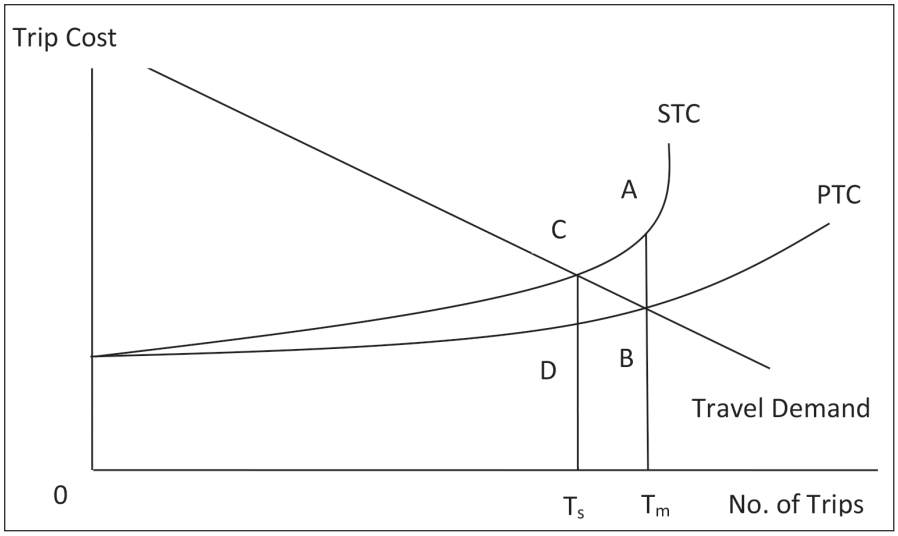


FIGURE 3. Congestion Pricing.

Assuming the cost of construction per unit capacity of highway to be equal to A, then the total cost of construction of the public facility = xA. The aggregate cost to the society = construction cost + total congestion cost:

$$C_S = xA + nc(\frac{n}{x}) \quad (18)$$

The capacity x that minimises the aggregate social costs C_S solves the society's optimisation problem.

The first order condition is:

$$\frac{\partial C_S}{\partial x} = A - \left(\frac{n^2}{x^2}\right)c'\left(\frac{n}{x}\right) = 0 \text{ or, } A - \left(\frac{n^2}{x^2}\right)c'\left(\frac{n}{x}\right) = 0 \text{ or, } xA = \\ = \text{Construction cost} = \left(\frac{n^2}{x}\right)c'\left(\frac{n}{x}\right) \quad (19)$$

Consider the congestion pricing of the highway once optimal capacity is installed. Each additional road user increases every other user's congestion cost by $\frac{\partial c}{\partial n} = \left(\frac{1}{x}\right)c'\left(\frac{n}{x}\right)$. As there are n users who suffer this externality damage, each user will be required to pay a Pigovian toll of $n\left(\frac{1}{x}\right)c'\left(\frac{n}{x}\right)$ under congestion charging. Thus, the total revenue from congestion charging will be equal to

$$R = n\left(\frac{n}{x}\right)c'\left(\frac{n}{x}\right) = \left(\frac{n^2}{x}\right)c'\left(\frac{n}{x}\right) \quad (20)$$

A comparison of (19) and (20) reveals that total cost of construction of the congestible public facility (highway) = aggregate congestion toll revenue. Thus, the congestion pricing breaks even. The above result, the Mohring-Harwitz theorem is subject to the simplified assumptions adopted. However, it builds the theoretical foundation for the congestion charging scheme adopted by cities like Singapore, London and Stockholm.

6. A Model for Urban Infrastructure Financing

We now combine the theories of wider economic benefits (Venables Model), land value taxation (Henry George Theorem) and congestion charging (Mohring-Harwitz Theorem) under a single framework to put forth a robust model for infrastructurefinancing in smart cities.

