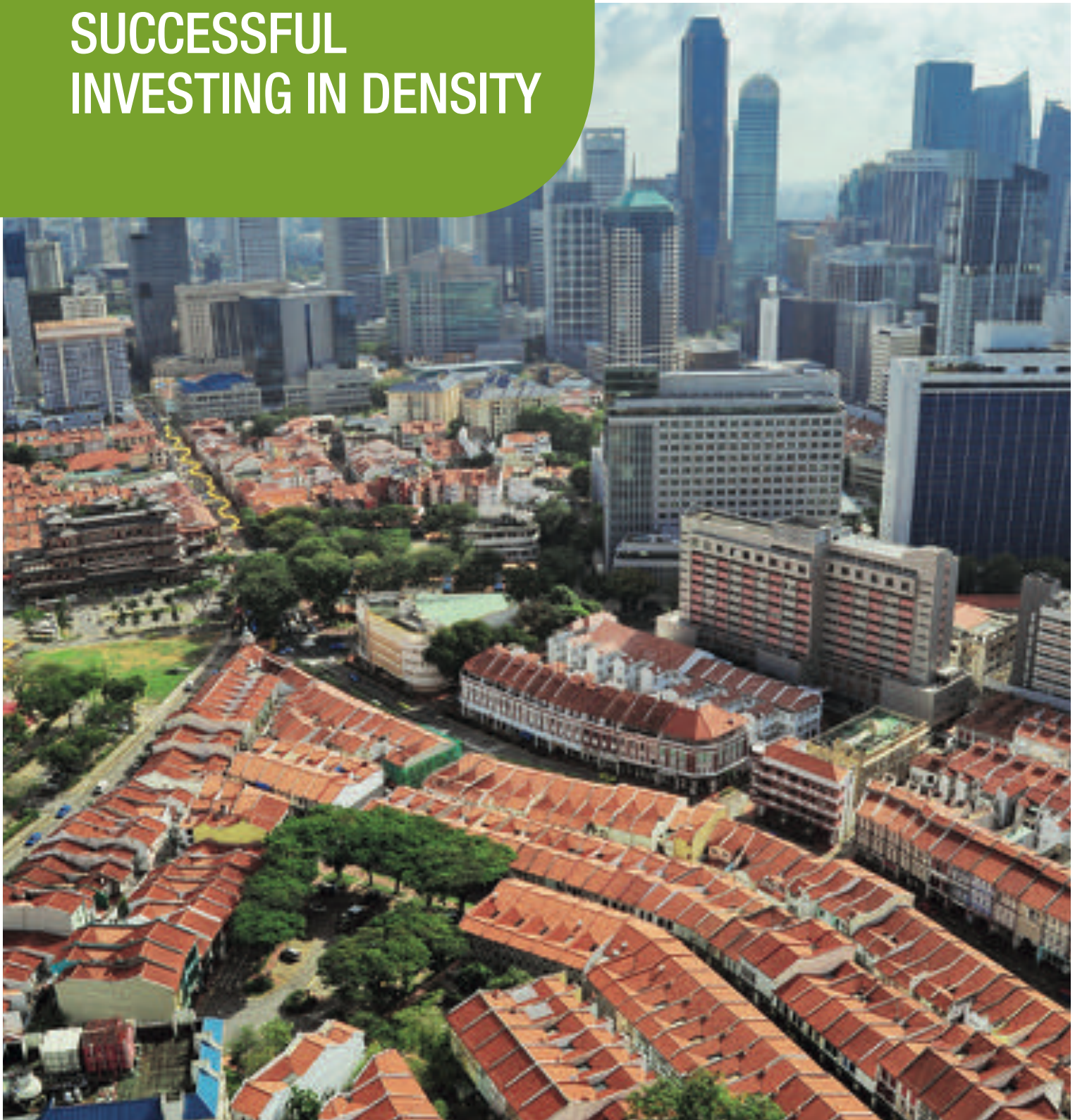


# SUPPORTING SMART URBAN DEVELOPMENT: SUCCESSFUL INVESTING IN DENSITY

## COALITION FOR URBAN TRANSITIONS

A New Climate Economy Special Initiative





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## ABOUT ULI

The Urban Land Institute is a global, member-driven organisation comprising more than 40,000 real estate and urban development professionals dedicated to advancing the Institute's mission of providing leadership in the responsible use of land and in creating and sustaining thriving communities worldwide.

ULI's interdisciplinary membership represents all aspects of the industry, including developers, property owners, investors, architects, urban planners, public officials, real estate brokers, appraisers, attorneys, engineers, financiers, and academics. Established in 1936, the Institute has a presence in the Americas, Europe, and Asia Pacific regions, with members in 76 countries.

The extraordinary impact that ULI makes on land use decision making is based on its members sharing expertise on a variety of factors affecting the built environment, including urbanization, demographic and population changes, new economic drivers, technology advancements, and environmental concerns.

Peer-to-peer learning is achieved through the knowledge shared by members at thousands of convenings each year that reinforce ULI's position as a global authority on land use and real estate. In 2017 alone, more than 1,900 events were held in about 290 cities around the world.

Drawing on the work of its members, the Institute recognizes and shares best practices in urban design and development for the benefit of communities around the globe.

ULI has been active in Europe since the early 1990s and today has more than 3,000 members across 27 countries. It has a particularly strong presence in the major Europe real estate markets of the UK, Germany, France, and the Netherlands, but is also active in emerging markets such as Turkey and Poland.

More information is available at [uli.org](http://uli.org). Follow ULI on Twitter, Facebook, LinkedIn, and Instagram.

## ABOUT THE COALITION FOR URBAN TRANSITIONS

The Coalition for Urban Transitions is a major global initiative to support national governments to take action for economic productivity, climate safety, and inclusion by transforming the development path of cities.

The Coalition is a special initiative of the New Climate Economy and is a rapidly growing collaboration between over 40 research institutes, city networks, intergovernmental organizations, investors, infrastructure providers, strategic advisory companies, and NGOs to provide the best evidence, cutting-edge policy ideas, and analysis for national governments, particularly in rapidly urbanising countries, looking to step up to the challenge.

It is jointly hosted and managed by the World Resources Institute (WRI) Ross Center for Sustainable Cities in Washington, D.C., and the C40 Cities Climate Leadership Group in London. The initiative is funded with UK Aid from the UK government; however, the views expressed do not necessarily reflect the UK government's official policies.

Learn more about the work at [coalitionforurbantransitions.org](http://coalitionforurbantransitions.org). Follow the Coalition on Twitter @NCEcities, Facebook @coalitionforurbantransitions and LinkedIn.

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HONG KONG, CHINA



# FOREWORD

Urban areas today are more attractive than ever as places to live and work: they are magnets for talent, hubs of new ideas and innovation, and reflecting all of this, appealing destinations for investment. Yet cities also experience profound challenges, not least for the environment, as they are also substantial generators of carbon emissions. Urban sprawl continues to characterise urban growth in many locations around the world. Unfortunately, urban development is likely to continue along this 'business as usual' path until there is a compelling case for change.

In response, both the public and private sectors are searching for solutions to accommodate urban growth in a way that preserves both the environment and the quality of life for residents and visitors. Internationally, many dense and well-connected cities have a positive track record for offering both a high quality of life and success in reducing their carbon emissions. In addition, what this report refers to as 'good density' – dense, well-connected development that is thoughtfully designed to promote a high quality of life – may be more sustainable and prosperous in the long term and therefore more likely to provide more resilient risk-adjusted returns for investors.

This report is the result of collaboration between a powerful group of innovative real estate investors and developers that are actively building the cities of the future. Collectively, this group owns or manages over US\$300 billion worth of real estate assets worldwide. The research underpinning the report was initiated by the Urban Land Institute, a global membership organisation dedicated to creating and sustaining thriving communities worldwide, and the Coalition for Urban Transitions, a global project working to provide national governments with the evidence they need to support low-carbon and inclusive urban development.

We began this project with an ambitious objective: to evaluate the impact of compact, connected urban development on real estate investment returns and on carbon emissions. We hoped to learn more about the areas of common interest between investors, city residents, and the national and local governments tasked with making our cities run well for everyone.

The research demonstrates for the first time how investors as well as citizens benefit from compact urban forms with good public transport connections, shared green spaces, and a mix of housing, shops, services, and businesses rather than urban sprawl. The research findings support the understanding and practices of leading investors in this field. We hope it will help a much wider group of real estate firms make smart decisions about where and how to invest to make an attractive, resilient, risk-adjusted return – and at the same time support efforts on climate change and sustainable development.

We hope this report inspires cities and investors alike to work together to improve urban form and function in ways that promote good density.

**Lisette van Doorn**, CEO, ULI Europe

**Nick Godfrey**, Director, Coalition for Urban Transitions

# EXECUTIVE SUMMARY

Unprecedented levels of urbanisation coupled with revolutions in transport, energy, and data technology offer new opportunities to reshape cities. Cities of the future need to be planned strategically to support environmental and social well-being as well as economic productivity.

To do so, cities must encourage compact and connected urban growth. However, encouraging large concentrations of people to live and work closely together brings its own challenges.

Building upon previous research by ULI, this report analyses the characteristics of 'good density' and begins to quantify the relationship between these characteristics, investor returns, and carbon emissions.

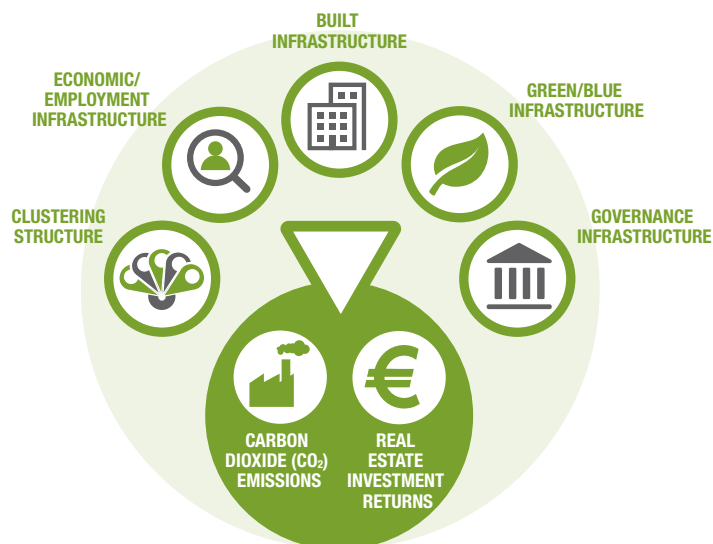
The research team found that cities with good density – that is, dense development thoughtfully designed to promote a high quality of life – are likely to be more resilient and prosperous in the long term, and therefore more likely to provide sustainable

returns for investors, than cities without good density. Based on a quantitative analysis of 63 global cities, the report finds that cities with good density are associated with higher returns, capital values, and levels of investment flows for commercial real estate.

The research is global in scope and provides evidence of important issues for the long-term resilience of cities both in the OECD and in fast-growing developing regions.

The study was conducted in two phases and undertaken by a multi-disciplinary research team led by Professor Kathy Pain at Henley Business School of the University of Reading. Through a systematic review of existing literature, the team identified six characteristics of urban form as commonly being related to good density and looked at the relationship between these characteristics, investor returns, and carbon emissions. The study components are summarised in figure ES-1.

**FIGURE ES-1. STUDY COMPONENTS**



## ES-2. SUMMARY OF STRENGTH OF EVIDENCE DISCOVERED IN RESPONSE TO RESEARCH QUESTIONS

Relationship found from quantitative analysis	Strength of evidence
Larger cities and more dense cities are associated with higher returns for office real estate investment returns.	Strong
Cities with higher levels of innovation and a stronger presence of business services and financial services are associated with higher levels of office real estate investment flows.	Strong
Cities with higher levels of tourism are associated with higher retail capital values.	Strong
Cities with higher levels of business services are associated with higher retail capital values.	Strong
Cities with a strong business and financial services presence are associated with higher office real estate investment returns.	Moderate
Cities that are more innovative are associated with higher office real estate investment returns.	Moderate
Cities with better green environments are associated with higher office real estate investment returns.	Moderate

The research team selected 12 indicators that could be used to represent five of the six good density characteristics and identify the links between each characteristic and real estate returns.

The team excluded public transport from the quantitative analysis because they were not able to identify an appropriate indicator for this characteristic across different cities. The team selected three data sets to capture the dynamics of the real estate market and fund management, and investor interest in returns, investment value, and performance. CBRE supplied real estate yields data that were used to calculate returns for 63 international cities. Cushman and Wakefield supplied data for capital value and rents for 27 European cities, which allowed analysis of data for prime retail as well as office markets. The team used Real Capital Analytics data to examine cross-border real estate portfolio capital flows.

Figure ES-2 summarises the associations between good density characteristics and real estate investment returns and flows found by the correlation analysis.

The research shows that larger cities and more dense cities are associated with higher returns for real estate investment. Importantly, the relationship between density alone and retail investment returns does not appear to be significant. This finding suggests that other factors might be more important, including the location of property assets within a city. These findings highlight that the local city context is critical and that factors such as transparency, crime levels, or walkability might be very significant within individual cities.

In the absence of granular data on density, this analysis suggests that tourism might serve as a proxy for the attractiveness of cities. Tourism is strongly associated with investment returns and may reflect good density characteristics such as walkability or green space (as well as other characteristics such as cultural, architectural, or historical interest). Tourism measures encompass both those travelling for leisure (who may wish to enjoy the cultural and retail opportunities) and those travelling for work (who might be taking advantage of financial or business services).

The need for strategic policy interventions to safeguard the quantity and quality of open space, to support a green urban environment, and to invest in public transport infrastructure and services in densely developed cities is highlighted by the research as a priority to help offset total and displaced carbon emissions and avoid bad density.

For investment managers, the results on the positive relationship between built density and compactness, and commercial office investment performance, is an important consideration. However, if cities do not have good governance, traffic-related emissions in dense cities that cause environmental and air quality degradation can be expected to compromise not only the health and well-being of city residents and workers but also property values and returns on investment.

The results provide the groundwork for further quantitative and qualitative research to investigate in depth other factors potentially influencing good density and its relations with investment performance and returns. This research includes a need for city and city-region level studies incorporating robust longitudinal and qualitative data and expert appraisal to better understand the development conditions that underpin present and future bad and good density, and their causal relations with investment performance.





# SECTION 1

## INTRODUCTION

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### “THE BATTLE FOR SUSTAINABLE DEVELOPMENT WILL BE WON OR LOST IN CITIES.”

— Jan Eliasson, UN Deputy Secretary-General

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Much has been written in recent years about the urbanisation of the world's population. Although urbanisation is not a new trend, the scale of this growth poses a substantial challenge for urban development and land use; the world gained 77 million new urban dwellers a year between 2010 and 2015.<sup>1</sup> Managed well, cities can capitalise on this population growth to build on their track record as engines of economic growth, prosperity, and innovation. However, to do so requires managing the social and environmental externalities of urban population growth. Currently, urban areas account for approximately 70 per cent of global carbon emissions from energy use.<sup>2</sup> Effective management of land use and urban form is essential to a low-carbon future.

