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The Compact City in Empirical Research: A Quantitative Literature Review

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Abstract
The ‘compact city’ is one of the most prominent concepts to have emerged in the global urban policy debate, though it is difficult to ascertain to what extent its theorised positive outcomes can be substantiated by evidence. Our review of the theoretical literature identifies three main compact city characteristics that have effects on 15 categories of outcomes: economic density, morphological density and mixed land use. The scope of our quantitative evidence-review comprises all theoretically relevant combinations of characteristics and outcomes. We review 321 empirical analyses in 189 studies for which we encode the qualitative result along with a range of study characteristics. In line with theoretical expectations, 69% of the included analyses find normatively positive effects associated with compact urban form, although the mean finding is negative for almost half of the combinations of outcomes and characteristics.

Keywords: compact, city, density, meta-analysis, sustainability, urban
JEL Classifications: R38; R52; R58

1 Introduction

The compact city is a broadly defined set of objectives rather than a single outcome. The concept idealises a city that is distinctively urban in very general terms of density, but also in more specific terms such as a contiguous building structure, interconnected streets, mixed land uses, and the way people travel within the city. Discourses of conviction concerning the compact city have been heavily adopted by policy makers. Compact cities have been promoted for increasing productivity due to agglomeration economies, for supporting sustainable city outcomes such as shorter trips, and for having smaller ecological footprints and better city health (Gleeson 2013). While the compact city concept still generates debate, policy makers expect it to play a role in achieving sustainable city objectives as itemised by UNEDP, the World Bank and the OECD (World Bank 2010; OECD 2010). While the degree of spatial concentration of economic activity in urban areas is already high, the general consensus in the global policy debate is that, on average, even higher densities within cities and urban areas are desirable (Boyko & Cooper 2011; Holman et al. 2014).

The vision of an ideal compact city has been increasingly successful. By now, most countries pursue policies that implicitly or explicitly aim at promoting compact urban form (OECD 2012; Shopping Centre Council of Australia 2011; IAU-IDF 2012), be it at the metropolitan (usually referred to as 'compact city policy' or neighbourhood (usually referred to as 'compact urban development') level (OECD 2012; Geurs & van Wee 2006; Burton et al. 2003).[1] Implicit to the wide support the concepts receive in the urban policy debate, is the agreement that for the most part the returns to density and compactness exceed the cost, which can come in the form of reduced affordability, traffic congestions, a high concentration of pollution, and loss of open and recreational spaces. Critiques of the concept of the compact city, although present, are subsequently not as keenly adopted by policy discourses (Neuman 2005; O'Toole 2001; Cheshire 2006). More specific compact policies, such as density or green belt policies have been more widely prone to critique due to their adverse effects on affordability (Cheshire & Hilber 2008; Thompson 2013).

It is difficult to determine to what extent the positive normative statement prevailing in the policy debate can be substantiated by evidence (Neuman 2005). There is a sizable literature that empirically investigates the effects of various aspects of compact urban form, but the evidence is scattered across several literatures, both thematic and geographical. The main limitation is that there is no

[1] This does not imply that the effects of 'compact city' policies cannot be observed within cities or those of 'compact development' policies between cities.

consolidated self-contained empirical literature on compact city effects. Instead, most of the relevant evidence is spread across separate literature strands which are often only implicitly concerned with specific effects and selected aspects of compact urban form.

As a result, the compact city literature tends to differentiate between various characteristics and effects of the compact urban form, theoretically, but references to empirical evidence often remain casual. To empirically substantiate the claims brought forth in support of the concept, the compact city is often treated as a single entity whereas the evidence is specific to outcomes (e.g., productivity, trip times or affordability) and characteristics (e.g., density or mixed use). This is a problem because different compact city characteristics can impact on the same outcome in opposite directions and the same characteristics can have positive and negative effects on different outcomes (Holman et al. 2014). As an example, given a constant infrastructure and land use pattern, a high density of users can result in a more intense usage of roads and increased congestion (Burton 2000; Angel et al. 2005; Churchman 1999). At the same time, a mixed land use pattern *ceteris paribus* tends to reduce the number of automobile trips and thus alleviates road congestion (Burton 2000; Burton 2003; Churchman 1999). Likewise, economic density in the form of a high spatial concentration of workers and firms can lead to higher productivity and wages (Neuman 2005). These positive effects directly map to an increased demand for space, which – along with the limitations to creating additional space in already dense areas – puts pressure on house prices and office rents (Alexander 1993; Churchman 1999). The result can be an affordability problem for low-income groups, which stands at odds with the frequently stated claim or ambition that compact cities are or should be inclusive.