Urban Production Function with Agglomeration externalities:

$$X = f(N) = g(Z,N)\, f(N) \quad (21)$$

$$\frac{\partial g}{\partial Z} > 0\,; \frac{\partial g}{\partial N} > 0; \frac{\partial f}{\partial N} > 0$$

$$\frac{\partial^2 g}{\partial Z^2} < 0\,; \frac{\partial^2 g}{\partial N^2} < 0\,; \frac{\partial^2 f}{\partial N^2} < 0$$

X is urban production function
g is agglomeration function
N is urban population
Z is urban infrastructure (Congestible local public good)
Infrastructure Cost Function:

$$C = C\,(Z,N) \tag{22}$$

$$\frac{\partial C}{\partial Z} > 0; \frac{\partial C}{\partial N} > 0$$

Representative City Household's Utility Function

$$u = u\,(x,h,Z) \tag{23}$$

$$\frac{\partial u}{\partial x} > 0\,; \frac{\partial u}{\partial h} > 0\,; \frac{\partial u}{\partial z} > 0$$

x is a private good assumed to be a numeraire
h is housing (assuming, 1 unit of housing equals 1 unit of land)
Z is public good/urban infrastructure

Society's Budget Constraints:

$$\text{Endowment Constraint: } g\,(Z,N)\,f\,(N) = Nx + C\,(Z,N) \tag{24}$$

$$\text{Urban Land Constraint: } T = Nh \tag{25}$$

Society's Optimisation Problem:

$$Max\ u = u(x,h,Z)\ subject\ to$$

$$g\,(Z,N)\,f\,(N) = Nx + C\,(Z,N)\ and\ T = Nh$$

$$T = Nh$$

Forming the Lagrangean:

$$\int = u\,(x,h,Z) + \lambda\,[g\,(Z,N)\,f\,(N) - Nx - C\,(Z,N)] + \mu\,(T\text{-}Nh) \tag{26}$$

First Order Conditions,

$$\frac{\partial \int}{\partial x} = \frac{\partial u}{\partial x} - \lambda N = 0 \text{ or, } u_x = \lambda N \tag{27}$$

$$\frac{\partial \int}{\partial h} = \frac{\partial u}{\partial h} - \mu N = 0 \text{ or, } u_h = \mu N \tag{28}$$

$$\frac{\partial \int}{\partial Z} = \frac{\partial u}{\partial Z} + \lambda[f(N)\frac{\partial g}{\partial Z} - \frac{\partial C}{\partial Z}] = 0 \text{ or, } u_Z + \lambda f(N)\frac{\partial g}{\partial Z} = \lambda C_Z \tag{29}$$

$$\frac{\partial \int}{\partial N} = \lambda\left[g\frac{\partial f}{\partial N} + f\frac{\partial g}{\partial N} - x - \frac{\partial C}{\partial N}\right] - \mu h = 0 \text{ or, } g\frac{\partial f}{\partial N} + f\frac{\partial g}{\partial N} - x - C_N = \frac{\mu}{\lambda}h \tag{30}$$

$$\frac{\partial \int}{\partial \lambda} = g(Z,N)f(N) - Nx - C(Z,N) = 0 \text{ or, } C(Z,N) = g(Z,N)f(N) - Nx \tag{31}$$

$$\frac{\partial \int}{\partial \mu} = T - Nh = 0 \text{ or, } T = Nh \tag{32}$$

From (27) and (28) we get,

$$\frac{\mu}{\lambda} = \frac{u_h}{u_x} \tag{33}$$

From (29), substituting for $\lambda = \frac{u_x}{N}$ from (27):

$$u_Z + \frac{u_x}{N} f(N) \frac{\partial g}{\partial Z} = \frac{u_x}{N} C_Z \text{ or, } N \frac{u_Z}{u_x} + f(N) \frac{\partial g}{\partial Z} = C_Z \tag{34}$$

(34) implies that at the margin, the benefits of increase in investment in Z, taking both consumption and production sides, equal the cost increase due to such investment.