Managing land use and urban form is an essential aspect of getting cities right. As the world's urban population increases, the land area occupied by cities has increased at an even higher rate. On average, cities are expanding their urban land cover at twice their population growth rates.<sup>3</sup> Figure 1 shows how built-up-area densities in cities, particularly those in developing countries, have decreased over time. In part, this is caused by increased demand for space, as economies grow. More problematically, much of urban development globally is characterised by urban sprawl. This is a function of land use patterns, transportation systems that prioritise private cars, and social norms favouring low-density housing and segregated land use in some countries.<sup>4</sup> Economic incentives, such as land and property taxes that favour low-density development, or mortgage finance regulation that favours single-family dwellings also

play a role. As a result, whereas the world's urban population is expected to double in 43 years, the urban land cover is expected to double in only 19 years.<sup>5</sup>

The demographic profiles of cities are also changing. For example, larger UK cities have been growing faster than smaller ones, led predominantly by movements of young, highly educated, single residents.<sup>6</sup> However, it is population ageing that brings significant challenges and opportunities to cities across the world. For example, in countries of the Organisation for Economic Co-operation and Development (OECD), the share of population 65 years of age and older was 17.8 per cent in 2010 and is forecast to climb to 25.1 per cent by 2050. Whilst the majority of older people are not currently city dwellers (43.2 per cent of older people live in cities), trends show a greater likelihood for them to be so in future years. Changes to the age structure of people living in cities will bring about changes in local revenues and expenditure patterns, differences in the labour supply, and opportunities for new types of housing stock specifically designed to meet the needs of older people.<sup>7</sup>

**THE WORLD'S POPULATION IS EXPECTED TO DOUBLE IN 43 YEARS, WHEREAS THE URBAN LAND COVER IS EXPECTED TO DOUBLE IN ONLY 19 YEARS.**

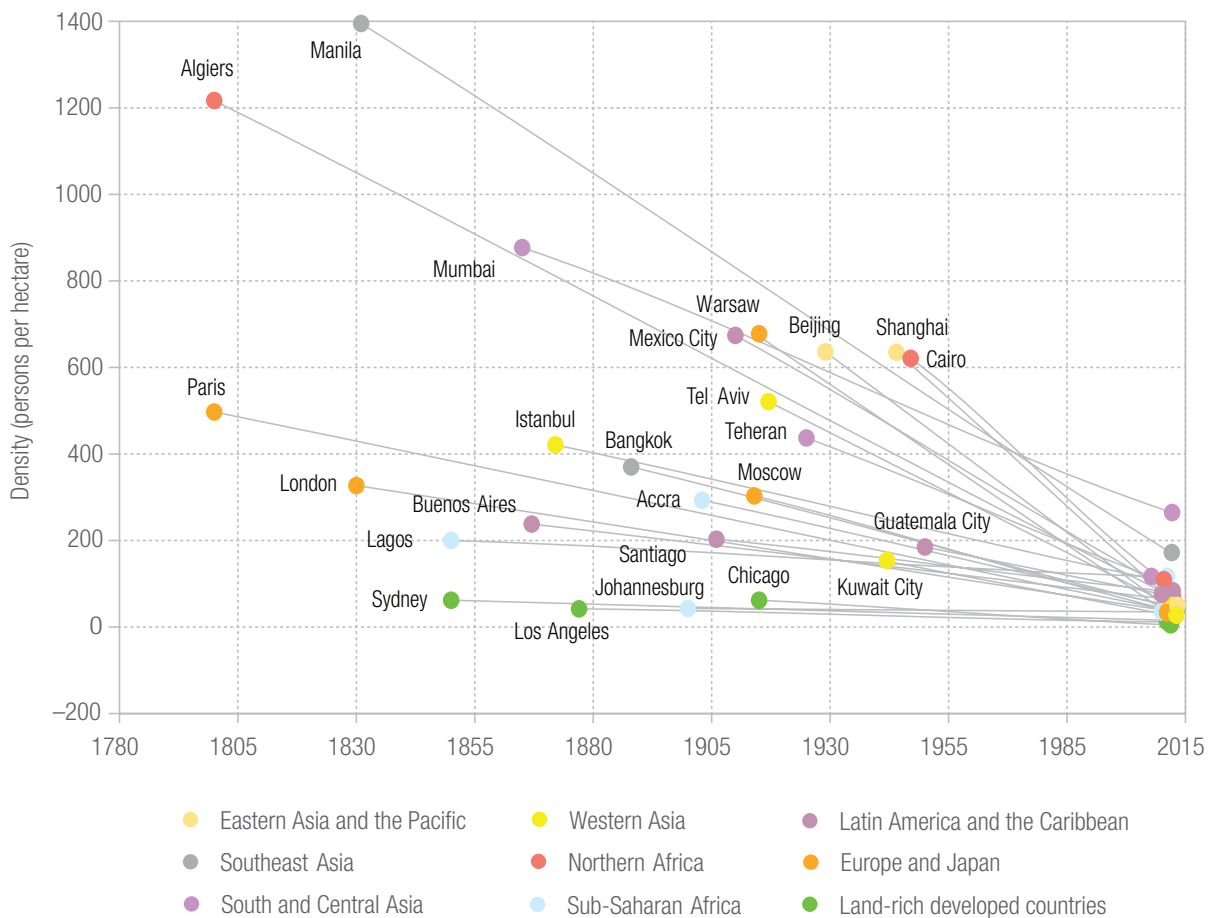
Changes in technology are influencing the ways in which real estate is being occupied, leased, built, sold, and valued. Workers are becoming ever more mobile, blurring the distinction between places of work, home, and leisure and contributing to changes in office space requirements. Demand is growing for 'space as a service' models with greater flexibility of lease arrangements, and people have higher expectations of the quality of services available within buildings.<sup>8</sup>

Taken together, demographic, economic, and technological changes are likely to lead to an increased need for higher density in cities, especially 'good density' including mixed use, good connectivity, and flexibility. The buildings and infrastructure that are constructed over the next half century will have substantial consequences for our economies, quality of life, and above all the environment. If managed and directed wisely, harnessing these trends can be a critical part of the solution to the challenges of urbanisation.

**THE TOTAL GLOBAL STOCK OF PRIME (CLASS A) OFFICE REAL ESTATE WILL INCREASE BY NEARLY 17 PER CENT BETWEEN 2017 AND 2021.**

To accommodate the growth of urban populations in a sustainable way, the density of the built environment will need to increase in many cities. ULI previously commissioned two reports exploring meanings of the term 'density' and how density has been delivered in different cities around the world.<sup>9</sup> The ULI framework for good and bad density is shown in figure 2.

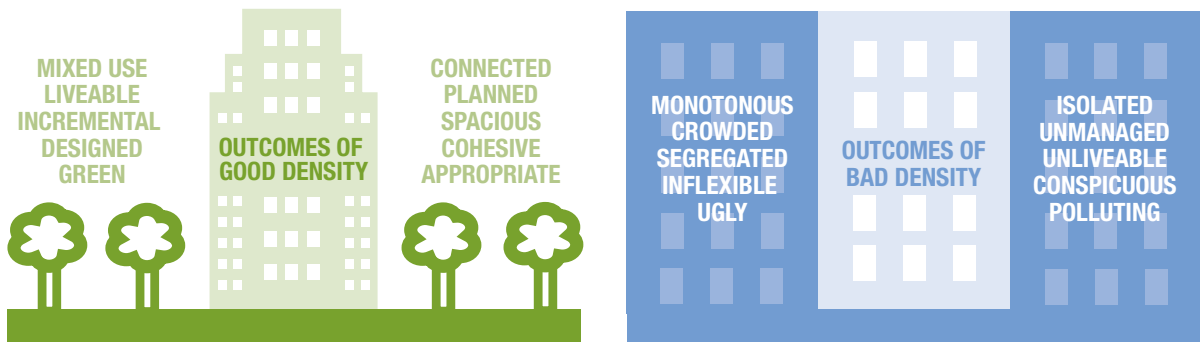
**FIGURE 1. BUILT-UP-AREA DENSITIES IN 25 CITIES, 1800–2015**



Sources: UN-Habitat, World Cities Report (Nairobi: UN-Habitat, 2016), based on data from Angel, et al., 'The Dimensions of global urban expansion'. Kuwait City from world cities capitals data set, Atlas of Urban Expansion.



**FIGURE 2. ULI'S GOOD AND BAD DENSITY FRAMEWORK**



Source: G. Clark and E. Moir, *Density: Drivers, dividends and debates* (London: Urban Land Institute, 2015).

This work found that dense development brings about not only opportunities to improve the economic, social, and environmental performance of cities, but also risks. It can enable the more efficient provision of public services, reduce the need for travel, and increase opportunities for making journeys on foot, which also brings environmental and health benefits. Similarly, research by the New Climate Economy shows that compact and connected cities can create vibrant dynamic urban centres that are more competitive, inclusive, and resilient as well as cleaner, quieter, and safer, and have lower carbon emissions.<sup>10</sup> However, bringing more people into a city needs careful planning and management to avoid the potential negative effects of increased density, which can include congestion, air pollution, and loss of open space including green and blue amenity spaces. Green amenity spaces are often found in residential areas and are spaces for informal activities close to work or home. They can also be used for landscaping and noise reduction. Blue amenity spaces are areas of water, such as harbours, rivers, ponds, lakes, ports, canals, and fountains. Densification must also be carried out sensitively to ensure that existing communities are not left feeling overwhelmed by the scale of new development and do not suffer from a decline in their local public service provision.

The real estate development and investment communities are playing an important role in this transition.<sup>11</sup> The majority of the urban growth described here will occur in mid- and low-income countries, particularly in Africa and Asia where commercial real estate markets are emerging.<sup>12</sup> Although urban growth rates are much lower in the already highly urbanized OECD countries, these markets will also see substantial changes to the built environment in the coming years. Jones Lang LaSalle global research estimates that the total global stock of prime (Class A) office real estate will increase by nearly 17 per cent

between 2017 and 2021, and North America and Europe will see increases of over 5 per cent in this time period.<sup>13</sup> Three-quarters of all buildings in these countries will still be standing in 2050,<sup>14</sup> so large-scale refurbishment will be necessary to reduce the environmental impact of the building stock.

Institutional real estate investors can play a crucial role in making compact, connected cities the default future urban growth model. If the investment community were to commit to supporting urban development and infrastructure projects that embrace the principles of good density, and were supported by appropriate policies, this could have a substantial impact on the way cities grow and develop. However, greater understanding is still needed of the relationships between compact and connected urban development, investment returns, and carbon emissions.

This report summarises research that explores these relationships. A technical report, with the research team's complete analysis and findings, is available on the ULI website. The work was commissioned by ULI and the Coalition for Urban Transitions (a special initiative of the New Climate Economy), and supported by a steering group consisting of global real estate and infrastructure fund managers and investors. The research reviewed the characteristics that make up good density within urban areas and how these relate to investment returns and carbon emissions. This report seeks to identify the extent to which the interests of real estate investors align with those of the state and therefore opportunities to align public policy and private finance to deliver more prosperous, liveable cities and higher risk-adjusted investment returns.

# SECTION 2

## RESEARCH METHODOLOGY

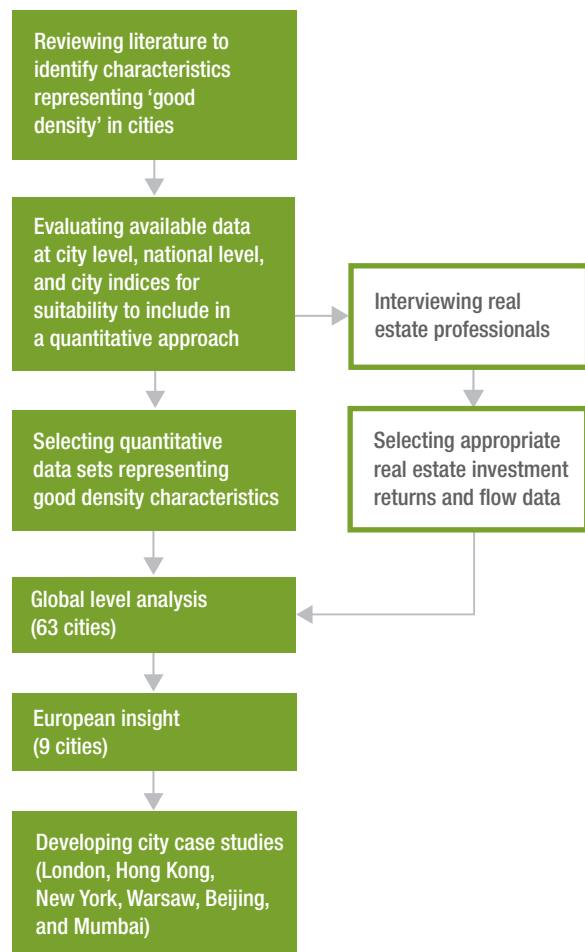
### STUDY COMPONENTS: REVIEW OF 65 STUDIES, 20+ INTERVIEWS, HIGH-LEVEL ANALYSIS OF 63 CITIES WORLDWIDE, DETAILED ANALYSIS OF 9 EUROPEAN CITIES.

The research was conducted by a multi-disciplinary team led by Professor Kathy Pain of the Henley Business School at the University of Reading. This section summarises the research approach taken, which involved a qualitative review to identify the characteristics of urban form that are linked to good density, followed by a quantitative analysis of the relationship between these characteristics and investment returns. The approach is summarised in figure 3 and explained further in this section.

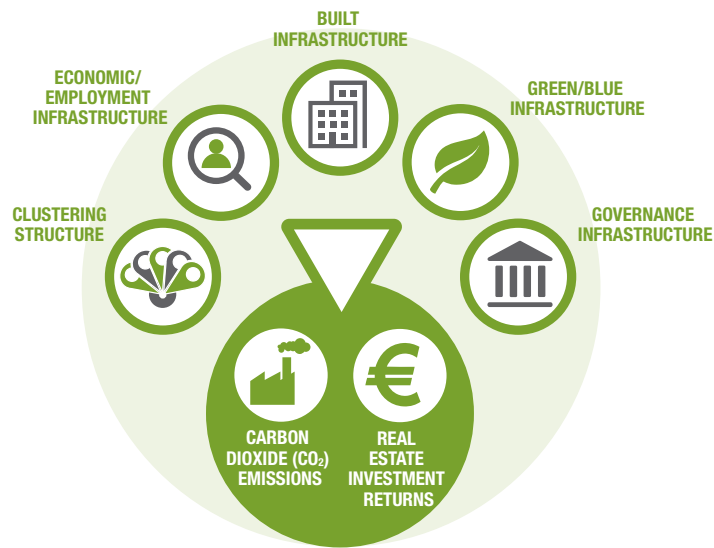
The project began with a review of existing literature, to provide a solid basis for developing a quantitative approach and selecting case studies. The aim of the review was to (1) produce a shortlist of urban form characteristics associated with good density, and (2) isolate the links between the identified urban form characteristics and investment returns, infrastructure costs, carbon emissions, and any other relevant metrics.

The research team reviewed literature from a range of sources, including international peer-reviewed academic journals and reports published by official bodies and think tanks such as the Urban Land Institute and Coalition for Urban Transitions. To identify relationships between investment and good, compact, connected development, the review was extended beyond the urban design and planning literature to include research on real estate investment returns, urban infrastructure (including green and blue infrastructure), and carbon emissions.

FIGURE 3. RESEARCH PROCESS



**FIGURE 4. STUDY COMPONENTS**



The team also conducted semi-structured interviews with project steering group members and a select group of industry experts to develop a better understanding of how good density is currently incorporated into the investment decision-making approaches of companies and to help identify additional relevant data. The interviews also helped identify cities of potential interest as good density investment locations and the value of different approaches to analysis from a research user perspective.

In total, the team evaluated 65 separate studies, some of which were themselves reviews of existing literature. The team then applied inductive and deductive reasoning approaches to analyse each of the separate literature reviews of existing evidence and to derive the six core characteristics of urban form affecting good density that were used in the study.

## DATA SELECTION

The second phase of the project focused on quantitative analysis of the relationships between the six core urban form characteristics (as identified from the literature review), real estate investment returns, and carbon dioxide (CO<sub>2</sub>) emissions (see figure 4). To conduct this analysis, the research team sought globally comparable data sets.

## QUANTITATIVE METHODS

The quality and comparability of data sets initially identified by the team were mixed. Some cities lacked key data points or comparable time-series data, so the ability to conduct analysis in terms of formal econometric modelling was limited.

Furthermore, the influence of local factors (such as geographic constraints to city growth, city-level development policies, and land availability) could not be accounted for within a global analysis. Local factors may influence the relationships between good density and real estate value significantly because value is not simply a byproduct of demand for urban property and space use value and location. Research analysing real estate holdings has shown that the relationship between commercial investment levels and returns is complex and based not solely on expectations about risk and returns but also on investor perceptions of liquidity in the market. In addition, investment levels are affected by behavioural factors such as wanting a presence in a global market, ownership of flagship buildings, and the benefits of location of assets in cosmopolitan cities with all their services, which are not easily modelled.<sup>15</sup>



## UNDERSTANDING CORRELATION COEFFICIENTS AND P-VALUES

In statistics, correlation coefficients are used to measure the strength and direction of a linear relationship between two variables on a scatter plot. The value of the correlation coefficients always lies between  $-1$  and  $+1$ . If, for example, the greater the built density is within a city, the higher the investment returns are found to be, Spearman's rank ( $\rho$ ) will return a positive correlation. Conversely, if the higher the unemployment a city has, the lower the investment return, Spearman's rank ( $\rho$ ) will return a negative correlation.

This descriptive statistical test assesses the strength and direction of relationship between two variables but does not account for causality. Correlations can also be influenced by both directions. For example, density may lead to high office valuations, but high office valuations may also lead to higher density. Correlations can also suffer from omitted variables, which is where the relationship between the two variables is caused by a hidden third variable.

A p-value is then used to see if a correlation is statistically significant. First a null hypothesis is set that any observed difference is caused by sampling or experimental error. For example, in this research, a null hypothesis is that city density is not associated with investment returns. If the p-value is less than 0.05, then strong evidence exists to reject the null hypothesis. However, if the p-value is more than 0.05, then there is weak evidence and the null-hypothesis is not rejected. We would therefore state that the observed differences are due to a sampling error or experimental error and we cannot reject the null hypothesis.

As a result of these constraints, the research team tested but chose not to apply a multiple regression analysis approach. Instead, to determine the relationship between the data sets representing good density, the research team ran a series of Spearman's rank-based correlation coefficients for each of the 12 data sets and the investment returns data. The team also tested the p-value of the correlations to determine significance of the results.