Because the compact city concept is an umbrella for various urban characteristics that have potentially different effects on different outcomes, an empirical account of the support for compact city policies requires a systematic approach. The evidence base needs to be condensed in such a way that facilitates a comparison of the effects of different compact city characteristics on the same outcome as well as the effects of the same characteristic on different outcomes. A fair assessment of the evidence on the effects of compact city characteristics needs to be guided by theory. Only if all theoretically expected channels through which different compact city characteristics impact on distinct outcomes are understood will the evidence be fully conclusive. Else, the gaps in the literature need to be identified in a transparent manner to understand the limitations of the evidence. Finally, the evidence base needs to be interpreted in light of the nature of the evidence, which can range as much as from anecdotal character to well-identified econometric results. To date, an evidence re-

view that satisfies these criteria is not available. This lack of systematic, theory-consistent, and accessible evidence complicates evidence-based policymaking in the direction of sustainable urban economic development (Matsumoto 2011; Angel et al. 2005).

Our contribution to the literature is twofold. First, we condense the theoretical compact city literature to a compact matrix that links the key compact city characteristics (causes) to a range of outcome categories (effects). Where extant, we isolate the economic mechanisms through which causes lead to effects as well as the theoretically expected direction of the effect. The purpose of this exercise is not to provide an in-depth survey of the theoretical literature, but to present a systematic overview of the literature in accessible form. Importantly, the theory matrix paves the way for our second contribution, a quantitative review of the empirical evidence on the effects of compact urban form. To ensure that we cover as comprehensively as possible the different dimensions of the relevant evidence and uncover potential gaps in the literature, we conduct separate literature searches for every combination of compact city characteristics and outcome categories for which we theoretically expect a causal effect. We quantify the nature of the reviewed evidence and subject the results to a statistical analysis using techniques that we borrow from meta-analytic research. This evidence review of the effects of compact urban form is unique in terms of the scope of the evidence base, the quantity of the reviewed studies, and the quantitative approach to summarise the results. In terms of the various compact city characteristics, the scope in this paper is substantially broader than in a companion paper in which we restrict ourselves to a meta-analysis of results that can be summarized as a density elasticity (Ahlfeldt & Pietrostefani 2017). To keep the review independent, we exclude all original analyses of density effects on various outcomes reported in that companion paper.

In our theoretical and empirical reviews, we cover 15 categories of outcomes and three classes of compact city characteristics. The outcomes include accessibility (job accessibility, accessibility of private and public services), various economic outcomes (productivity, innovation, value of space), various environmental outcomes (open space preservation and biodiversity, pollution reduction, energy efficiency), efficiency of public service delivery, health, safety, social equity, transport (ease of traffic flow, sustainable mode choice), and subjective well-being. The compact city characteristics include economic density (employment and population density), morphological density, which is specifically related to the built environment (e.g., compact urban land cover, street connectivity, high floor area ratios), and mixed use (e.g., co-location of residential, commercial and retail uses). Our review of the theoretical literature reveals potentially causal links for 32 of the 45 theoretically

possible combinations of characteristics (causes) and outcomes (effects). For 15 of the 32 channels, the literature expects normatively positive effects, with another 13 being associated with ambiguous expectations and only four channels expected to yield negative effects. For six out of 15 outcome categories, the theoretical literature suggests unambiguously positive effects associated with compact urban development while the expected effects on the remaining nine are ambiguous.

In total, we review 321 empirical analyses in 189 studies that are concerned with any of the 32 combinations of compact city characteristics and outcome categories for which the theoretical literature has hypothesised a causal link. Of these 32 theoretically expected links, the evidence base covers 28, but the evidence base is thin for a range of outcomes and characteristics other than economic density, implying significant gaps in the literature that should be addressed in further original research. In general, the evidence base aligns well with theoretical compact city literature and suggests effects of compact urban form on various outcomes that are positive in a normative sense. There seems to be general consensus that effects are negative on *open space preservation*, *traffic flow*, *health,* and *well-being.* For most other categories, the average finding in the literature is positive. *Productivity* and *innovation* are the categories where the positive effects of compact urban form are least controversial. Given the nature of the reviewed evidence, these results are best understood as area-based effects, i.e. for individual-based outcomes (e.g. productivity), positive findings may be partially attributable to differences in the composition of individuals and firms (sorting).

The remainder of this paper is organised as follows. The next section engages with the theoretical compact city literature. In sections 3 and 4 we lay out how we collect and interpret the evidence. In section 5 we summarise the evidence base by compact city characteristic, outcome category and various attributes of the reviewed analyses and provide a comparison of empirical evidence and theoretical expectations by category. The final section concludes.

2 The compact city in theory

2.1 History of thought

The OECD defines the compact city as a 'spatial urban form characterised by 'compactness' (OECD 2012, p.15). Its most recent definition described the characteristics of the compact city as 'dense and proximate development patterns,' 'urban areas linked by public transport systems' and 'accessibility to local services and jobs' (OECD 2012, p.15). The term compact city is often said to have first been used by Dantzig and Saatay (1973) who were principally interested in a more efficient

use of urban resources. It also stems from the critique of modernist planning approaches (Jacobs 1961), supporting both density and mixed use in line with a European-style address of inner-city spaces. Its origins in this theoretical framework quickly explain the literature's focus on certain outcomes, such as sustainable mode choice and improving accessibility (Thomas & Cousins 1996). Compact city policies focus, in fact, on holistic approaches to achieve 'compactness' by impacting on the ways urban environments are used. It is the comprehensive approach of compact city policies, expected to fulfil a series of urban sustainability objectives by improving economic, social, and environmental dimensions of the city, that have made them so popular.