From (30) using (33) i.e., $\frac{\mu}{\lambda} = \frac{u_h}{u_x}$

$$g \frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f} \frac{\partial \mathrm{g}}{\partial \mathrm{N}} - \mathrm{x} - \mathrm{C_N} = \frac{u_h}{u_x} \mathrm{h} \tag{30A}$$

Multiplying both sides by N,

$$N\left[g \frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f} \frac{\partial \mathrm{g}}{\partial \mathrm{N}}\right] - \mathrm{Nx} - \mathrm{NC_N} = \frac{u_h}{u_x} \mathrm{Nh} \text{ or,}$$

Using (32):

$$N\left[g \frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f} \frac{\partial \mathrm{g}}{\partial \mathrm{N}}\right] - \mathrm{Nx} - \mathrm{NC_N} = \frac{u_h}{u_x} \mathrm{T} \text{ or,}$$

$$Nx = N\left[g \frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f} \frac{\partial \mathrm{g}}{\partial \mathrm{N}}\right] - \mathrm{NC_N} - \frac{u_h}{u_x} \mathrm{T} \tag{35}$$

Combining (35) and (31) yields:

$$C(Z,N) = g(Z,N) f(N) - N\left[g \frac{\partial \mathrm{f}}{\partial \mathrm{N}} + \mathrm{f} \frac{\partial \mathrm{g}}{\partial \mathrm{N}}\right] + \mathrm{NC_N} + \frac{u_h}{u_x} \mathrm{T} \tag{36}$$

Note:

$g \frac{\partial f}{\partial N}$is is the wage under competitive conditions

$g \frac{\partial f}{\partial N} + f \frac{\partial g}{\partial N}$is is the wage recognised by the society taking into account agglomeration externalities.

$\frac{u_h}{u_x}$ is the rate of marginal transformation between housing (land) and numeraire private good. It also represents, the price ratios in equilibrium or the land rent (as private good price equals unity).

$\frac{u_h}{u_x}$ is the rent to land or under competitive conditions - the aggregate residual rent.

C_N is the Pigovian Toll for Congestible Public Good
NC_N is the Aggregate Pigovian Congestion Toll

Thus (36) states that the total cost of public infrastructure provision equals to the sum of revenues generated through agglomeration rent, congestion toll and land rent.

$$C(Z,N) = \textit{Agglomeration Rent} + \textit{Congestion Toll} + \textit{Land Rent}$$

This result is powerful and provides theoretically elegant and practically attractive ways to finance urban infrastructure in smart cities of developing countries.

7. A Tool-box of Financing Instruments

The discussions in the previous sections suggest that smart cities need to be empowered with (i) taxes on agglomeration rents, (ii) taxes on land rents/land value tax/land value increment tax and (iii) congestion charges/taxes. Venables model refers to agglomeration benefits translating into income tax and other taxes such as payroll tax, goods and services tax, etc. – taxes that keep pace with economic growth. Henry George Theorem makes case for land based taxes: property tax, vacant land tax, land value tax, land value increment tax, betterment levy, etc. Mohring-Harwitz Theorem calls for congestion toll or in absence of that motor vehicle and motor fuel related taxes. These important theories make a strong case for benefit taxation and congestion charging to self-finance urban infrastructure. Table 2 lays down a tool-box of instruments for urban infrastructure financing in developing countries, especially smart cities based on our theoretical model.

Table 2. A Tool-box of Financing Infrastructure in Smart Cities.

Category	Instruments
Beneficiary Pay Charges	
User charges	Water supply charges; Park entrance fees; Charges for public transportation services, etc.
Benefit charges	Sewerage and storm drainage charges hooked onto water charges; Access or connectivity charges to water, sewerage, drainage and road networks; Charges for roads, street lighting, solid waste management, fire and other services linked to property characteristics such as plinth area or unit area value, capital value, plot frontage, road width, etc.
Special assessments	Charges levied on residents of designated areas to finance costs of internal and external infrastructure, covering facilities such as access roads, public transport, street lighting, water supply, sewerage, drainage, fire protection, etc.; Betterment charges, etc.
Land-based Taxes	
Planning-related charges	Land use conversion charges; Development charges; Development Impact fees
Land-based benefit taxes	Property tax; Land hoarding tax; Tax on Land value; Vacant land tax; Land value increment tax; Stamp duty/property registration tax (share).
Agglomeration-related taxes	
Local agglomeration taxes	Entertainment tax; advertisement tax; profession tax; payroll tax; business licensing tax.
General taxes	Local option (piggyback) taxes - city surcharge on Income tax, Excise tax,Value added tax, Sales tax, Business tax, Goods and services tax (GST), etc. or sharing in such taxes, especially GST.
Congestion Charging Instruments	
Congestion charges	Road toll (Pigovian)
Congestion-related taxes	Motor vehicle tax; motor fuel tax; tax on registration of vehicles, etc

Source: Mohanty (2016, 2019); Authors.