The team initially calculated correlation coefficients at the global level using returns and investment data for offices and the density indicators providing data for up to 63 cities.

To provide an insight into the European market, the team then calculated further correlations for retail as well as office markets for nine European cities where urban form density data were also available: Berlin, Budapest, London, Paris, Madrid, Milan, Moscow, Vienna, and Warsaw. Given the small sample size, generalization on the basis of the European-level results is not possible; however, these results offer interesting insights into relationships in selected European mature and developing office and retail markets.

For correlations where data were available for more than 50 cities, univariate and multivariate regressions were also adopted as a robustness check for the baseline correlation results. Overall, using regression analysis did not lead to different conclusions.

This report also presents additional insights for selected cities in mature economies (London, New York, and Hong Kong) and developing economies (Beijing, Mumbai, and Warsaw) to demonstrate how the factors influencing good density vary between locations.

## SECTION 3

# LESSONS FROM EXISTING RESEARCH

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MUCH EVIDENCE SHOWS THAT INCREASES IN URBAN DENSITY ARE ASSOCIATED WITH DECREASES IN LOCAL, DIRECT PER CAPITA CARBON EMISSIONS AND ENERGY CONSUMPTION.

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The literature review showed that substantial empirical evidence demonstrates the links between population and building density and lower carbon emissions. This seems to be primarily but not solely attributable to opportunities to reduce transport energy consumption. However, debate exists about the overall magnitude and exact causation of this association. Furthermore, relatively little rigorous empirical data or theoretical evidence is available that helps define the relationships between urban form and investment returns. Figure 5 summaries the core characteristics of good density identified in the literature review. Each is described in more detail below.

### BOTH CITY AND REGIONAL CLUSTERING PATTERNS ARE IMPORTANT



Clustering patterns within cities and at a city-region scale determine the amount of travel required for work and leisure activities, the materials required for construction, and the energy efficiency of buildings. Clustering patterns also strongly influence the level of inward investment and the development of agglomeration economies.<sup>16</sup> Real estate development and investments both play a vital role in shaping these large-scale patterns and thereby have the scope to contribute to good density and leverage the value that these patterns have for public and private investors. Figure 6 provides a visual representation of different types of urban regions that exist today.

Analysis of major cities and city-regions in northwest Europe demonstrates key differences between ‘monocentric’ and ‘polycentric’ urban forms in relation to density. Cities with the strongest global connections to innovative international businesses, such as London, have multiple hubs of economic and social activity within the city-region, each of which benefits from the clustering and investment of several business sectors. In the case of London, despite its monocentric physical urban form, multi-sector business clustering extends to much smaller secondary towns and cities around its periphery, including Reading, Southampton, Cambridge, and Milton Keynes. So although London dominates in terms of its size, its city-region is polycentric in terms of business functions important for economic growth. In comparison, less internationally connected cities are more likely to have city-regions with specialised clusters in other urban centres in their surrounding region, each dominated by a single commercial sector. For example, the Rhine-Ruhr is Germany’s largest metropolitan area. It is home to a number of smaller cities in close proximity (such as Bonn, Cologne, Düsseldorf, and Wuppertal), each of which has some specialisation and less global connectivity. Emerging polycentric ‘mega’ city-regions both in the most urbanised and rapidly urbanising areas of the world generate carbon emission and environmental impacts due to travel flows between centres.

**FIGURE 5. CORE CHARACTERISTICS OF URBAN FORM THAT AFFECT GOOD DENSITY**

#### CLUSTERING STRUCTURE

Land use patterns within cities and at city-region scale determine levels of carbon-generating movement, i.e., travel for work, business meetings, and leisure. They also determine the scope for agglomeration economies and inward investment and therefore influence economic activities and growth.



#### ECONOMIC/EMPLOYMENT INFRASTRUCTURE

Connectivity to and concentration of foreign investment, quality value-adding jobs, labour, skills, diversity, and innovation capacity all feature in creating a strong, resilient city economy.

#### BUILT INFRASTRUCTURE

Elements of built infrastructure that affect good density are mixed-use planning, technological and design quality, and amenities at property level and urban landscape scale.



#### PUBLIC TRANSPORT INFRASTRUCTURE

The capacity of public transportation serving a city, accessibility to the public transport network, and the quality of services contribute to good density.

#### GREEN/BLUE INFRASTRUCTURE

The network of natural and semi-natural areas, features, and green spaces in rural and urban, and terrestrial, freshwater, coastal, and marine areas are essential to good density.

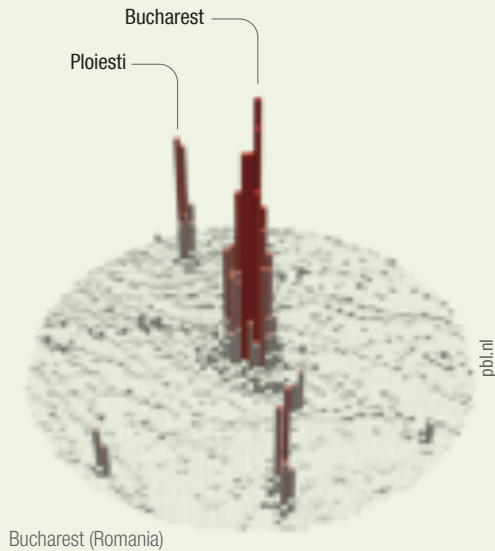


#### GOVERNANCE INFRASTRUCTURE

Coordination of national, regional, and city policies; city leadership and financial authority; transparency and accountability; and policy coherence at the local level play a part in creating good density.

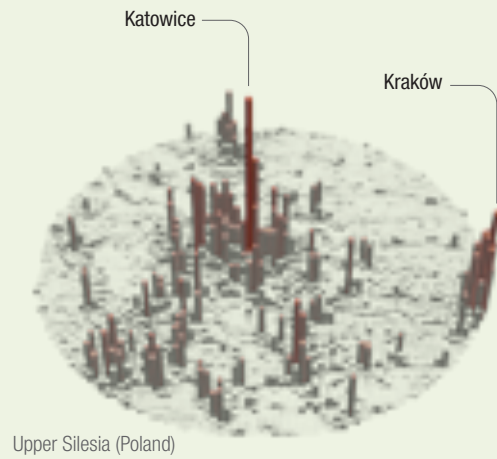
**FIGURE 6. EXAMPLES OF DIFFERENT TYPES OF REGIONAL FORMS**

Urban areas in Europe come in all shapes and sizes. In general, four different morphological types can be distinguished: monocentric, dispersed, linear, and polycentric urban regions.



**Monocentric urban region**

Regions with monocentric urban structures can be found in France, Spain, Portugal, and countries in the northern and eastern parts of Europe, where cities are distributed over relatively wide areas.



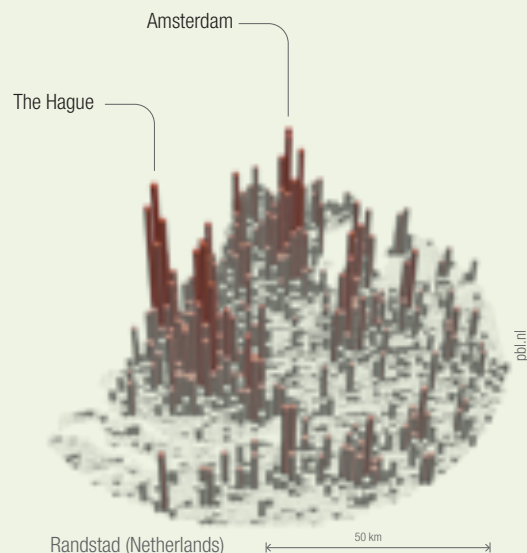
**Dispersed urban region**

Dispersed urban patterns are formed by scattered or sprawling cities, towns, and suburbs with relatively low densities. Examples can be found in parts of Belgium, in northern Italy, and in the south of Poland.



**Linear urban region**

Regions with linear forms of agglomeration have emerged along some of Europe's coastlines, for instance in Portugal, in the southern parts of Spain and France, and in the east of Italy. Linear urban regions are also present in mountain valleys in Switzerland and Austria.



**Polycentric urban region**

In polycentric urban regions, multiple cities lie in close proximity to one another. These kinds of regions can be found in the Netherlands, the western part of Germany, and the southern half of the United Kingdom.

Source: Infographic 29-05-2016, PBL Netherlands Environmental Assessment Agency, [www.pbl.nl/en/infographic/different-types-of-urban-regions](http://www.pbl.nl/en/infographic/different-types-of-urban-regions). Population density 2014: On a grid of 2 x 2 kilometres Source: LandScan, adaptation by PBL

**FIGURE 7. HOLLAND METROPOLE REGION**

Source: G. Clark, T. Moonen, J. Couturier, and J. Nunley, *Fit for the Future? Benchmarking Holland Metropole against the World's Best* (London: *The Business of Cities*, 2017).

## KEY COMPETITIVE ADVANTAGES OF THE HOLLAND METROPOLE REGION

- **An exceptional combination of transport and digital connectivity**, including Schiphol airport, port facilities for international travel and trade, and the unique ability to connect multiple large cities within 40 minutes' journey time. The region has also strongly adopted non-car modes with 63 per cent of travel using other transport modes. Internet speeds in the region are the fourth best among its peers (London, Paris, Singapore, Hong Kong, Greater Sydney region, Greater Boston, San Francisco Bay Area, Greater Toronto, and Munich Metro). It also has a cluster of diplomatic and security-related sectors in The Hague Security Delta with strong local hubs specialising in cyber security, forensics, international peace, and critical infrastructure.
- **A globally competitive regional innovation system**, as demonstrated in the region's high rankings in global indices and data sets on innovation and record spending of €7.5 billion annually on research and development. The region benefits from a strong higher education offer with six of its universities holding places within the global 200 best institutions.
- **A high-quality, liveable, and adaptable offer for its residents and visitors** through the provision of a distinctive development and infrastructure model that provides adaptable growth options and ensures integrated, healthy, affordable, and environmentally friendly growth.<sup>21</sup>

Multi-sector clustering, a feature of major physically monocentric cities, is a critical spur to cross-sector concentration, which is valuable to international city users and foreign investors.

Conversely, in physically polycentric regions like the Rhine-Ruhr, businesses cluster in different specialised urban centres (e.g., advertising in Dusseldorf, insurance in Cologne, and logistics in Dortmund/Duisburg). Policies promoting urban polycentricism fail to take into account the distribution of functions across large urban regions and the consequent travel flows between closely located cities. Furthermore, research has found that coordinated development planning and governance of multi-centre regions is lacking in cases studied worldwide.<sup>17</sup> This problem is particularly pressing in mature economies<sup>18</sup> where sprawl is already extensive.<sup>19</sup>

An example of a polycentric region is Holland Metropole, comprising The Hague, Rotterdam, Amsterdam, and Utrecht, where each city plays a complementary role (figure 7). Holland Metropole has a growing reputation for international data centres, renewable energy, space exploration, fashion, and biotechnology and is becoming more attractive as a location for direct foreign investment. Its population of 7.57 million people is also projected to grow. Competitive polycentric regions in Europe require coordinated development strategies that take into account cross-cutting traffic flows between urban centres associated with vibrant business.<sup>20</sup>

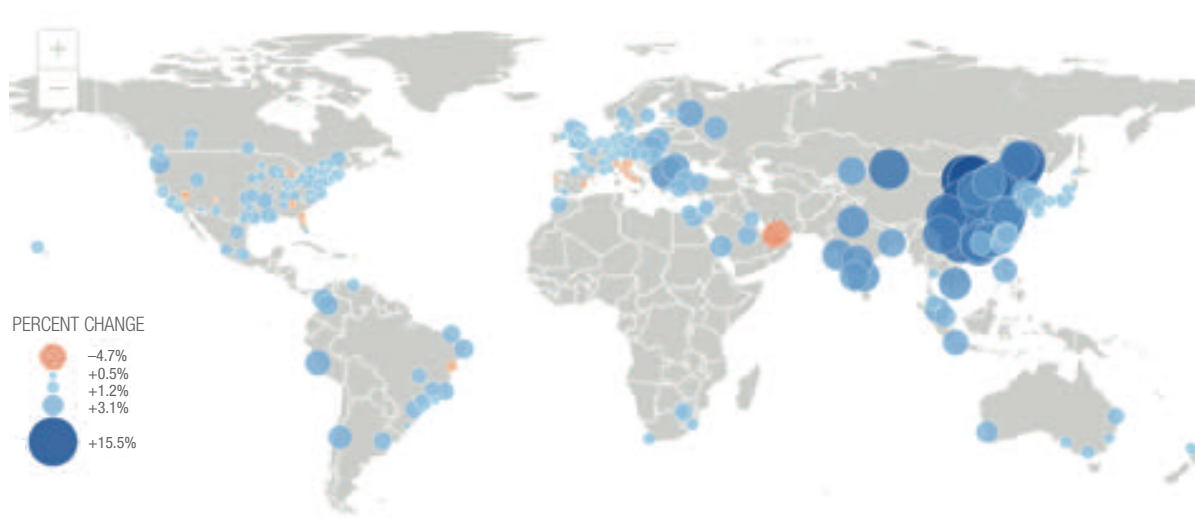
From the perspective of real estate investors, some of the world's most economically attractive cities are the densely developed international financial and business districts where global trade is conducted and value-adding wholesale services (such as corporate financial, insurance, legal, accountancy, marketing, consultancy, and design services) are clustered. These activities are highly synergistic and require locational proximity and immediacy for access to specialised skills, face-to-face transactions, and information exchange.

They depend on supreme digital and transport connectivity at a local, regional, national, and international scale. They may also foster a creative environment, for example, by generating the resources necessary to support the arts, entertainment, retail, hospitality, and tourism industries.

By encouraging interactions among, and specialisation of, individuals and firms, the co-location of these service sectors typically generates agglomeration economies that help sustain innovation and economic growth. This in turn creates a rewarding environment for international investment in multi-use urban space and high-spec/high-value office, retail, and residential property.



**FIGURE 8. PERCENTAGE CHANGE IN INFLATION-ADJUSTED GDP PER CAPITA (ANNUALIZED) FOR GLOBAL CITIES, 2000–2014**



Source: A. Berube, J.L. Trujillo, T. Ran, and J. Parilla, 2015 *Global Metro Monitor* (Brookings Institution, 2015).

Urban concentration and regional expansion have different spatial outcomes, both physically and functionally. These different patterns of urban development then affect both carbon emissions, and real estate and infrastructure investment. Growth processes associated with the structure of urban clustering across different scales require an in-depth assessment of qualitative as well as quantitative data to guide appropriate investment decisions.<sup>22</sup>

### ECONOMIC AND EMPLOYMENT INFRASTRUCTURE SHAPE THE PRODUCTIVITY OF CITIES



Changes in world economic development provide an important context for understanding the relationship between urban economic and employment structure, good density, and real estate investment. Urban areas now account for approximately 80 per cent of global economic output, and by 2050 two-thirds of the global population are expected to live in urban areas.<sup>23</sup> The fastest-growing urban populations are in China and India, and nearly 90 per cent of global urban population growth will happen in Asia and Africa.<sup>24</sup> Whereas over half the world's population today live in urban areas, the majority of those urban areas have fewer than 0.5 million inhabitants. However, large cities will contribute substantially more to future growth. The largest 150 world metropolitan economies constitute only 13 per cent of the global population but generate 40 per cent of global gross domestic product (GDP). For example, the

economic output of Tokyo is higher than the combined output of the 220 largest metropolitan areas in low-income countries.<sup>25</sup>

Two independent but closely related megatrends underpin these global changes: the increasing use of information and the integration of the world economy as cities in developed and developing countries move from a manufacturing industry and manual skills base to knowledge-intensive skills and the production of specialised advanced services. As major rural-to-urban migrations continue, Africa and Asia, which currently comprise 90 per cent of the world's rural population, are expected to have urbanisation levels of 56 per cent and 64 per cent, respectively, by 2050.<sup>26</sup>

These development trends are sustained and long term, with increasing world employment in services, manufacturing, and informational industries expected by 2025, leading international and national authorities to direct investment and planning attention from countries to cities. Real estate and infrastructure investment in sustainable urban form for large cities that are rapidly expanding into extensive urban regions is therefore critically important.

The economic growth of cities varies widely around the world, reflecting different levels of income, cultural norms, and historical legacies. Figure 8 shows changes in GDP per capita for cities around the world. Cities located in developing economies often enjoy faster economic growth than those in high-income countries.

## “UNDERSTANDING THE SPECIFICS OF DENSITY REQUIRES MORE THAN A SPREADSHEET OR MATRIX; IT IS A QUALITATIVE CONCEPT AS WELL AS A QUANTITATIVE MEASURE.”