Churchman (1999) first provided an itemised disentangling of the advantages and disadvantages of compact city features on economic, social, and environmental outcomes revealing the complexity and heterogeneity or the concept. Neuman (2005) also presents a helpful critique in his juxtaposition of 'compactness' and 'sprawl', however as with other publications that discuss the concept, the presence of varied definitions of the compact city amplifies the difficulties in understanding characteristics and outcomes and generates confused debate. The confusion also stems from a rhetoric through case-study analysis (Neuman 2005; Williams et al. 2000; Roo & Miller 2000) of whether compact cities are sustainable, instead of addressing potential costs and benefits more specifically (with some exceptions (Churchman 1999)). In discussing specific outcomes, the literature focuses on the reduction of automobile trips and the increased use of alternative modes of transportation (Burton 2000; Schwanen et al. 2004; Neuman 2005), improving the environmental qualities of cities (Burton 2002; Churchman 1999) and the provision of high-density housing in the proximity of retail and to support equity (Burton 2001; Churchman 1999). Although the rhetoric focuses on these aspects, countless more are mentioned.

There is no consensus on a breakdown of how compactness is measured. What is clear, however, is the presence of three main features: economic density, morphological density, and the mixed use of land, although within each umbrella there is a wide array of possibilities: residential, population, employment or firm density; parcel density, street intersection or road capacity (Hitchcock 1994; Churchman 1999). The multiplicity of characteristics is reflected in the empirical evidence collected and underlines the difficulty in comparing much of the evidence.

Burgess & Jenks (2002) address the compact city in the context of developing countries, stressing the dangers of categorising cities between developed and developing. Because cities in developing countries are often characterised by specific features such as e.g. higher-density inner cities or a larger presence of urban informality, they may also experience specific costs and benefits associat-

ed with compact urban form. Thus far, the case-study (usually few in number) context-led approach of most compact urban form studies in the global south does not allow for general conclusions.

2.2 Compact city characteristics and outcomes

As discussed above, the policy debate on compact urban form associates a range of city characteristics with a multitude of potential outcomes. The multiplicity of characteristics and outcomes results in a high dimensionality of cause-and-effects channels that come under discussion in the theoretical debate. The literature is vast and many contributions are concerned with some particular characteristics and outcomes or do not make clear distinctions between the features of the compact city, its outcomes, and the processes by which they are associated. To guide our empirical review of the compact city literature, we therefore first synthesise the theoretical literature to a matrix that presents the theoretical links between the most commonly considered classes of characteristics (causes) and category of outcomes (effects) in a highly accessible form. Three primary classes of compact city characteristics emerge from the theoretical literature.

Tab. 1. Compact city characteristics

Index	Characteristic	Summary
A	Economic density	Refers to the number of economic agents living or working within a spatial unit and is typically measured as population or employment density (Thomas & Cousins 1996; Churchman 1999; Burton 2002; Neuman 2005).
B	Morphological density	Refers to the density of the built environment and captures aspects of the compact city such as compact urban land cover, demarcated limits (demarcated urban/rural land borders), street connectivity, impervious surface coverage and a high building footprint to parcel size ratio (OECD 2012; Wolsink 2016; Neuman 2005; Burton 2002; Churchman 1999).
C	Mixed land use	Captures the co-location of employment, residential, retail and leisure opportunities (Churchman 1999; Burton 2002; Neuman 2005), both horizontally across buildings and vertically within buildings Burton (2002).

The selection of the outcome categories was guided by both the theoretical literature and policy reports, in particular Churchman (1999) and Neuman (2005) in untangling the concept of density, and the OECD's (2012) *Comparative Assessment*. Distinctions between the three characteristics are especially important in accounting for different evolutions of densities: between 1950 and 2012 OECD countries increased their built-up areas by 104% while their population only increased by 66% (OECD 2012). These characteristics have in some cases been defined as the 'three Ds' as coined by Cervero and Kockelman (1997): density (population and employment), diversity (proportion of dissimilar land uses, vertical mixture, proximity to commercial retail-uses), and design (street patterns, site design, and pedestrian provisions). Although we have generally followed the spirit of these definitions, which were later re-employed in the literature (Ewing & Cervero 2010;

Cervero & Duncan 2003), our approach has redefined them to allow for a sharp separation of characteristics and outcomes that we introduce in Tables 1 and 2.

While it is difficult to provide a complete representation, our reading of the theoretical and empirical literature suggests that the list below includes at least the most popular economic, environmental, and social outcome categories. The list includes individual-based outcomes for people and firms (e.g. productivity, innovation, well-being) as well as area-based outcomes (e.g. pollution or equality). It is noteworthy in this context that because of sorting an individual-based effect (e.g. a productivity of an individual as if randomly assigned) is not the same as the effect on an outcome measured at the level of an area (e.g. the average productivity of all individuals in an area). As an example, density may make the same worker more productive, but it also tends to be associated with the presence of, on average, more productive workers (Combes et al. 2012).