Ahmad *et al.* (2019) argue for strategically combining all these different tax instruments and ensuring fiscal sustainability where the national government must ensure coordination among all tiers. They make a case for a coordinated or systems approach to urban finance and emphasise on the need to raise the scale of resources to finance sustainable urban infrastructure. In similar lines Dulal, Hari and Govinda (2010) also state that to effectively mitigate externalities, multiple policies must simultaneously be used as most policy options are not mutually exclusive. They

also point out that policy tools aimed at reducing congestion are mostly limited to industrialized economies. Cities is developing countries need to be empowered to levy suitable taxes and charges, keeping the above instruments in view. Such sources can be escrowed to resort to debt-financing of urban infrastructure and undertake planned urban land development.

8. Conclusion

'Smart city' programs are gaining prominence in the developing world. However, cities need the edifices of planning, financing and governance before becoming smart. In other words, application of smart tools and techniques will depend on the existing state of urban infrastructure and the system of its financing. In this context, the theories of WEBs and agglomeration rents referred to by the Venables model, the Henry George Theorem and Mohring-Harwitz Theorem present theoretically elegant and practically feasible principles to develop urban infrastructure financing strategy in developing economies. 'Beneficiaries pay' and 'congesters pay' are the two fundamental paradigms highlighted by the theories. These paradigms can be considered as the cornerstones of a robust urban financing strategy. From the Henry-George Theorem, it was deciphered that landowners are the primary beneficiaries of planned urban development. However, urban economics and NEG literature also state that cities generate the benefits of agglomeration and networking economies that may not be confined to land alone. These externalities manifest in the form of 'agglomeration rents' accruing to both immobile and mobile factors of production through WEBs. NEG theorists argue that even mobile factors reap significant benefits of unearned rent due to strong forces of agglomeration in cities; these rents can be rightly taxed without the tax base vanishing. The Stiglitz-Piketty debate also identifies other variants of rents, such as monopoly rents, natural resource rents and rents to capital. Paradoxically, the approach to urban infrastructure financing in developing economies like India neglects externality-induced tax bases linked to WEBs. It also does not consider the Henry George Theorem or its extension through NEG literature. Similarly, the Mohring-Harwitz theorem of pricing of congestible local public goods at a scale adequate enough to meet the social costs of congestion is not included in the design of city financing instruments.

The Venable's Model, Henry George Theorem and Mohring-Harwitz Theorem are barely discussed by policy-makers or scholars in emerging developing countries like India. This paper is an attempt to fill some of the gap in research. We have emphasised on two things: (i) the importance of cities with relevance to its various externalities and (ii) a theoretically coherent model of urban infrastructure financing that takes into account taxation of agglomeration rent, land taxation and congestion charging instruments, including their proxies. Such proxies may include income tax, goods and services tax (GST), land value tax, property transfer tax, motor vehicles and motor fuel tax, etc. Theory and empirical evidence suggest that if taxation of 'agglomeration rents', 'land rents' or 'land-based taxes' and instruments of 'users pay', 'beneficiaries pay', 'polluters pay', 'congesters pay', 'exacerbaters pay' and 'growth pays' in various forms are adopted, the process of

planned urban development in countries like India could be self-financing – at least in large cities.

The basic tenet is that cities generate powerful agglomeration economies and congestion diseconomies, and city financing strategy must take these explicitly into consideration. Cities must explore the neglected phenomena of externalities as a resource for their development based on a self-financing paradigm. The future research would delve into this matter and present cases of international best practices along with a comparative analysis of existing practices of developing countries. Further, one could check for an experimental result of the proposed model.

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