— **Clark and Moir**, *Density: Drivers, dividends and debates* (London: ULI, 2015)

This is because they benefit from scope for skills development and knowledge and technological transfer and are starting from lower incomes so comparable changes are higher. Construction to address historical infrastructure deficits and respond to anticipated population growth can also support job creation and economic expansion. In cities based in developed countries, stable urban populations, an established infrastructure stock, and early adoption of technology mean they may have more limited investment and job creation opportunities and therefore slower growth. Many other factors also influence city economic growth, such as variations in resource endowments, institutional infrastructure, and the skill levels of their citizens.<sup>27</sup>

### BUILT INFRASTRUCTURE MATTERS BUT IS NOT EASILY QUANTIFIABLE



Technological and design quality, mixed-use development, and amenities at the property and urban landscape scales all contribute to good density. At the city and sub-city levels, urban planning and design literature suggest that good density is not just a feature of quantity (i.e., higher density), but also of the quality of built form, including the matching of urban form with work and lifestyle behaviours of city users and residents.<sup>28</sup> In emerging economies, the development of good-quality built infrastructure necessary for the attainment of good density appears particularly challenging.<sup>29</sup>

Discussions are ongoing about optimum levels of crowding and how they can be determined. However, quantification of the relationship between good density and urban form is in its infancy and qualitative assessment is needed at least in the short term.<sup>30</sup> The use of big data may help overcome some of these issues; for example, tracking of mobile phone data can provide measures of how intensively an area is used at different times of the day.

At the property and landscape levels, descriptors are required to support qualitative appraisals that are relevant to distinctions between high- and low-quality urban design.<sup>31</sup> Technological developments, such as automatic recognition of physical elements (for example, processing of Google Street View images) may facilitate measurement of small-scale urban form, but a certain degree of qualitative appraisal is required for the evaluation of design quality.

Furthermore, the quality of ‘place’ is determined not just by the urban form itself but by how the space is managed and developed.<sup>32</sup> Because of the complexity of interrelationships and the length of time that urban environments take to evolve and for impacts to manifest,<sup>33</sup> few clear examples are available of which higher-density and high-quality urban form approaches work.<sup>34</sup>

The successful densification of development with a reduction in car use, for example, requires strong city and regional management to change behavioural patterns and to minimise the localisation of pollution impacts that are generated. Research found that increased density on its own, and particularly at a small scale, is likely to worsen local environmental conditions.<sup>35</sup> ‘Pull’ measures, such as improved public transport with intensification of buildings and population along those transportation routes or nodes, and better high-quality walking and cycling routes, do not suffice alone. ‘Push’ measures, such as reductions in parking provision, non-residential parking restrictions, and restraints on car circulation, need to be part of a comprehensive strategy for built and transportation infrastructure solutions.

Optimum levels of density in cities will vary depending on the perception of the city’s residents to density and how the change of density is integrated within the existing city fabric. Regulatory mechanisms and management approaches need to be developed that support good density through built infrastructure appropriate to different political, economic, and cultural contexts.

**TO A CONSIDERABLE DEGREE, HEALTHY AND RESILIENT WAYS OF LIVING AND WORKING IN HIGH-DENSITY LOCATIONS DEPEND UPON WHETHER AGGLOMERATION EFFECTS OR CONGESTION EFFECTS DOMINATE.**

BEIJING, CHINA

## INVESTMENT IN ACTIVE OR PUBLIC TRANSPORT IS CRUCIAL FOR GOOD DENSITY



As journeys by conventional cars generate carbon emissions, providing alternative transport modes and creating neighbourhoods that are essentially walkable and have all the necessary amenities and uses are important ways to decrease such emissions. Sufficient capacity, quality, and accessibility of public transportation serving a city are vital to support urban density. To a considerable degree, healthy and resilient ways of living and working in high-density locations depend upon whether agglomeration effects or congestion effects dominate.<sup>36</sup>

Qualitative research has shown that the clustering of international finance and linked business services that generate mutual benefits for firms, contributing to knowledge, technological innovation, and economic growth<sup>37</sup>, is threatened by lack of adequate city investment in public transportation infrastructure and good services.<sup>38</sup> A general consensus exists that low-density urban sprawl and 'leapfrog' development beyond metropolitan fringes are responsible for high costs of infrastructure as well as higher energy consumption.<sup>39</sup>

For these reasons, high-quality compact urban development with appropriate public transport infrastructure and services is likely to deliver some substantial net good density benefits.<sup>40</sup> The scale of analysis of the relationship between density and form is therefore critically important in understanding associated real estate and infrastructure benefits, risks, and costs. This is particularly relevant when agglomeration is both concentrated and spread out across physically separate but economically and functionally interlinked proximate urban centres.<sup>41</sup> Evidence on the relationships between public transport infrastructure and good density endorses the need for coordinated horizontal and vertical planning across the economy, land use, and transportation, including in mature economies where dispersed development and sprawl are already extensive.<sup>42</sup>

Researchers show how accessibility in cities is created through the co-dependence of urban form and transport systems.<sup>43</sup> It is the combination of urban public transport infrastructure and urban form that facilitates accessibility within metropolitan regions while mediating carbon emissions and is therefore essential to support sustainable economies of scale, agglomeration effects, and networking advantages.

## GREEN AND BLUE INFRASTRUCTURE MAKE A VITAL CONTRIBUTION



The capacity and quality of natural and semi-natural green (vegetation) and blue (water) spaces in urban areas contribute to ecological sustainability, air quality, and human health and well-being. Accessibility to blue and green infrastructure as well as their overall quantity and quality are important in achieving good density.

The many specific benefits include biodiversity conservation, sustainable land and water management, climate change mitigation, and reduced ambient temperatures. Green and blue infrastructure reduce urban heat-island effects and help lower energy demand. Benefits offer increased carbon storage, additional wildlife habitat and recreational space, improved air quality and human health and well-being, capital cost savings, and the potential to increase property values by up to 30 per cent.<sup>44</sup>

**A 10 PER CENT INCREASE IN GREEN INFRASTRUCTURE IN HIGH-DENSITY URBAN AREAS WITH LITTLE EXISTING GREEN SPACE COULD NEGATE A FOUR-DEGREE CENTIGRADE INCREASE IN TEMPERATURE OVER THE NEXT 80 YEARS.**

In North American and European cities, urban sprawl and low-density development are held responsible for increased environmental degradation through consumption of land resources and social segregation. Evidence also indicates that urban containment associated with higher density often results in a loss of permeable surfaces and tree cover, thereby intensifying stormwater and flood risks. In some climatic conditions, the same issues increase discomfort and negative health impacts of hotter summers.<sup>45</sup>

Therefore, taken together, studies point to an inherent contradiction of climate change mitigation and adaptation processes that are directly linked to urban density and the form of urban development. Good density and climate change mitigation require a denser urban environment to reduce vehicle miles travelled and building energy use, and at the same time, adapting to climate change requires more space for blue and green infrastructure.<sup>46</sup>

Few studies directly link urban density with green and blue infrastructure costs, empirically or theoretically. Ecosystem valuation studies attempt to evaluate the monetary costs and benefits of green infrastructure ecological assets. High-density urban areas require more interventions concerning green and blue infrastructure developments, for example, to reduce urban heat-island effects.

Researchers found in Vienna, the maximum heat load is concentrated in densely built-up areas and the introduction of new vegetation or water surfaces produces a higher cooling effect compared with low-density areas.<sup>47</sup> A 10 per cent increase in green infrastructure in high-density urban areas with little existing green space could negate a four-degree centigrade increase in temperature over the next 80 years.<sup>48</sup> Green spaces in high-density, built-up areas that are heavily degraded represent 'gaps' in good density which require restoration through coordinated public/private investment.<sup>49</sup> However, it is not clear to what extent such benefits and costs are being taken into account by city development authorities.<sup>50</sup>

Green and blue infrastructure also play a major role in the health and well-being of those living in cities. Among the significant factors for mental health are noise and light levels, building layouts and wayfinding, access to nature, and design of everyday products, buildings, transport systems, and information/communication devices, all of which contribute to levels of stress or contentedness, and a sense of inadequacy or self-efficacy and of isolation or connection to others.<sup>51</sup> Good-quality green and blue infrastructure requires spaces where people can exercise, relax, and improve their overall physical health and sense of well-being.

Sustainable green and blue infrastructure provision, which needs to be managed through public and private interventions, is vitally important to support good density. This can include, for example, the design of green/white roofs and green streets in built infrastructure. Such interventions can result in property-level monetary benefits and savings as well as climate change adaptation or mitigation benefits.<sup>52</sup> This is demonstrated through reduced operations and maintenance costs, decreased stormwater management costs, and lower particulate pollution as well as carbon absorption benefits and energy savings owing to reducing buildings' heating and cooling requirements. Once again, coordinated governance is called for to support and promote such interventions.



KUNGSTRÄDGÅRDEN, STOCKHOLM, SWEDEN

## GOVERNANCE IS CRITICAL FOR DELIVERING GOOD DENSITY



Although beyond the scope of this research, the literature review highlighted that good governance underpins all good density elements. Policy matters a great deal in ensuring that density helps reduce carbon emissions and risks of displacement impacts. Modern city governance faces a range of challenges, including coping with forces that are beyond local in scope, such as changes in climate, population growth and movement, trade patterns, technology, and policy and regulatory environments.<sup>53</sup> To effectively cope with the drivers of future change in cities, four elements of coordinated urban governance are essential. These are multi-level governance with effective coordination of national, regional, and city policies; city leadership and financial authority; transparency and accountability; and policy integration at the local level.<sup>54</sup>

The following common factors lie behind successful densification of cities:

- Creating a city-wide framework for density that sets out the long-term shared vision for the city as a whole and enables strategic delivery in specific locations. In practice, this often means developing a strategic spatial plan for the city and surrounding region.
- Recognising the potential importance of joint initiatives between the public and private sectors as a means of establishing and financing local projects and ensuring appropriate levels of governance are established.
- Concentration in prioritised areas within the city which have been identified as having sufficient scale and critical mass to support focused delivery.
- Using financial tools for investment in good density, for example to improve transport links to under-optimised areas and open them up for dense development.
- Designing and planning for place-making and liveability to increase the attractiveness of an area.<sup>55</sup>
- Promoting diversity and protecting the well-being and livelihoods of low-income residents.



## THE EFFECTS OF COMPACT URBAN FORM: OECD RESEARCH

Many countries now pursue policies that implicitly or explicitly aim at promoting compact urban form. Recent research by the OECD, published by the Coalition for Urban Transitions, *The Effects of Compact Urban Form: A qualitative and quantitative evidence review*<sup>6</sup>, analysed more than 300 academic papers that study the effects of compact urban form. Of these papers, 69 per cent find positive effects associated with more compact urban forms, compared to sprawling modes of development. Over 70 per cent of studies find positive effects of economic density (the number of people living or working in an area). A smaller majority of studies attribute positive effects to mixed land use (58 per cent) and the density of the built environment (56 per cent).

**DENSELY DEVELOPED, COMPACT URBAN FORM INCREASES ECONOMIC PRODUCTIVITY BY PROVIDING ACCESS TO MORE JOBS, SERVICES, AND AMENITIES BUT REQUIRES INTERVENTION TO MITIGATE AGAINST INCREASING CONGESTION, NEGATIVE IMPACTS ON HEALTH AND WELL-BEING, AND HIGHER HOUSE PRICES.**

These averages hide significant variation across specific dimensions of urban development. To understand the effects of compact urban form, the report quantifies the impact of changing the level of economic density in a city. Specifically, it identifies 15 social, economic, and environmental outcomes of increased density and then estimates the monetary effect of increasing density by 10 per cent. The estimates come with several caveats because a series of assumptions had to be made to calculate them, and they should accordingly be seen as reflecting orders of magnitude rather than being highly precise. Nonetheless, the findings are significant.

The major benefits of compact urban form arise from economic gains. A 10 per cent increase in economic density creates per capita estimated benefits from higher productivity (US\$71.40), followed by benefits from higher job accessibility (US\$61.70), and benefits from better access to services and amenities (US\$49.30). Further benefits are generated through the preservation of urban green space, greater energy efficiency, pollution reduction, and safer urban environments. The major costs of higher economic density are related to congestion, and health and well-being. Increasing compactness can also contribute to higher land values and housing costs, which are borne disproportionately by renters and first-time buyers.

Increasing economic density therefore requires accompanying policy interventions to maximise the benefits and minimise the costs associated with compactness. In particular, policy makers need to facilitate large-scale investment in housing supply and public transport networks to ensure efficient and equitable access to housing, services, and jobs in compact cities.



## THE RELATIONSHIP BETWEEN URBAN DENSITY AND CARBON EMISSIONS IS COMPLEX

Cities are crucial to both economic growth and climate action. Urban areas are home to over half the world's population but generate about 80 per cent of global economic output,<sup>57</sup> consume around 70 per cent of global energy, and produce between 71 per cent and 76 per cent of energy-related greenhouse gas emissions.<sup>58</sup> This section reviews the existing research linking density of cities with carbon emissions and then applies correlations between the indicators of good density identified in the literature review and carbon emissions per city.

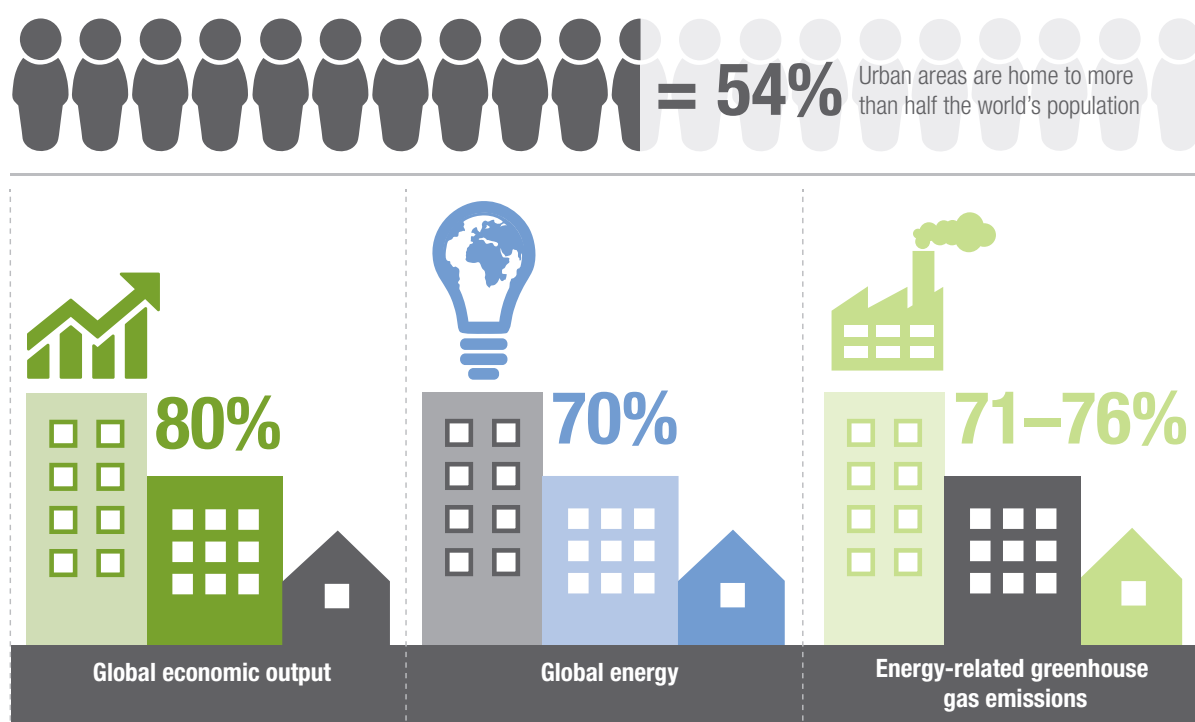
Much evidence shows that increases in urban density are associated with decreases in local, direct per capita carbon emissions and energy consumption. The emission reductions are primarily associated with reduced use of private motor vehicles, although gains also come from improved building energy efficiency, reduced infrastructure construction, and reduced land use change around the urban periphery.<sup>59</sup>

Some debate continues about the overall magnitude and exact causal mechanisms of this correlation. Some studies suggest that the mitigation potential is minor in comparison to broader technological trends and socio-economic consumption patterns.<sup>60</sup> Others argue that increasing urban density may act to displace emissions away from urban areas towards less-regulated areas and has potential to result in an overall increase in emissions.<sup>61</sup>

Key findings of existing research show the following:

- Co-locating residential, employment, and recreational spaces (i.e., mixed land use) within cities can reduce emissions, particularly those related to transport.<sup>62</sup> For traffic emissions, the most important urban form-related variable controlling emissions seems to be distance to jobs and activities.<sup>63</sup>
- Providing safe, reliable, and affordable public transport systems and improving the safety of walking and cycling can encourage modal shift away from private vehicles. This strategy further reduces per capita urban emissions.<sup>64</sup>

FIGURE 9. THE ECONOMIC AND ENVIRONMENTAL IMPACT OF CITIES



- As population and built density increase, per capita local carbon emissions tend to decrease, but per area local emissions increase.<sup>65</sup> Therefore, carbon efficiency has improved although a greater share of emissions may be attributable to a specific geographic location.
- For emissions from building operations, building energy modelling studies have suggested urban form can alter building energy demand by 3 to 10 per cent.<sup>66</sup> Key street- and neighbourhood-scale impacts associated with different levels of density include levels of solar access, extent of reflective surfaces, and opportunities for district heating and cooling. However, how individual building form affects overall energy use and emissions is still unclear. Smaller dwelling sizes associated with high population density tend to reduce per capita energy consumption, but preliminary evidence suggests that after a certain size, high-rise apartment buildings tend to become less energy/carbon efficient than low-rise or semi-detached homes.<sup>67</sup> This reduction in energy efficiency of high-rise buildings needs to be balanced with potential savings to overall infrastructure provision enabled by higher levels of density and is an area that requires more analysis to better understand the interplay between the two factors.<sup>68</sup>
- At regional scales (i.e., areas larger than cities), evidence indicates that planning policies promoting urban density may not actually reduce overall emissions, but merely relocate emissions outside city boundaries.<sup>69</sup> These studies suggest that with higher density and increased regulations, new development is pushed towards less regulated areas or outside urban green belts further away from city centres. Residents in these communities may then commute longer distances into the city, thus resulting in minimal traffic emission reductions or even increases.<sup>70</sup>
- Evidence from life cycle analysis studies suggests that emissions reductions achieved from urban density are minor compared to overall emissions from consumption of energy, goods, and services.<sup>71</sup>

The lessons from the existing research provide a vital starting point for our quantitative analysis. In section 4 we outline the approach taken to identify robust data series to use in our analysis and present the findings in section 5. Section 6 provides our conclusions.