Tab. 2. Summary of principal compact city outcomes

Index	Outcome category	Summary
1	Productivity (individual-based)	The compact city literature alludes to a positive association between economic density and productivity (Neuman 2005; OECD 2012). This is in line with literature on agglomeration economies that emphasises external returns to scale (Marshall 1920).
2	Innovation (individual-based)	Competition (Jones et al. 2010) and urbanization economies (Maskell & Malmberg 2007) imply that innovation increases in economic density.
3	Value of space (individual-based)	An increase in demand due to higher productivity or consumption value in denser areas is expected to capitalize into the value of usable space (Alonso-Mills-Muth model; Rosen-Roback) and, eventually, land. Morphological density can also make places more attractive and therefore increase the value of space (Glaeser et al. 2001; Knox 2011). Construction costs generally increase in height (Epple et al. 2010; Ahlfeldt et al. 2015), although building more densely can be economical in certain instances (Alexander 1993; Churchman 1999). Some policies associated with compact urban form (urban growth boundaries) can increase the value of space by restricting supply (Cheshire & Hilber 2008).
4	Job accessibility (individual-based)	Higher economic density and morphological density (due to demarcated city limits) reduce the separation of home and work and potentially reduces time or money spent on commuting (Neuman 2005; OECD 2012). Higher economic density makes public transport more viable, which improves accessibility (Beer 1994; Laws 1994; Dieleman & Wegener 2004). Higher economic density and morphological density does not necessarily entail reduced travel times due to potentially higher congestion (see 12).
5	Services access (area-based)	Higher economic density results in the clustering of recreational amenities (restaurants, bars, etc.) that require large consumer base (Churchman 1999; Burton 2000; Burton 2002). Denser areas also have more specialised services available, influencing consumption variety (Schiff 2015). Morphological density (small, connected and interlinked streets, walkability) makes spaces more attractive to services such as cafes, bars, restaurants, shops, which increase consumption in these areas (Bonfantini 2013). Mixed land use further reduces distance between services and consumers.
6	Efficiency of public services	Higher economic density increases the comparative advantage of public transport, usage, and – because public transport is usually not profitable –

Index	Outcome category	Summary
	(area-based)	the cost of delivery (Matsumoto 2011; Carruthers & Ulfarsson 2003). Economic density is associated with returns to scale in public services such as waste collection and recycling, but the effect of morphological density (narrow streets/old town) likely works in the opposite direction (Troy 1992).
7	Social equity (area-based)	The compact city is frequently argued to ultimately improve social equity (Burton et al. 2003), but the causal channels are typically not worked out explicitly. Economic density tends to increase both wages and rents, with effects that potentially vary across social groups. Economic density may enhance spatial and social mobility (Savage 1988). Morphological density can lead to segregation as tall buildings are only viable at high rents (Radberg 1996).
8	Safety (area-based)	A higher economic density naturally leads to more crime (Burton 2000; Chhetri et al. 2013), but not necessarily a higher crime rate. Street intersections, mass transit stations, and other elements of morphological density, may cause crime and criminals to cluster according to the 'hot-spot theory' (Braga & Weisburd 2010). However, morphological density also facilitates light design which may prevent crime (Farrington & Welsh 2008). Economic and morphological density may lead to higher formal (Tang 2015) and informal (Jacobs 1961) surveillance and may thus reduce crime.
9	Open space (area-based)	High economic and morphological density tends to reduce open space and biodiversity within cities due to higher opportunity costs (Neuman 2005; Wolsink 2016; Ikin et al. 2013), but has the opposite effect outside the city (Burton et al. 2003; Dieleman & Wegener 2004; Helm 2015).
10	Pollution reduction (area-based)	Economic density can result in less automobile use, shorter trips, and fewer CO2 emissions (Bechle et al. 2011). However, concentration of traffic in dense areas can result in a higher density of emissions and noise on main transport axes (Troy 1996). Morphological density (tall buildings) can be associated with higher local energy efficiency (see 11.). Mixed use reduces local automobile trips (and trip length) and emissions (Gordon & Richardson 1997), but leads to more noisy activities in residential areas, which increases stress levels (World Health Organization (WHO) 2011).
11	Energy efficiency (area-based)	Tall buildings tend to be more energy efficient (Schläpfer et al. 2015; Rode et al. 2014). The co-location of residents can result in common energy systems that share local energy-generation technologies (OECD 2012).
12	Traffic flow (area-based)	Higher economic density implies a higher density of usage of transport systems and potentially higher road and pedestrian congestion (Burton et al. 2003; Rydin 1992). Morphological features designed to attract services and people (e.g., improved walkability) tend to slow down cars and increase congestion. Mixed use tends to reduce car trips and road congestion.
13	Sustainable mode choice (individual-based)	Economic density increases the mode share of walking and cycling because of shorter average trip length (Churchman 1999; Burton 2000; Thomas & Cousins 1996). It increases the mode share of public transport since areas are easier to serve by public transport and typically higher congestion and scarcity of parking (Burton 2000; Neuman 2005). Morphological density (walkable street layout, demarcated city limits) and mixed land use have similar effects. Because walking, cycling, and public transport are affordable, this outcome can be considered equitable.
14	Health (individual-based)	Economic and morphological density and mixed land use imply positive health effects due to a higher share of walking and cycling (see 13.). Effects on health in light of lower emissions, but higher density of emissions are ambiguous (see 10). High residential density - more people and limited space – may influence mortality rates through higher density of road traffic and higher number of accidents (Troy 1996; Burton 2000).

Index	Outcome category	Summary
15	Well-being (individual-based)	Economic density can have negative effects on well-being due to a lower overall sense of community (Wilson & Baldassare 1996), anxiety, stress, social withdrawal, and a feeling of loss of control (Churchman 1999; Chu et al. 2004). Economic and morphological density may negatively affect perceptions of space because a higher cost of space (see 3.) results in less domestic space (Burton 2000) and tall, dense structures obstruct views, cause shadowing, reduce open space, and give a visual sense of lack of proportion (Hitchcock 1994). Mixed use of space results in noisy activities in residential areas which increases stress levels (World Health Organization (WHO) 2011). Improved access due to density and mixed land use potentially increases social well-being (Churchman 1999) as do comfortable/agreeable urban environment due to morphological density (walkability)(see 13.) (Vorontsova et al. 2016).

The compact city literature frequently refers to intensification as the process of steering development into a direction that is consistent with compact city characteristics. We do not explicitly cover this aspect of the debate because the purpose of this review is to evaluate the effect of compact urban form and not the efficiency of compact city policies. Our results, nevertheless, speak directly to this policy debate as they reveal how the intensification of certain characteristics (A–C) can impact on different outcomes (1–15).

2.3 A stylised representation of the theoretical literature

The three characteristics (A, B, C) along with the 15 outcome categories introduced above result in 45 potential cause-effect relations of which, however, not all are theoretically relevant. In Table 3 we aim at providing an accessible summary of the theoretically anticipated causal links between compact city characteristics and outcomes, which will guide our empirical literature review. For this purpose, we link compact city characteristics (causes) to outcome categories (effects) via a matrix, in which each outcome-characteristics cell provides a brief description of the nature of the anticipated effect (positive, ambiguous, negative) and the economic mechanism through which an effect materialises. We only consider links between outcomes and characteristics that are commonly discussed in the theoretical literature, which results in 32 theoretically relevant outcome-characteristics relations. References to the relevant theoretical work are excluded in an attempt to keep the presentation compact. They are provided in an identically structured table in the appendix (Table A1). To connect to the empirical part of our review we add examples of variables that are typically observed in the empirical literature for each category.

Tab. 3. Theoretically expected effects of compact urban form on various outcomes

	Compact city effects		Compact city characteristics		
#	Outcome category	Empirically observed	Residential and employment Density	Morphological Density	Mixed use
1	Productivity	Rents, wages	*Positive effects* due to agglomeration economies (MAR externalities)	-	-
2	Innovation	Patents	*Positive effects* due to agglomeration economies (interactions, matching, spill overs, peer effects)	-	-
3	Value of space	Land values, house prices, rents	*Positive effects* (in the sense of an increase) due to higher productivity and services availability (demand side) and higher cost due to scarcity of land (supply side) [a]	*Positive effects* (in the sense of an increase) because of potentially more attractive locations (demand side) and higher cost of building taller (supply side) [a]	-
4	Job accessibility	Commuting times, distances, costs	*Ambiguous effects* due to shorter trip length and improved transport connectivity (lower costs) and more road congestion (higher costs)	*Ambiguous effects* as demarcated limits reduce trip length (lower costs) and potentially increase road congestion (higher costs)	-
5	Services access	Distance from services and amenities	*Positive effects* (shorter distance) due to clustering of services and amenities requiring a large consumer base, also resulting in greater consumption variety	*Positive effects* (shorter distance) since favourable street layouts (small interconnected streets) attract consumption amenities (e.g., restaurants)	*Positive effects* (shorter distance) as co-location of uses improves access to amenities and services and consumption variety
6	Efficiency of public services	Cost of operating transport systems, waste disposal	*Positive effects* due to scale economies (high fixed cost and low marginal costs)	*Negative effects* since high building density increases the cost of, e.g., waste disposal and high cost of brownfield development	-
7	Social equity	Real wages segregation, social mobility	*Ambiguous effects* due to potentially positive effects on wages and rents (affordability) and higher social mobility [b]	*Negative effects* since tall buildings are feasible with high rents, which increases segregation [b]	
8	Safety	Crime rates	*Ambiguous effects* on crime (density) as very highly frequented places attract criminal activity (hot-spot theory), but more informal surveillance (eyes on the street) increase safety	*Positive effects* (less crime) due to forn informal surveillance in walkable are more street lighting	-
9	Open space	Open space, biodiversity	*Ambiguous effects* due to higher opportunity cost of space within city limits but preserved space outside	*Ambiguous effects* as demarcated city limits increase density within city limits but preserve space outside	-