## SECTION 4

# DATA SELECTION

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### THE TEAM CONSIDERED 182 POSSIBLE INDICATORS TO MEASURE GOOD DENSITY, ULTIMATELY SELECTING 12.

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The difficulties of finding robust data sets on which to make international comparisons between cities are well known. Cities use a wide variety of different indicators to measure their performance and growth, and rarely do cities adopt the same approach to the collection of such data. This lack of comparable data makes quantitative analysis challenging when it comes to better understanding the relationship between density, investor returns, and impacts on carbon emissions.

The team created a comprehensive list of 182 possible indicators that could be used to measure the six characteristics of good density. Ultimately 12 were selected to use for

quantitative analysis to determine the relationship between five of the six core urban form characteristics and real estate investment returns (see figure 10). These were chosen based largely on the availability of globally comparable, city-level data.<sup>72</sup> The important role of public transport infrastructure in supporting good density was identified from the literature reviewed but because of a lack of globally comparable infrastructure data, the research team were unable to incorporate this element within the quantitative analysis. Further details about the data selected are provided in appendix 2.



**FIGURE 10. THE 12 DATA SETS USED TO REPRESENT THE FIVE DENSITY CHARACTERISTICS**

Density characteristic	Indicator	No. cities	Source	Notes
<b>Clustering structure</b> 	Urban-extent density	50	Atlas of Urban Expansion	The ratio of the total population of the city and its extent measured in persons per hectare.
<b>Economic/employment infrastructure</b> 	Business services	63	Globalisation and World Cities Network	GaWC business and financial services shed light on commercial office occupation and <i>functional density</i> , complementing the AoUE focus on urban <i>residential density</i> (population per hectare).
	Financial services	59	Globalisation and World Cities Network	
	Innovation	63	Thinknow	
	Tourism	28	Euromonitor	
<b>Built infrastructure</b> 	Built-up-area density	61	Atlas of Urban Expansion Globalisation and World Cities Network	Data are based on built form, urban extent, and open space ratio (i.e., size of block or open space). As building uses and heights are not surveyed by AoUE, the GaWC data on commercial office use are used as a proxy for building heights.
	Walkability ratio	28	Atlas of Urban Expansion	Data are based on metrics available from remote photography, but the quality of walking route (e.g., whether a route is safe and enjoyable to walk) is unknown.
<b>Green/blue infrastructure</b> 	Green Environment	37	Arcadis Sustainable Cities Index	A composite city ranking of indicators relevant for good density that draws on a number of reputable individual sources.
	Open-space ratio	28	Atlas of Urban Expansion	
<b>Governance infrastructure</b> 	Transparency	57	Jones Lang LaSalle	JLL transparency data are taken from an index composed of national metrics.
	Low unemployment	63	Mayor of London/New York City Global Partners	
	Low crime	62	NUMBEO	

Source: authors.

Note: AoUE = Atlas of Urban Expansion; GaWC = Globalisation and World Cities Network; JLL = Jones Lang LaSalle.

## RETURNS DATA

With the 12 density indicators identified, the next step was to identify returns data to explore the relationship between the density indicators and real estate returns.

A challenge for international real estate research is the lack of consistent analytical methodologies applied across countries. Data collection practices vary, and comparable data are lacking on rents and yields. This makes analysis difficult when looking across developing and mature markets, particularly for markets other than commercial offices. Moreover, globally comparable data are lacking at the sub-city level (e.g., districts) and the wider city-region level, which can be important scales for assessing the impacts of density.

Recognising these limitations, the research team used data covering returns from commercial offices and retail investments, focusing on the city as the scale of analysis. To reflect the fund management and investor interest in returns, investment value, and performance, three separate data sources for investment returns were used in the analysis.

- Returns were calculated using conventional global real estate yield data, supplied by CBRE.<sup>73</sup>
- Capital value and rents for European office and retail markets were supplied by Cushman & Wakefield.
- Real Capital Analytics data previously used by the researchers provided figures on cross-border real estate portfolio capital flows.<sup>74</sup>

## CARBON DATA

The research team used city-scale CO<sub>2</sub> emissions data from 2013, sourced from the Carbon Disclosure Project (CDP), to inform global analysis on the relationship between CO<sub>2</sub> emissions, density indicators, and real estate investment returns for more than 50 cities.<sup>75</sup> Carbon data are available for more cities, but only those cities that also had returns data were included in the analysis.

## DATA CAVEATS

Density data are from a single point of time and do not reflect how cities are changing over time. They do not therefore capture how the density of cities may be increasing or decreasing.

Returns data from Cushman and Wakefield and CBRE are for the period between 2008 and 2015. The Real Capital Analytics investment flows data are for the period between 2008 and 2014. An average of the data is used within the correlation coefficients to reduce the volatility of point-in-time returns. Returns data were selected on the basis of availability and so do not reflect the full investment cycle.

The carbon data need to be interpreted with caution because the cities are self-reporting, and emissions are estimated using different methods – although most used either the Global Protocol for Community-Scale Greenhouse Gas Emissions or the 2006 Guidelines for National Greenhouse Gas Inventories of the Intergovernmental Panel on Climate Change.

Appendix 2 contains further detail about the data used in the research.



## SECTION 5

# THE RELATIONSHIP BETWEEN GOOD DENSITY AND INVESTMENT RETURNS AND FLOWS

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### FINDINGS CONFIRM THAT BOTH LARGER CITIES AND MORE DENSE CITIES ARE ASSOCIATED WITH HIGHER RETURNS FROM COMMERCIAL OFFICE SPACE.

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#### FINDINGS FROM CORRELATION ANALYSIS

This section presents the findings of the correlation analysis from the global-level analysis that looks at the relationship between commercial office investment returns and flows with the indicators of good density. Findings are then presented for a smaller selection of European cities to provide an insight into the relationship between capital and rental values for the retail market as well as returns for commercial offices. Finally, the relationship between CO<sub>2</sub> emissions, the good density indicators, and real estate investment returns and flows is shown.

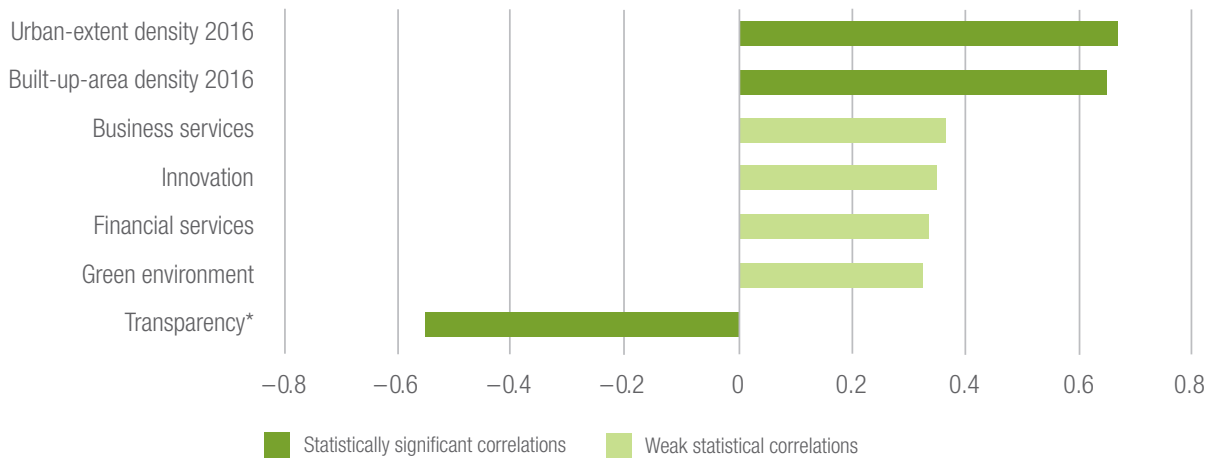
Total investment returns are made up of income returns (yield) and capital growth. Income returns are less volatile as they are based on underlying contracts. In contrast, capital growth, which is affected by a wide range of economic, social, and demographic effects as well as the building quality itself, is more volatile. Typically, investors will accept a lower income return in markets that are deemed less risky. In theory, the better the good density within a city, the lower yield returns an investor would anticipate and the higher the capital growth rate as the good density makes the city more attractive to potential employers, residents, and investors.

#### COMMERCIAL OFFICE RETURNS AND GOOD DENSITY

From the analysis of global cities, our results show that urban-extent density and built-up-area density are strongly correlated with office real estate returns (see figure 11). This finding suggests that more dense cities are associated with higher returns from commercial office space. The relationship holds for both developing and mature markets.

Business services, innovation, financial services, and green environment have a positive but weaker correlation with investment returns than built-up-area and urban extent density. The remaining indicators of open space, low unemployment, walkability, low crime rates, and tourism are not significantly related to returns.<sup>76</sup> Full correlation tables with p-values are given in appendix 3.

**FIGURE 11. CORRELATION COEFFICIENTS BETWEEN INDICATORS OF GOOD DENSITY AND COMMERCIAL OFFICE REAL ESTATE INVESTMENT RETURNS**



\* Transparency is highly negatively correlated with office real estate returns. This unexpected result is driven by U.S. cities, which have the highest levels of transparency but which, on average, have a low level of returns. When U.S. cities are removed from the analysis, the correlation result for returns and transparency is 0.07.

### REAL ESTATE INVESTMENT FLOWS AND INDICATORS OF GOOD DENSITY

The team also analysed the relationships between cross-border real estate investment flows and density indicators at the global level, the results of which are shown in figure 12. This proved to be different from that of office investment returns and density indicators.

Physical density as represented by the metrics of built-up-area and urban-extent density is not statistically significant in terms of its relationship to investment flows across international cities. However, investment flows do correlate with innovation (with a correlation coefficient of 0.68) and business services and financial services (with correlation coefficients of 0.52 and 0.50, respectively). The other good density indicators are not significantly related to investment flows.

That investment flows are associated with financial and business services reflects the fact that larger international investors have traditionally focused their investments on larger transactions in the major global cities, which in practice often means office

buildings with grade A international tenants, many of them active in finance and business sectors. Generally, these buildings are located in the densely developed business district of the city. Given the size of the buildings and the generally higher land value in a business district, investment activity is concentrated in these parts of the city where real estate values are higher, hence there is a positive relationship between investment flows and financial and business services. City economies with high proportions of finance and business service industries are also those that are most internationalised and attractive for international capital flows.

The results suggest that the innovation and quality of services of a city are what is associated with good density when it comes to real estate flows rather than the more traditional measures of urban form.

# NINE ELMS, LONDON

## SUPPORTING DENSITY WITH TRANSPORT INVESTMENT



©Battersea Power Station

Home to 8.8 million residents, London is a remarkably low-rise city. The city's population density has increased in recent years, but three-quarters of buildings are still three storeys or less, compared with 55 per cent in Tokyo and 39 per cent in New York. With development around the city limited by its greenbelt, as London grows it will have no choice but to densify, a challenge that is acknowledged in the latest version of the city's main spatial strategy, the London Plan.

Densification is already occurring in Nine Elms, a major urban regeneration project located in southwest London adjacent to the River Thames. The area covers 227 hectares and surrounds one of London's most iconic buildings, the Battersea Power Station. The redevelopment comprises more than 40 separate projects and will result in improvements to local infrastructure, including a new linear park and river walk and a pedestrian bridge.

The extension of the London Underground's Northern Line into the area, with two new stops, is a crucial part of the project's overall viability. Construction of the new line began in

2015, and the new stations are expected to open in 2020. Because the area currently is not well served by public transport, improved accessibility was essential to increase density and attract commercial and retail occupants. Together, the local government bodies, Greater London Authority (GLA), Transport for London, Wandsworth Borough Council, and Lambeth Council, developed an approach to financing this critical but extremely costly project.

To fund the Northern Line extension, the GLA took out a loan of up to £1 billion, which will be paid back through two revenue streams. First, to repay loans in the initial development period, is approximately £270 million in developer contributions from area building projects. In the UK planning system, these contributions normally pay for community benefits such as affordable housing and improvements to local infrastructure and the public realm. In Nine Elms, most developer contributions for redevelopment of the Battersea Power Station and smaller proportions of the contributions for other projects in the area went towards funding the extension.

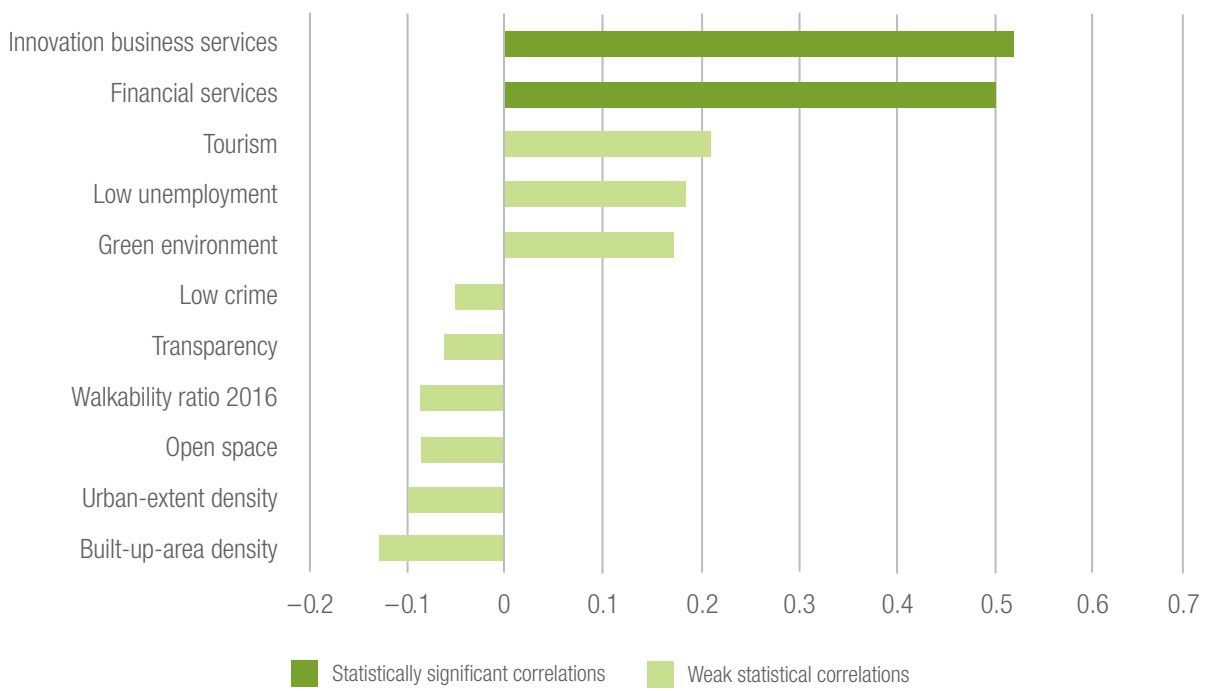
The second revenue stream comes through a tax increment financing (TIF) mechanism, used to direct the increased tax revenue resulting from economic growth in an area to fund a project that is necessary to enable such growth.<sup>1</sup> In the UK, taxes on commercial development (known as business rates) are normally paid to the central government. To enable the TIF, the government set up an 'enterprise zone' covering much of Nine Elms and the surrounding area. Under this arrangement, any increase in revenue from taxes on businesses in the zone, over the baseline level before the development, is paid to the GLA. This arrangement will last for the 25-year duration of the enterprise zone, which began in April 2016.