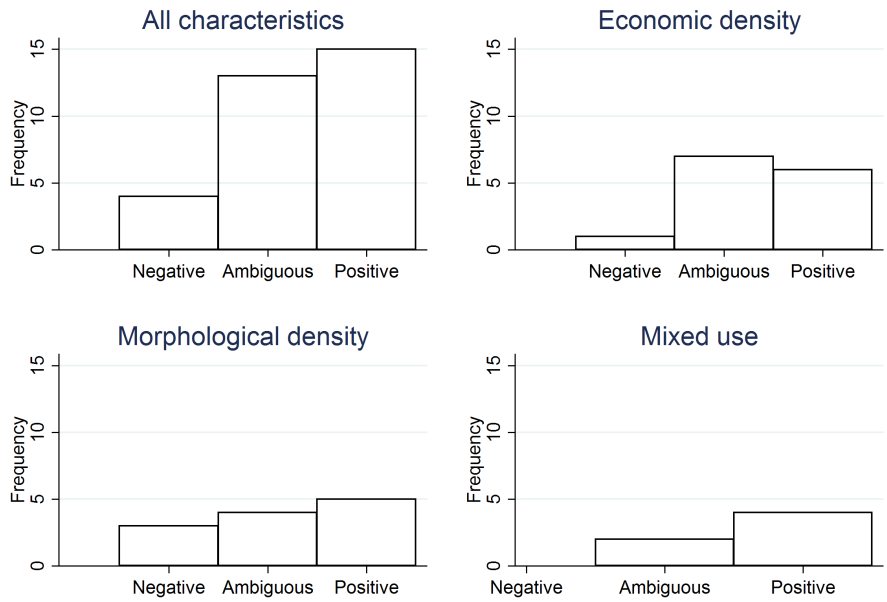
	Compact city effects		Compact city characteristics		
#	Outcome category	Empirically observed	Residential and employment Density	Morphological Density	Mixed use
10	Pollution reduction	Carbon emissions, noise	*Ambiguous effects* due to less automobile use (fewer emissions), but potentially higher density of emissions due to higher concentration	*Ambiguous effects* as taller buildings tend to emit less pollution particles but could also 'trap' pollution	*Ambiguous effects* as co-location of employment, residences, retail, and leisure opportunities reduce trip length but increase noise in residential areas
11	Energy efficiency	Energy consumption	-	*Positive effects* as taller buildings tend to be more energy efficient	*Positive effects* as co-location of uses allows for sharing local energy-generation technologies
12	Traffic flow (speed)	Road congestion, pedestrian congestion	*Negative effects* (lower speed) since higher economic density implies a higher density of potential users and higher opportunity cost of road space	*Negative effects* (lower speed) since morphological designs that improve walkability and attract services tend to reduce road capacity	*Positive effects* (higher speed) since mixed use reduces car trip length and a higher share of non-car uses
13	Sustainable mode choice	Walking, cycling	*Positive effects* as higher densities imply shorter trip lengths, which makes walking, cycling, and (public transit) more attractive	*Positive effects* since demarcated city limits and favourable street layouts make walking and cycling more attractive. High building density creates scarcity of parking space.	Positive effects because co-location of employment, residences, retail, and leisure implies shorter trips
14	Health	Mortality, disability, morbidity	*Ambiguous* due to higher likelihood of walking and cycling (positive), less emissions (positive), potentially higher emission density (negative) and increased number of traffic accidents (negative)	-	-
15	Well-being	Subjective well-being, happiness, perception of urban space	*Ambiguous effects* as dependent on all other outcomes. Additional channels include less domestic space (due to high rent), lower sense of community and anxiety, social withdrawal, and feeling of loss of control.	*Ambiguous effects* as dependent on all other outcomes. Additional channels include less private exterior space and worsened space perception as high-density developments obstruct views, causing shadowing.	*Ambiguous effects* as dependent on all other outcomes.

Notes: The categories and theoretical channels are potentially non-exhaustive and are restricted to those discussed in the theoretical literature. The direction of theoretically expected effects are borrowed from that literature. Where not otherwise indicated, positive and negative are used in a normative sense. Sources for each effects-characteristics cell are presented in Table A1 to keep the presentation compact. [a] An increases in value of space can be considered normatively positive to the extent that they reflect changes on the demand side. [b] An increase in social equity can be considered normatively positive with a social welfare function that is concave in individual income.

For 15 of the 32 outcome characteristics relations reviewed in Table 3, the literature expects positive effects, with another 13 being associated with ambiguous expectations and only four channels expected to yield negative effects. In Figure 1, we illustrate the distribution of the nature of the expected effects (positive, ambiguous, negative) on the 15 outcomes by compact city characteristics. Based on this stylised representation, *mixed land use* is perhaps the most positively seen compact city characteristic in the theoretical literature as unambiguously positive expectations are found for four of the six outcome categories, with the remaining two being ambiguous. The theoretical expectations are also generally positive for the two other categories, *economic density* and *morphological density*, reflecting the generally positive tone of the compact city theory and policy debate. With expected negative effects for three of the 12 categories, *morphological density* is perhaps the least uncontroversial compact city characteristic.