Few businesses operated on site before the project began, meaning that most business rates from the new development in Nine Elms will go to the GLA until 2041. The GLA expects significant revenue from business rates to begin coming in by 2021. To guarantee that the GLA will be able to repay the loan, the central government has agreed to extend the enterprise zone for an additional five years, if necessary.

<sup>1</sup> Transport for London, Land value capture, (London: Greater London Authority, 2014)



**FIGURE 12. CORRELATION COEFFICIENTS BETWEEN INDICATORS OF GOOD DENSITY AND COMMERCIAL OFFICE REAL ESTATE INVESTMENT FLOWS**





## EUROPEAN INSIGHT

Figure 13 shows correlations ( $\rho$ ) between key density indicators and capital values and rental rates for nine European cities where urban form density data were available: Berlin, Budapest, London,

Madrid, Milan, Moscow, Paris, Vienna, and Warsaw. Given the small sample size, generalization on the basis of these results is not possible. However, this analysis offers promising insights into relationships between density and returns in selected mature and developing European office and retail markets.

The European data support the finding from the global-level analysis that city density as measured by urban-extent and built-up-area density correlates strongly with office capital values. Innovation (office values and retail rent) and business services (retail capital values) also prove to have significant, positive correlations with key returns variables.

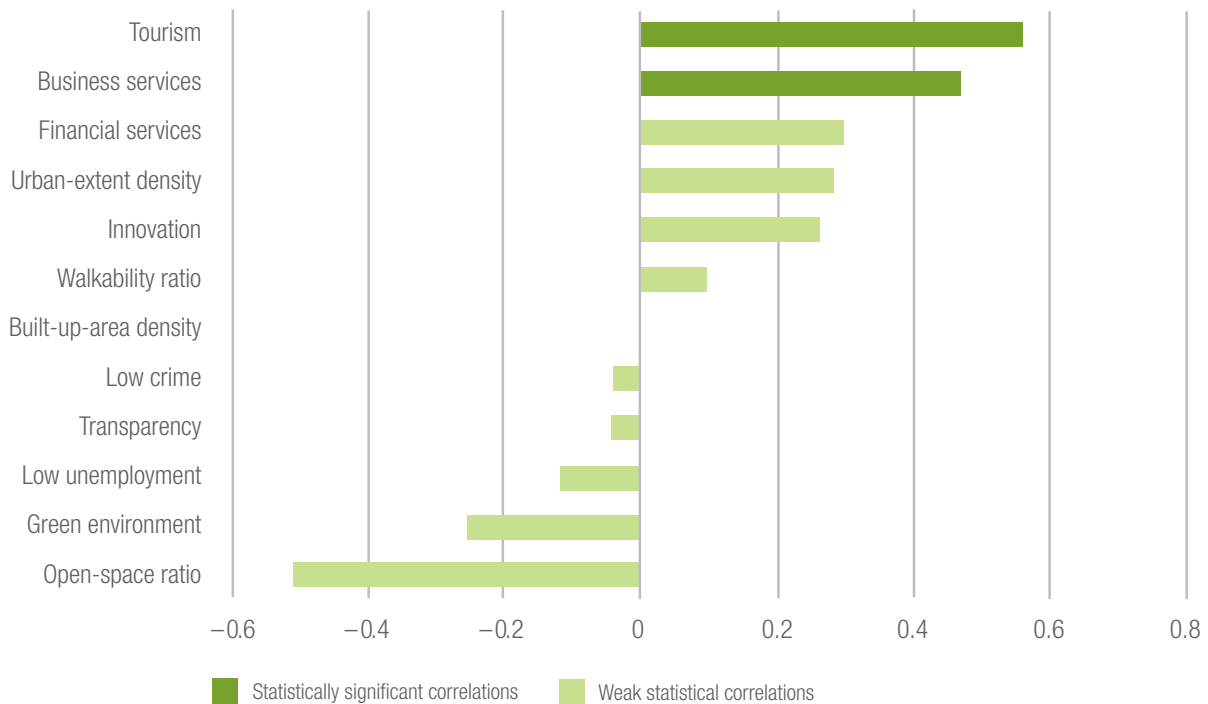
**INNOVATION AND BUSINESS SERVICES ALSO PROVE TO HAVE SIGNIFICANT, POSITIVE CORRELATIONS WITH KEY RETURNS VARIABLES.**

**FIGURE 13. CORRELATION COEFFICIENTS FOR THE INDICATORS OF GOOD DENSITY WITH CAPITAL AND RENTAL VALUES FOR BOTH OFFICE AND RETAIL SPACES**

	Office capital values	Retail capital values	Office rent	Retail rent	Number of cities
Business services	0.09	0.47	-0.25	0.17	24
Financial services	0.06	0.3	-0.06	0.1	24
Innovation	0.52	0.23	0.37	0.63	24
Green environment	-0.02	-0.25	0.36	0.2	21
Transparency	0.29	-0.04	0.39	0.1	24
Urban-extent density	0.8	0.27	-0.02	0.05	9
Built-up-area density	0.73	0	-0.15	-0.13	9
Open-space ratio	-0.33	-0.52	-0.57	-0.53	9
Walkability ratio	0.03	0.1	0	0.13	9
Tourism	0.33	0.55	-0.01	0.43	17
Low unemployment	-0.19	-0.12	-0.06	-0.07	20
Low crime	-0.18	-0.04	-0.27	-0.18	22

■ Statistically significant correlations    ■ Not statistically significant correlations

**FIGURE 14. CORRELATION COEFFICIENTS BETWEEN INDICATORS OF GOOD DENSITY AND RETAIL CAPITAL VALUES**



The factors affecting good density appear to be different for the office and retail sectors. In terms of good density indicators for retail, only tourism and business services are associated with retail capital values (figure 14). The significance of business services for retail capital value performance in the European context is of interest given the association between this indicator and high office returns from the global-level analysis. It is also of potential interest for further research, given that tourism is likely to reflect qualitative aspects of city-level good density for which reliable global data have not been identified for this study.

The other good density indicators were not correlated with real estate performance for either offices or retail. However, the results highlight that a focus on individual cities is necessary to deepen understanding of the nuances important in understanding relationships between both good and bad density, and property performance.

The general lack of significance of walkability found in both the global and the European results seems likely to reflect the fact that Atlas of Urban Expansion walkability is a city-level metric

**THE EUROPEAN DATA SUPPORT THE FINDING FROM THE GLOBAL-LEVEL ANALYSIS THAT CITY DENSITY AS MEASURED BY URBAN-EXTENT AND BUILT-UP-AREA DENSITY CORRELATES STRONGLY WITH OFFICE CAPITAL VALUES.**

and does not account for sub-city density variations associated with commercial land use. In addition, the data are able to account only for distance and do not account for other factors that may influence the decision to walk, such as safety or scenery. However, based on the literature review, proximity is an important driver of commercial clustering within cities and walkability follows from this.

The full correlation tables are provided in appendix 3.

# ASPERN SEESTADT, VIENNA

## A COMPACT AND SUSTAINABLE NEW URBAN DISTRICT



Vienna, with a population approaching 1.87 million, is one of the fastest-growing cities in Europe. Its population increased by 12.7 per cent over the past decade, and the population of the core city is projected to reach about 2 million by 2030.<sup>i</sup> To accommodate this growth in a sustainable way, Vienna is currently building one of Europe's largest urban developments, Aspern Seestadt (Lakes). The €5.5 billion Aspern project is being built on a 240-hectare city-owned former airfield site ten kilometres northeast of Vienna's city centre. By the time of its completion in 2028, the district will provide living space for some 20,000 people and will have created 20,000 jobs.<sup>ii</sup>

The idea for a new urban district at Aspern emerged in 2004, when both demand for land and land prices were rising. Rather than subdivide the site into smaller lots and sell these to developers, the city instead developed a master plan for a high-density, mixed-use, and sustainable urban district. This was a transformative vision for the area, which was characterised by low-density housing.

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“Developers, planners, and architects began to realise that it is possible to build higher density without losing quality but gaining something. People started to realise that higher density is not a threat but a good way forward.”

— **Michael Rosenberger**, Senior Strategic Planner, City of Vienna

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In Aspern, the goal is for less than 30 per cent of journeys to be made by motorised vehicles. Shops and services will be located on the ground floors and spread evenly throughout the development, thereby eliminating the need for short car trips. Each apartment will have two bicycle parking spaces, but only 0.7 parking spaces. The city has also extended Vienna's metro system to Aspern. The cost of this major new infrastructure investment was funded by the city of Vienna and the federal government. Public transport ridership is also supported by a government subsidy for residents. The project will also improve the quantity and quality of public space: 50 per cent of the project will be devoted to public areas.

By 2016, about one-third of the Aspern site had been developed, providing homes for 6,000 new residents, while the Technology Centre hosts more than 500 employees. The quality of buildings and the public realm in Aspern is of a very high standard, and survey results show that about 80 to 85 per cent of residents like living there. Early-stage plans exist to develop a road connection between Aspern and Vienna's airport. If this road link progresses, the site has the potential to become increasingly attractive to international businesses.

<sup>i</sup> Vienna City Administration, Vienna in Figures 2017 (Vienna: City of Vienna, 2017).

<sup>ii</sup> Vienna Business Agency, Urban development with a difference, available at <https://viennabusinesagency.at/property/technology-centre-seestadt/aspern-viennas-urban-lake-side/>. Accessed 20 May 2018.

## DENSITY, CARBON EMISSIONS, AND INVESTMENT RETURNS AND FLOWS

The team analysed the relationship between CO<sub>2</sub> emissions, the good density indicators, and real estate investment returns and flows.

The results showed no statistically significant correlation between low carbon emissions per person and real estate returns (see figure 15). The team also found no significant correlation between total city-level carbon emissions and real estate returns. However, the order of correlation between per capita emissions and real estate returns ( $\rho = 0.25$ ) was stronger than the weaker correlation for total city-level carbon emissions ( $\rho = 0.16$ ). Findings from the literature review show that population and built density increases are associated with reductions in per capita emissions and increases in per area emissions.<sup>77</sup> In other words, cities with larger populations have more scope to reduce emissions through efficiency gains.

While not the focus of this study, it is interesting to note that there are significant relationships between emissions per person per square kilometre (km<sup>2</sup>) and good density characteristics such as innovation ( $\rho = 0.31$ ), walkability ( $\rho = 0.44$ ), and transparency ( $\rho = -0.47$ ).<sup>78</sup> Meanwhile, green environment is positively correlated with low total CO<sub>2</sub> emissions ( $\rho = 0.34$ ), but there is no correlation between green environment and emissions per person per square kilometre ( $\rho = -0.06$ ) (i.e., when accounting for population density).

When comparing cities that have data for both carbon emissions and investment returns, Hong Kong, San Francisco, and Singapore have the highest real estate returns relative to low per capita CO<sub>2</sub> emissions (figure 16). Paris has similarly high real estate returns but with somewhat higher per capita CO<sub>2</sub> emissions. In contrast, Moscow, Los Angeles, and Houston have low per capita emissions but much lower real estate investment returns.

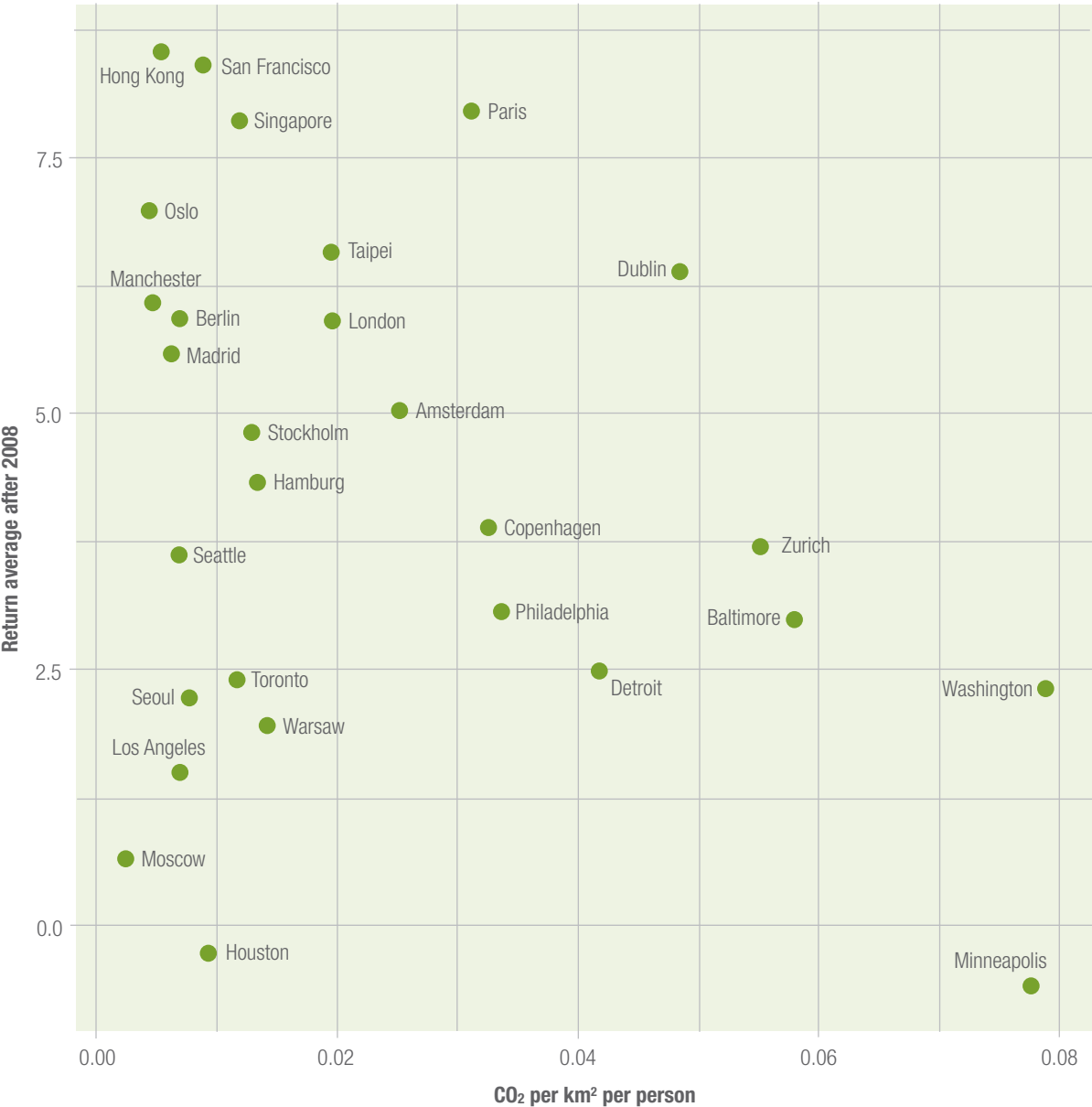
**FIGURE 15. CORRELATIONS BETWEEN LOW CARBON EMISSIONS, DENSITY INDICATORS, AND INVESTMENT FLOWS AND RETURNS**

Density indicator	Correlation with CO <sub>2</sub> emissions per km <sup>2</sup> per person		Correlation with total CO <sub>2</sub> emissions		Number of cities
	$\rho$	p	$\rho$	p	
Returns after 2008	0.25	0.17	0.16	0.39	32
Real estate investment flows	0.33	0.07	0.28	0.12	31
Business services	0.14	0.43	-0.28	0.12	32
Financial services	0.11	0.56	-0.34	0.06	32
Innovation	0.31	0.09	-0.16	0.38	31
Low unemployment	0.24	0.27	-0.10	0.66	23
Low crime	0.14	0.47	0.10	0.59	30
Green environment	-0.06	0.75	0.34	0.07	29
Transparency	-0.47	0.01	-0.10	0.60	32
Urban-extent density 2016	0.36	0.16	-0.26	0.31	17
Built-up-area density 2016	0.38	0.14	-0.29	0.25	17
Open-space ratio	-0.2	0.44	-0.04	0.89	17
Walkability ratio 2016	0.44	0.07	-0.41	0.10	17
Tourism	0.41	0.08	-0.45	0.06	19

■ Statistically significant correlations

Note: The carbon emissions are statistically significant correlations inverted to represent low emissions.

**FIGURE 16. TOTAL CARBON EMISSIONS PER KM<sup>2</sup> PER PERSON PLOTTED AGAINST REAL ESTATE INVESTMENT RETURNS**



Source: Research team.

Note: Carbon emissions are not inverted on this graph.

Figure 16 shows a relationship between carbon emissions per person per square kilometre and real estate returns, suggesting that lower carbon emissions is positively associated with higher returns in the cities included in this analysis.