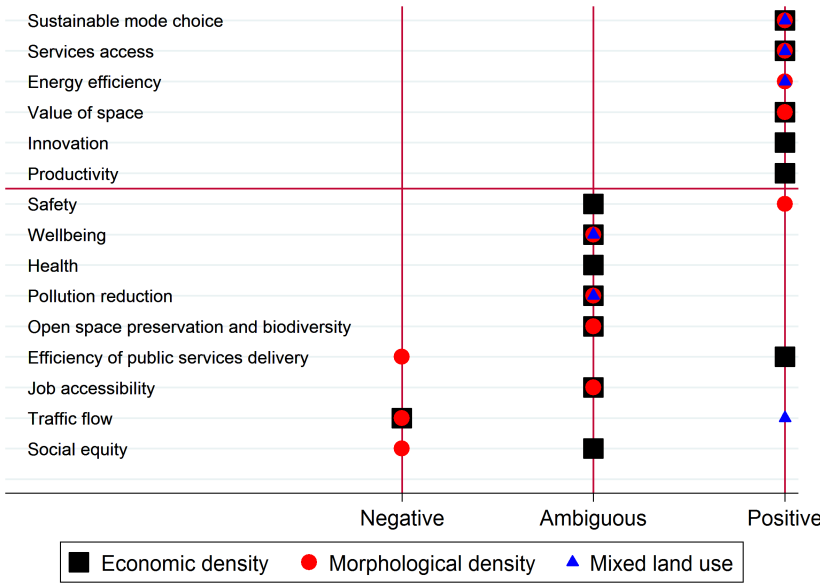
In Figure 2, we summarise the theoretically expected direction of the effects of compact city characteristics by outcome category. Theoretical literature suggests unambiguously positive compact city effects on *energy efficiency*, *innovation*, *productivity*, *services access*, *sustainable mode choice*, and *value of space*. For the remaining nine categories, the theoretical expectations are more ambiguous

Fig. 1. Theoretically expected effect of compact city characteristics across categories



Notes: Stylised representation of the theoretically expected direction of the characteristics-outcome channel described in Table 1.

Fig. 2. Theoretically expected effect of compact city characteristics by category



Notes: Stylised representation of the theoretically expected direction of the characteristics-outcome channel described in Table 1.

3 Collecting the evidence base

The evidence base collected for this paper covers, as broadly as possible, the theoretically relevant links between compact city characteristics and the outcomes discussed in section 2.2. We do not impose any geographical restrictions, i.e., we cover studies from the global north and south (to the extent that they exist). We also consider various geographic layers of analysis (from micro-geographic scale to cross-region comparisons), i.e. we consider studies comparing compact cities to less compact cities as well as compact developments within cities to less compact developments within cities (in general, there is no comparison to rural areas).

In collecting the evidence base for our quantitative literature review, we follow standard best-practice approaches of meta-analytic research, as reviewed by Stanley (2001). We explicitly consider studies that were published as edited book chapters, in refereed journals or in academic working paper series (we were also open to other types of publications) to prevent publication bias. We pursue a three-step strategy in assembling our evidence base. We begin with the standard practice of a keyword search in academic databases (EconLit, Web of Science, and Google Scholar) and specialist research institute working paper series (NBER, CEPR, CESIfo, and IZA). To allow for a transparent and theory-consistent literature search, we conduct specific searches for each outcome-characteristic combination using keywords that we summarise in Table A2 in Section 3 of the ap-

pendix. In the second step, we expand the search by an analysis of citation trees. This systematic literature search, which is described in more detail in the appendix section 3, resulted in 285 studies. Upon inspection (excluding empirically irrelevant work, duplications of working papers, and journal articles, etc.) we were left with 135 studies and 201 analyses (Table A3 in the appendix). We consider multiple analyses from one paper if these are concerned with different outcomes or characteristics.

Up to this point, our evidence collection is unbiased in the sense that it mechanically follows from the theory matrix discussed in section 2.3 and is not driven by our possibly selective knowledge of the literature, nor that of our research networks. For an admittedly imperfect approximation of the coverage we achieve with this approach we exploit the fact that the search for theoretical literature already revealed a number of empirically relevant studies that were not used in the compilation of the theory matrix unless they contained significant theoretical thought. From 19 empirically relevant papers known before the actual evidence collection, we find that step one (keyword search) and two (analysis of citation trees) identified six, i.e., 31%.

In the final step three of the evidence collection we add all relevant empirical studies known to us before the evidence collection (including those we came across in the search for theoretical literature) as well as studies that were recommended to us by colleagues working in related fields. To collect recommendations, we reached out by circulating a call via social media (Twitter) and email (to researchers within and outside LSE). Twenty-two colleagues contributed by suggesting relevant literature. This step increases the evidence base to 189 studies and 321 analyses. The evidence included at this stage may be selective due to particular views that prevail in our research community. However, recording the stage at which a study is added to the evidence base allows us to test for a potential selection effect.