It is important to note that interpretation of these relational patterns requires local information and insights, including on the implications of differing measurement methodologies used.

Missing variables, such as patterns of travel by car linked to urban form and differences in climate, rainfall, vegetation, and growing seasons, that impact emissions in cities in different world locations can confound analyses of good density indicators and returns without more granular data.

## SUPPORTING SMART URBAN GROWTH: LESSONS FROM CITY CASE STUDIES

The team selected six cities from the global-level analysis to provide insights into different combinations of good density indicators that are correlated with investment returns in an international commercial office market perspective. The team selected three cities in mature economies: Hong Kong, London, and Paris, as shown in figure 17; and three in developing economies: Beijing, Mumbai, and Warsaw<sup>79</sup>, as shown in figure 18. Associations revealed by the rank correlations analysis suggest interesting variations in relational patterns among these six cities, but it should be noted that global and local factors, which may potentially affect returns, could not be accounted for in this study.

### Mature Markets: Hong Kong, London, and Paris

Hong Kong has the highest returns from investment into commercial offices between 2008 and 2015 and also the highest built-up-area and urban-extent density. However, Paris achieves just slightly lower returns than Hong Kong over the same period but with much lower density levels. This result indicates that although built form density is generally a major contributor to higher returns, other aspects of good density, besides urban form, are also likely to be important for returns in some cities.

A common pattern in the three cities is the presence of high levels of real estate investment flows into the city and the importance of business services and financial services as part of the city economy. All three cities are attractive for tourists and experience high numbers of visitors. As may be anticipated, the amount of city land that is open space is relatively low for all three cities, especially so for Hong Kong.

Hong Kong has high city-wide total carbon emissions but low emissions per person relative to London and Paris, both of which have lower total city-wide carbon emissions but higher per person emissions.

Of the three cities, Hong Kong has the highest real estate investment returns but also the highest total emissions. London has the lowest total emissions relative to its investment returns despite having lower built-up-area and urban-extent density than Hong Kong.

### Developing Markets: Beijing, Mumbai, and Warsaw

Of the developing cities, Mumbai has the highest urban density and the highest returns on commercial offices between 2008 and 2015. Beijing with the second-highest urban density also has the second-highest investment returns. Investment flows, business services, and financial services are most highly represented in Beijing.

Similar to findings for the mature market cities, business services are an important sector of the developing cities' economies, as is the case, to varying degrees, with financial services. However, it is striking that the cities' ranking for innovation, which was shown to be highly correlated with returns at the global level, is relatively lower in the developing cities, especially for Mumbai and Warsaw. This finding is also the case for tourism, with far fewer visitor numbers in the developing cities than in the mature market city case studies.

The green environment and transparency rankings are low for all three cities, especially green environment for Beijing and transparency for Mumbai. Mumbai has the lowest open space within the city boundaries, but Beijing is unusual as it has high levels of both open space and investment returns. This finding demands further investigation using local information because it goes against the trend noted in the global analysis that open space is negatively correlated with investment returns.

Warsaw has the lowest returns of the three cities despite its having a high proportion of business services in its economy. The city's recent rise, along with other Polish cities, as a location for business processing activities rather than the more specialised financial and business services that are concentrated in mature city economies may explain this apparent anomaly.<sup>80</sup>

Warsaw has higher total CO<sub>2</sub> emissions than emissions per person per hectare and is thus in line with the general relationship that cities provide efficiency gains despite an overall increase in emissions from increased population and human activity. Emissions data for Mumbai and Beijing were not available.

# LAGOS DE TORCA, BOGOTÁ

## INNOVATIVE FINANCING TO ENABLE PLANNED DENSIFICATION



“It will change the way we build cities forever, and for the first time the owners of the land will pay all the costs (infrastructure, pipes and roads, among others) for the development.”

— Mayor Enrique Peñalosa<sup>iv</sup>

Bogotá, the capital of Colombia, underwent a period of rapid urban growth between the 1950s and the 1990s, with the population growing almost tenfold and the built area expanding over seven times. In 2014, the population of Bogotá Capital District was estimated to be around 8 million, with approximately 11 million in the wider metro area.<sup>i</sup> Bogotá's population density is estimated to be about 196 persons per hectare, substantially higher than that of other capital cities in Latin America.<sup>ii</sup> However, most of the areas of highest residential density are in low-rise, unplanned settlements on the periphery of the city, many of which are poorly served by public services and infrastructure.

Lagos de Torca is a new urban district planned on a 1,803-hectare site in the

north of Bogotá. Plans for the development include the construction of 120,000 new homes, half of which will be subsidised housing. The district will also be home to a new hospital, cultural facilities, and new educational facilities. The plans also include 600 hectares of public space including a network of linear parks.

Six new lines of Bogotá's TransMilenio bus rapid transit system will serve the area, and all new roads created in the scheme will form part of Bogotá's protected bicycle lane network, CicloRuta. The scheme is not without controversy as it is located next to a nationally protected wetlands area. The city plans to restore and protect the wetlands, and the planned new major road connecting to the area will be elevated to ensure that two wetland habitats in the area remain connected.

The scheme costs of approximately 4 trillion pesos (around US\$1.4 billion) are to be met by the private sector through an innovative mechanism. Investors in the scheme buy Representative Units of Contribution (known by their Spanish acronym, URAs), which are paid for by either land contributions or cash. Investors can then use these URAs to exercise building rights for the construction of the projects or sell them on. The value of the URAs is set centrally and rises by a set amount on a monthly basis. To motivate early investment, URAs can be purchased at a discount from the project launch until January 2020.

With an initial contribution of 10 billion pesos (US\$3.5 million) from 35 landowners, a trust has been set up to manage the development. The work will begin with extensions of the road network, and initial planning applications by the original investors are being processed.<sup>iii</sup> Work on site is expected to begin in 2019 with the first new structures delivered in 2021.

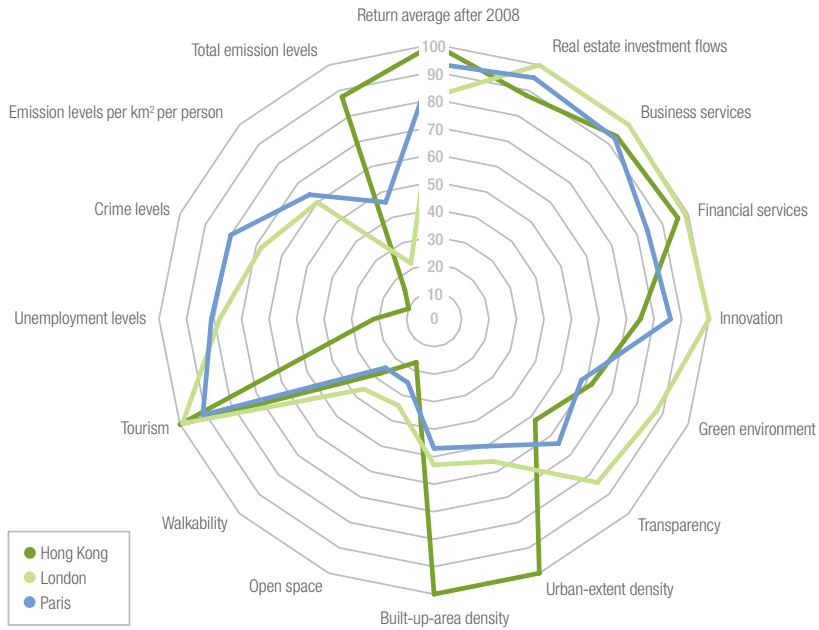
<sup>i</sup> Bogotá population (2017-10-20), worldpopulationreview.com (accessed January 17, 2018).

<sup>ii</sup> J.D. La transformación de Bogotá, in F. Cepeda Ulloa, ed, Fortalezas de Colombia (Bogotá: Editorial Planeta 2005), pp. 418–439.

<sup>iii</sup> 'Con \$ 10.000 millones comenzó recaudo para Lagos de Torca', *El Tiempo*, 25 January 2018, www.eltiempo.com/Bogotá/financiacion-del-proyecto-lagos-de-torca-en-Bogotá-175372.

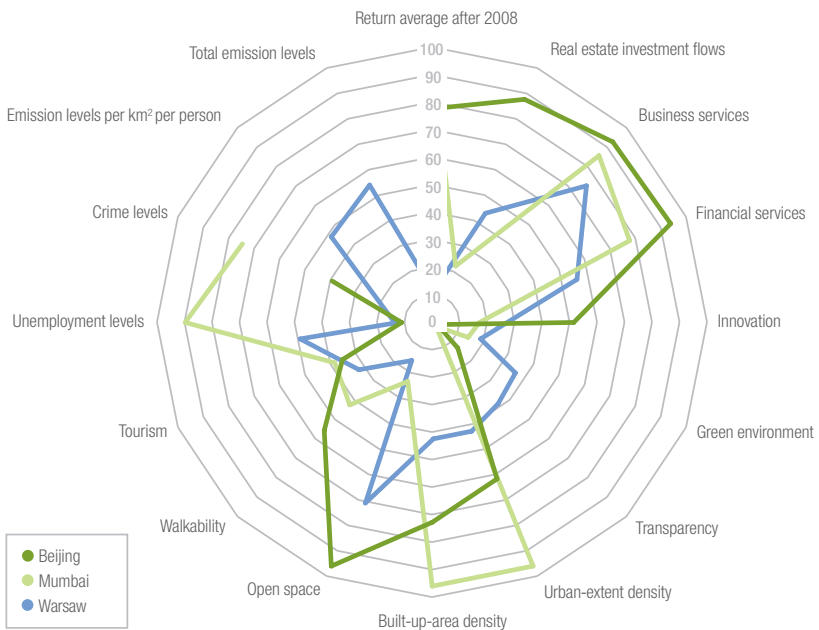
<sup>iv</sup> 'Lagos de Torca despegó con un plan de 128.000 viviendas', *El Tiempo*, 25 January 2018, www.eltiempo.com/bogota/firman-fideicomiso-para-construir-lagos-de-torca-en-el-norte-de-bogota-175198.

**FIGURE 17. PROFILES OF GOOD DENSITY INDICATORS FOR HONG KONG, LONDON, AND PARIS**



*Note:* The rank percentile of a city on a given scale (e.g., returns) is the percentage of cities that have a value equal to or lower than it. For example, Hong Kong has the highest level of returns, so has a rank percentile of 100 as 100 per cent of other cities have lower returns than Hong Kong. It is calculated by dividing the rank of the city by the total number of cities and then multiplying it by 100 to turn it into a percentage – e.g., percentile rank of A = (rank of A / number of observations) × 100. Employment, crime, and CO<sub>2</sub> rank metrics are reversed to show high unemployment, high crime, and high total and per capita emissions per city.

**FIGURE 18. PROFILES OF GOOD DENSITY INDICATORS FOR BEIJING, MUMBAI, AND WARSAW**





**FIGURE 19. THE EIGHT DATA SETS USED TO REPRESENT THE SIX DENSITY CHARACTERISTICS**



\* Crime levels are scored between 0 and 100 where scores lower than 20 are very low, between 20 and 40 are low, between 40 and 60 are moderate, between 60 and 80 are high, and higher than 80 are very high.



## SECTION 6

# CONCLUSIONS

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### THERE IS A POSITIVE RELATIONSHIP BETWEEN INVESTMENT RETURNS, HIGHER DENSITY, AND LOWER CARBON EMISSIONS IN CITIES THAT SCORE HIGH ON CHARACTERISTICS ASSOCIATED WITH GOOD DENSITY.

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This study identifies the characteristics that represent good density in urban areas based on a multi-disciplinary literature review and evaluates the relationships between the characteristics of good density, investment returns, and carbon emissions in a quantitative analysis. The research findings and strength of evidence discovered are summarised in figure 20.

Although data gaps prevented econometric analysis, the team used Spearman's correlations to identify patterns of association between real estate, good density variables, and CO<sub>2</sub> emissions. Six variables related to the physical density, economic structure, and greenness of a city are positively associated with investment returns.<sup>81</sup> Transport infrastructure was also identified from the literature reviewed as an important variable for cities to have good density and to reduce carbon emissions. This finding suggests significant relationships that can inform investment decision making.

The key finding, for the cities and variables studied, is that more dense and compact cities are associated with higher returns for office real estate investment. The association between real estate performance and compact urban form is also seen in the analysis of office capital values for nine major European cities: Berlin, Budapest, London, Madrid, Milan, Moscow, Paris, Vienna, and Warsaw. This is an important result, given the dearth of real estate studies directly investigating the spatial determinants of investment performance empirically.

Importantly, the relationship between density and retail investment returns does not appear to be significant. This finding suggests that other factors might be more important, including the location of property assets within a city. These findings also highlight that the local city context is critical as differences exist between patterns of association both between and within mature and developing markets. Factors such as transparency, crime levels, or walkability might be very significant within individual cities, particularly if they are outliers in these respects.

**FIGURE 20. SUMMARY OF STRENGTH OF EVIDENCE DISCOVERED IN RESPONSE TO RESEARCH QUESTIONS**

Relationship found from quantitative analysis	Strength of evidence
Larger cities and more dense cities are associated with higher returns for office real estate investment returns.	Strong
Cities with higher levels of innovation and a stronger presence of business services and financial services are associated with higher levels of office real estate investment flows.	Strong
Cities with higher levels of tourism are associated with higher retail capital values.	Strong
Cities with higher levels of business services are associated with higher retail capital values.	Strong
Cities with a strong business and financial services presence are associated with higher office real estate investment returns.	Moderate
Cities that are more innovative are associated with higher office real estate investment returns.	Moderate
Cities with better green environments are associated with higher office real estate investment returns.	Moderate

In the absence of granular and qualitative data on density, this analysis suggests that tourism might serve as a proxy for the attractiveness of cities. Tourism is strongly associated with retail capital values and is associated with high office returns for some mature market cities; this may reflect good density characteristics such as walkability or green space (as well as other characteristics, such as cultural, architectural, heritage, or historical interest). Tourism measures may encompass both those travelling for leisure (who may wish to enjoy cultural and retail opportunities) and those travelling for work (who might be taking advantage of financial or business services).

## INSIGHTS FOR INVESTORS

Investors commonly use the metric of risk-adjusted returns to measure the probability of securing the anticipated return. Theoretically, increased risk exposure (for example, associated with opportunistic investments) should be rewarded with a higher return on investment. Investors use a range of metrics when calculating the risks associated with their (projected) investments, including volatility of investment over time, liquidity, yields, rental growth, and occupancy planning.

The research suggests that investors should consider not only building-specific elements in their due diligence, but also city- and neighbourhood-specific elements related to whether a city has good density when determining where to invest.

For example, prospective investments in cities without a coherent, accountable governance system to deliver good density should have a higher risk score than investment in cities with appropriate governance processes and measures in place.

Simple measures of density (such as the number of people living and working in a city) are not sufficient, as higher density can also create costs that need to be mitigated. Investors will need to consider their returns over different time periods as developing good density in the short term may imply higher costs and lower returns (for example, to include affordable housing, or to allocate more green space within a development). However, because adding elements of good density improves the lifetime of a building and the area in which it is located in the longer run, developments can be expected to become less volatile through the property cycles and therefore positively affect returns. Investors need a richer understanding of what good density looks like to evaluate prospective risks.

As mentioned before, good governance is important to achieve resilient performance. In addition, reliable public transport systems can add value, as they improve connectivity and accessibility, and they reduce potential costs associated with air pollution and congestion that could affect a city's social and economic performance and therefore the appeal of its real estate market.



“Our city-focused investment program combines the objectives to create long-term value and reduce carbon emissions significantly by repositioning existing buildings on well-connected locations in cities we believe in. The selection of these cities will be key for our success.”

— **Tinka Kleine**, Senior Director Private Real Estate, PGGM

A city needs to have a solid governance and economic framework to attract investors, be of a sufficiently high density (for without density there can be no good density), and needs to provide a high quality of living in the longer run for its residents, workers, and visitors. The analysis has demonstrated a positive relationship between investment returns and higher density. The next step is to prove that cities adhering to enhancing good density are likely to be more resilient in the longer run and therefore more likely to provide higher returns for investors than cities which are simply growing, facing significant environmental, pollution, health, and social costs.

## INSIGHTS FOR POLICY MAKERS

Public authorities and city governments are responsible for many of the characteristics associated with good density, including strategic land use planning, oversight of built infrastructure, preservation of open space, and transparent and accountable governance. In partnership with national governments, they can also influence investment into public transport infrastructure and services, and spatial planning. Governments face a real need to coordinate across different spatial and administrative levels to deliver compact and connected urban forms and to manage the potential costs associated with higher density. This responsibility includes ensuring that the built environment and green spaces within a city are high quality and safe. The overall design of the city needs to encourage walkability, provide transport links, and protect the cultural heritage, biodiversity, and ecosystems within cities.

This research underscores the significant opportunities for governments to work with real estate investors to shape urban form and function in ways that enhance the social, economic, and environmental performance of a city and the health of the people who live and work in the city in the long term. Governments can create a stable policy environment, using spatial plans and regulation to steer investment towards compact, connected forms. Governments can also facilitate consultation with local communities and firms to ensure that the built and natural environments address local needs, and that the interests of low-income and other marginalised groups are protected. Good density – mixed land use, the conservation of green and blue spaces, social inclusion and proximity to jobs, services and amenities – is desirable for a city. It minimises the social and economic costs associated with sprawl, particularly congestion and higher capital expenditure on infrastructure provision. Therefore, if the process of densification is

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“A future-proof portfolio is the core of our investment strategy. This means we need to select the right places to invest and continuously improve the environmental performance of our assets. It is interesting to see that this study confirms our inherent belief in the presence of a creative community in a city, tourism and culture as driving factors behind an attractive investment climate. Understanding the spatial patterns in our built environment is crucial to be able to have a positive impact on cities and research into these topics is therefore a necessity.”

— Marrit Laning, Managing Director, Fund Management, Redevco

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managed well, mutual benefits could accrue to urban residents, governments, and investors. One of the positive outcomes might be higher and more stable returns on real estate investment, thereby providing an incentive for property developers and owners to work with governments and other urban stakeholders towards a shared vision for a city.

## INSIGHTS FOR FUTURE RESEARCH

The results of this study reveal a number of areas requiring future research. First, they highlight the challenges of finding appropriate data for a global model that can be used to benchmark good density across location and time. This remains a hurdle to be solved. It also highlights the importance of incorporating market and city-specific analysis incorporating longitudinal data series for predictive analysis to provide a guide for responsible private and public sector investment decision making. It is a first step: qualitative determinants of good density also need to be captured alongside the quantitative analysis.

**FIGURE 21. POTENTIAL APPROACH TO FUTURE RESEARCH USING A TOP-DOWN OR BOTTOM-UP METHOD**



Considerable potential exists to take forward the research begun in this study either with additional data sources at the city and even neighbourhood level to make use of detailed localised data or using alternative sources such as big data. Tourism may be a useful proxy for density, but tourism itself can also have negative impacts on a city in the form of negative externalities such as increased congestion and pollution. The research so far is limited to looking at associations between the good density characteristics and investment returns. With more robust and comparable data, it may in future be possible to apply a multivariate analysis that will identify causation of the relationships.

At the city level, it is possible to access localised data sources to provide sub-city-level analysis that could also incorporate time-series data to demonstrate the direction in which the city is moving in terms of good or bad density. For example, in London

a recent step change in the provision of cycle paths should affect journey mode choice and could contribute to a reduction in overall carbon emissions. By focusing on time-series data, it would also be possible to take into account the property cycle to see how good density affects the various investment return elements throughout the different phases of the property cycle. A possible way forward using a bottom-up approach is demonstrated in figure 21.

The current research has shown that the link between infrastructure costs and good density is complicated, and that reliable data for comparing cities globally are limited. Investigating the relationship would warrant further research and case study analysis at a city level, to be better able to support the business case for cities to invest in the necessary infrastructure to enable good density.

The link between infrastructure costs and good density and by extension investment returns is complex and deserving of much further research beyond this project. For example, a link is likely between transport operating costs (indicating size and usage of a city public transport network) and CO<sub>2</sub> emissions, and more generally with business efficiency in terms of worker and client accessibility, and their costs of transport options. A future expansion for the research is to build an understanding of how public sector infrastructure construction and maintenance costs are affected by good density metrics and ways in which investments into infrastructure contribute to quality of life within a city.

The research has highlighted how increasing density within cities in the right way will be critical to an economically prosperous and low carbon future. Future research is required to ascertain how different forms of development at increased density can potentially reduce carbon emissions.

Investment decision makers need to balance near-term returns with the long-term need to create cities where people want to live. Real estate investors have a unique and powerful role in shaping the future of urban development and have the opportunity to lay the foundations for economically dynamic and environmentally sustainable urban futures. To help with this vital role, a tool that can be used by investment managers to aid investment decisions that will help them enhance their investment allocations, better understand the impact of their investment decisions, and see how they can contribute to good density within the cities in which they are operating would be warmly welcomed. The preceding suggestions for further research can support the development of such a tool and help anticipate better asset allocation decisions by investors. A prototype visualisation tool developed by the research team is available in the technical report.

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“Density encompasses more than just the number of people living or working within a defined area. It has to account for key characteristics of urban form such as clustering patterns, mixed-use planning, amenity offer, and transport infrastructure, which collectively play a role in creating the right kind of density for cities.”

— **Simon Chinn**, Senior Analyst, Grosvenor

“M&G Real Estate has developed a number of tools that embrace the ULI’s definition of ‘good density’ within cities including innovation, connectivity, an efficient green transport network, and visionary governance. These are used to support the investment decision-making process by identifying investment opportunities beyond the popular gateway markets – an approach which is adding value in today’s low yielding environment.”

— **Vanessa Muscara**, Associate Director -  
Property Research, M&G Real Estate

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# APPENDIX 1

## DEFINITIONS

Following are definitions of the terms associated with urban density and form used in the research and referred to in the report.

- **(PHYSICAL) DENSITY** – can refer to both buildings or population; it is usually expressed as net or gross (residential) area, plot ratio, and/or site coverage percentage.<sup>82</sup>
- **'SOCIAL/PERCEIVED' DENSITY** – the subjective sense of density, which differs from person to person and context to context.<sup>83</sup>
- **SPATIAL DENSITY** – the distribution and concentration of people and infrastructure over a geographic area.
- **'GOOD DENSITY'** – liveable density, usually due to characteristics such as mixed use, connected, planned, cohesive, liveable, spacious, flexible, designed, green, appropriate.<sup>84</sup>
- **'BAD DENSITY'** – density which has negative impacts on residents, usually caused by characteristics such as monotonous, isolated, unmanaged, segregation, unliveable, crowded, inflexible, ugly, polluting, conspicuous.<sup>85</sup>
- **URBAN FORM** – the physical characteristics of an urban area, including the shape, size, density, and configuration of settlements.<sup>86</sup> Urban form can be considered from building to city-region level<sup>87</sup> and influenced by human choices and external factors over time.<sup>88</sup>
- **URBAN FORM 'ELEMENT'** – a tangible or physical characteristic of urban form (e.g. street, park, facade, etc.).
- **URBAN FORM 'CHARACTERISTIC'** – tangible, physical (e.g., mixed use), or intangible, process (e.g., planned), aspects of urban form.
- **URBANISATION** – the term urbanisation usually refers specifically to migration from rural to urban areas or to the increasing share of the world's population that is urban. However, two additional sources of urban population growth are natural population increase in cities where the birth rate is higher than the death rate and expansion of municipal boundaries to encompass areas previously defined as rural. For this research, urbanisation is taken as the overall growth in population living in an urban area.

## APPENDIX 2

# EXPLORING GOOD DENSITY INDICATORS

The following data sources may be used to calculate the strength of relationship between data sets representing good density and investment returns.

### GOVERNANCE AND ECONOMIC FRAMEWORK

**Transparency** – The Jones Lang LaSalle Global Real Estate Transparency Index captures which countries provide the most favourable operating environments for investors, developers, and corporate occupiers. It is based on 139 variables relating to transaction processes, regulatory and legal frameworks, corporate governance, and performance measurement and has data availability for 109 markets worldwide. These data are available only at a national level rather than a city level.<sup>89</sup>

**Business and financial services** – A quantitative measure of the Global Network Connectivity (GNC) of a city. An interlocking network model builds upon the aggregated location strategies of leading global service firms across cities. However, the connectivity measurements and consequently the global connectivity ranking rely on information about the importance of a city within a firm's office network (i.e., its service value). GNC is thereby a proxy for total global business services functional concentration. Financial Network Connectivity (FNC) is a proxy for global financial services concentration.<sup>90</sup>

**Innovation** – The Innovation Cities™ Index measures a city's innovation potential as an innovation economy. Pre-conditions for innovation are measured using a three-factor score covering cultural assets, human infrastructure, and networked markets; 445 cities are classified into five groups:

- **Nexus:** City is a critical nexus for large number of economic and social innovation segments, on an ongoing basis.
- **Hub:** City has dominance on key economic and social innovation segments based on current global trends.
- **Node:** City has a strong performance across many innovation segments, with key imbalances or issues.

All developed cities should score in these top three bands. Emerging cities are likely to be classified into two further groups:

- **Influencer:** City is competitive in some segments but is out of balance on many segments.
- **Upstart:** City has potential strong future performance, with some further improvement.

Cities that score below the Upstart band are not classified as they scored below a 50 per cent possible score.<sup>91</sup>

**Low unemployment** – New York City Global Partners reports city average unemployment rates drawn from reputable statistical sources.

## PHYSICAL DENSITY

**Urban-extent density** – Taken from the Atlas of Urban Expansion, this is the ratio of the total population of the city and its urban extent, measured in persons per hectare. Urban-extent maps are created using Landsat satellite imagery. Urban-extent density is the average density of the entire urban extent of the city because it is this measure that translates a city's population into the overall area it occupies.<sup>92</sup>

**Built-up-area density** – Taken from the Atlas of Urban Expansion, this is the ratio of the total population of the city and its built-up area, measured in persons per hectare. Built-up-area density is the density of the built-up area within the city's urban extent because this measure is independent from the degree to which a city may be fragmented. Built-up-area density is always higher than urban-extent density. Because the urban extent of the city contains its urbanized open space, urban-extent density is not independent from the city's level of fragmentation whereas built-up-area density is.<sup>93</sup>

## ENVIRONMENT

**Open-space ratio** – This is the share of city land in open space, including open countryside, forests, cultivated lands, parks, vacant lands that have not been subdivided, cleared land, and water bodies: seas, rivers, lakes, and canals. Fringe open space and captured open space, taken together, make up the urbanized open space in each study area. Fringe open space consists of all open space pixels within 100 metres of urban or suburban pixels. Captured open space consists of all open-space clusters that are fully surrounded by urban and suburban built-up pixels and the fringe open-space pixels around them and that are less than 200 hectares in area.<sup>94</sup>

**Walkability ratio** – This is the average ratio of the beeline distance and the street travel distance for 40 pairs of sample points within the locale that are more than 200 metres apart.<sup>95</sup>

**Green environment** – Eleven individual metrics (sourced as indicated) comprise the Arcadis Sustainable Cities Index representing 'green environment':

- Natural catastrophe exposure: International Disaster Database;
- Green space as per cent of city area: Siemens Green City Index;
- Energy use: Energy Information Administration;
- Renewables share: Energy Information Administration;
- Energy consumption per dollar GDP: Energy Information Administration;
- Mean level of pollutants: World Health Organization;
- Greenhouse emissions in metric tonnes (per capita): CDP Cities open data;
- Solid waste management (landfill vs recycling): World Bank;
- Share of wastewater treated: OECD & FAO Aquastat;
- Access to drinking water (per cent of households): World Health Organization; and
- Access to improved sanitation (per cent of households): World Health Organization.

**Low crime** – The NUMBEO Crime Index is an estimation of overall level of crime in a given city. Crime levels are classified as follows:

- Very low, a score of less than 20;
- Low, a score between 20 and 40;
- Moderate, a score between 40 and 60;
- High, a score between 60 and 80; and
- Very high, a score of 80 or higher.

The rank order of the data is reversed for the present research to represent good density. Although national records of crime committed may be accurate, the data are less reliable for cross-country comparison analysis because of differences in crime reporting and national legislative differences in how crime is defined.<sup>96</sup>



NEW YORK CITY, USA

**Tourism** – Euromonitor data record city arrivals for cities in a total of 135 countries. Arrivals refers to international tourists, that is, any person visiting another country for at least 24 hours, for a period not exceeding 12 months, and staying in collective or private accommodation. Each arrival is counted separately and includes people travelling more than once a year and people visiting several countries during one holiday. Domestic visitors are excluded. This encompasses all purposes of visit, such as business, leisure, and visiting friends and relatives. The data are sourced directly from national statistics offices, airport arrivals, hotel/accommodation stays, and other methods.<sup>97</sup>

## INVESTMENT RETURNS DATA

Three data sources were selected to capture the dynamics of the real estate market and fund management and investor interest in returns, investment value, and performance. The conventional real estate yields<sup>98</sup> data, supplied by CBRE, have been used to calculate returns. Data supplied by Cushman & Wakefield (CW) for capital value and rents for European markets and data from research on global cross-border real estate portfolio capital flows,<sup>99</sup> sourced from Real Capital Analytics (RCA), were also incorporated.

CBRE data are available on a quarterly basis for 63 cities internationally.<sup>100</sup> CW rental and yield data for a sub-set of 27 European cities allowed the incorporation in analysis of data for prime retail as well as office markets. In both cases, data are based on local appraisal information. RCA global data for commercial office property based on transaction values were therefore also incorporated in analysis to shed light on cities that are attracting major property investment flows. CBRE and CW data are for the period 2008 to 2015. RCA data are for the period 2008 to 2014.

# APPENDIX 3

## FULL CORRELATION RESULTS

**FIGURE 22. SPEARMAN CORRELATIONS BETWEEN OFFICE REAL ESTATE INVESTMENT RETURNS AND DENSITY INDICATORS**

Density indicator	Correlation with office returns	p-value	Number of cities
Urban-extent density 2016	0.68	0.0000774	28
Built-up-area density 2016	0.66	0.000119	28
Business services	0.36	0.003940	63
Innovation	0.32	0.010800	62
Financial services	0.31	0.013300	63
Green environment	0.29	0.039400	50
Tourism	0.2	0.230000	37
Low crime	0.19	0.170000	57
Real estate investment flows	0.14	0.280000	59
Walkability	0.09	0.630000	28
Low unemployment	-0.03	0.870000	37
Open-space ratio	-0.27	0.170000	28
Transparency*	-0.55	0.0000035	61

\* Transparency is a country-level metric that is highly negatively correlated with office real estate returns. This unexpected result is driven by U.S. cities which have the highest levels of transparency but which, on average, have a low level of returns. When U.S. cities are removed from the analysis, the correlation result for returns and transparency is 0.07.

Statistically significant correlations
  Weak statistically significant correlations
  Not statistically significant correlations

**FIGURE 23. SPEARMAN CORRELATIONS BETWEEN GOOD DENSITY INDICATORS AND OFFICE REAL ESTATE INVESTMENT FLOWS**

Good density indicator	Correlation with office real investment flows	p-value	Number of cities
Business services	0.52	0.00002	59
Financial services	0.5	0.00006	59
Innovation	0.68	0.00000	59
Low unemployment	0.18	0.30000	37
Low crime	-0.05	0.72000	54
Green environment	0.16	0.27000	48
Transparency	-0.07	0.58000	58
Urban-extent density 2016	-0.1	0.62000	27
Built-up-area density 2016	-0.13	0.53000	27
Open-space ratio	-0.09	0.66000	27
Walkability ratio 2016	-0.09	0.67000	27
Tourism	0.21	0.23000	35

■ Statistically significant correlations    ■ Not statistically significant correlations

**FIGURE 24. SPEARMAN CORRELATIONS BETWEEN GOOD DENSITY INDICATORS AND OFFICE REAL ESTATE AND RETAIL CAPITAL VALUES AND RENTS**

	Office capital values		Retail capital values		Office rent		Retail rent		Number of cities
	Correlation	p	Correlation	p	Correlation	p	Correlation	p	
Business services	0.09	0.66	0.47	0.02	0.25	0.24	0.17	0.430	24
Financial services	0.06	0.77	0.3	0.15	-0.06	0.77	0.1	0.640	24
Innovation	0.52	0.01	0.23	0.27	0.37	0.08	0.63	0.001	24
Green environment	-0.02	0.95	-0.25	0.27	0.36	0.12	0.2	0.390	21
Transparency	0.29	0.17	-0.04	0.86	0.39	0.07	0.1	0.650	24
Urban-extent density	0.8	0.01	0.27	0.49	-0.02	0.97	0.05	0.900	9
Built-up-area density	0.73	0.02	0	1.00	-0.15	0.70	-0.13	0.730	9
Open-space ratio	-0.33	0.38	-0.52	0.15	-0.57	0.11	-0.53	0.140	9
Walkability ratio	0.03	0.93	0.1	0.80	0	1.00	0.13	0.730	9
Tourism	0.33	0.20	0.55	0.02	0.01	0.97	0.43	0.090	17
Low unemployment	-0.19	0.42	-0.12	0.60	-0.06	0.80	-0.07	0.770	20
Low crime	-0.18	0.43	-0.04	0.86	-0.27	0.24	-0.18	0.420	22

■ Statistically significant correlations    ■ Not statistically significant correlations



VIENNA, AUSTRIA

# NOTES

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