Table 4 summarises the distribution of analysis collected by outcome categories and compact city characteristics. The large majority of the analyses are concerned with the effects of economic density. Only 12 analyses are explicitly concerned with the effects of mixed land use. A comparison to Table 3 reveals the major gaps in the literature. All combinations of outcomes and characteristics for which a causal link is theoretically expected (in Table 3) but no evidence was found are marked by '0' (in bold). This concerns four out of the total of 32 theoretically expected links, mostly concerning mixed use effects. Original empirical research addressing these gaps would be desirable. Table 4 reveals that analyses of the effects of morphological density and mixed land use are scarce. Analyses that consider all three compact city characteristics at the same time are even scarcer. Be-

cause the characteristics are likely correlated, we cannot infer conditional effects (e.g. the effect of mixed use conditional on economic density) from the reviewed evidence. While we consider any of the characteristics as a proxy of compactness it is clear from Table 4 that the results will be driven by economic density.

Tab. 4. Evidence base by outcome category and compact city characteristic

	Compact city effects	Compact city characteristics			
#	Outcome category	Economic density	Morph. density	Mixed land use	Total
1	Productivity	35	-	-	35
2	Innovation	9	1	-	10
3	Value of space	14	8	2	24
4	Job accessibility	13	3	2	18
5	Services access	15	2	**0**	17
6	Efficiency of public services delivery	14	2	-	16
7	Social equity	10	**0**	-	10
8	Safety	18	4	-	22
9	Open space preservation and biodiversity	2	5	-	7
10	Pollution reduction	12	3	**0**	15
11	Energy efficiency	23	8	1	32
12	Traffic flow	4	2	1	7
13	Sustainable mode choice	60	10	6	76
14	Health	13	3	-	16
15	Well-being	14	2	**0**	16
	Total	256	53	12	321

Notes: All numbers indicate the number of analyses collected within an outcome-characteristics cell. '**0**' indicates missing evidence in theoretically relevant outcome characteristic cell. '-' indicates missing evidence in theoretically irrelevant relevant outcome characteristic cell.

4 Interpreting the evidence base

4.1 Encoding study attributes

We choose a quantitative approach to synthesise our broad and diverse evidence base. Our aim is to provide an accessible synthesis of the evidence on the effects of compact city characteristics within and across outcome categories. As with most quantitative literature reviews we use statistical approaches to test whether existing empirical findings vary systematically in the selected attributes of the studies, such as the context, the data or the methods used. In line with the standard approach in meta-analytic research (Stanley 2001) we encode the results as well as the attributes, below, of the reviewed studies into variables that can be analysed using statistical methods.

i) The outcome category, one for the 15 categories defined in section 2.2
ii) The compact city characteristic, i.e., economic density, morphological density, mixed use
iii) The stage (1–3) at which an analysis is added to the evidence base
iv) The publication venue, e.g., academic journal, working paper, book chapter, report
v) The disciplinary background, e.g., economics, regional sciences, planning, etc.
vi) The dependent variable, e.g., wages, land value, crime rate
vii) The study area, including the continent and the country
viii) The period of analysis
ix) The spatial scale of the analysis, i.e., within-city vs. between-city
x) The quality of evidence as defined by the Scientific Maryland Scale (SMS) used by the What Works Centre for Local Economic Growth (2016)
The quality can take the following values:
    0. Exploratory analyses (e.g., charts). This score is not part of the original SMS
    1. Unconditional correlations and OLS with limited controls
    2. Cross-sectional analysis with appropriate controls
    3. Good use of spatiotemporal variation controlling for period and individual effects, e.g., difference-in-differences or panel methods
    4. Exploiting plausibly exogenous variation, e.g., by use of instrumental variables, discontinuity designs or natural experiments
    5. Reserved to randomised control trials (not in the evidence base)

A typical approach in meta-analytic research is to analyse the findings in a very specific literature strand. The results that are subjected to a meta-analysis are directly comparable, and are often parameters that have been estimated in an econometric analysis. Recent examples in the related literature include the meta-analysis of the several estimates of the output elasticity of transport (Melo et al. 2013), the density elasticity of wages (Melo et al. 2009) and a range of transport mode choice parameters (Ewing & Cervero 2010). In contrast, the scope of our analysis is much broader. In an attempt to maximise the evidence base, we consider studies that relate to different outcome categories and compact city characteristics and use different empirical approaches. Therefore, the evidence collected is often not directly comparable across studies, not even within outcome categories.

To facilitate the systematic analysis of such a heterogeneous evidence base, we categorise the results into three discrete classes. The empirical result is classified as *positive* if a compact city characteristic is associated with increases in the outcomes as defined in Table 3. Note that we have defined the outcomes in a way that ensures that positive changes imply positive effects in a normative sense. As an example, an increase in "pollution reduction" corresponds to less pollution, which, arguably, is a normatively positive change. The empirical result is classified as *negative* if it points in the opposite direction and is statistically significant. The remaining cases are classified as *insignificant*. This metric is qualitative in the sense that we are unable to infer the magnitude of the effects on outcomes. Yet, it allows a summarising of the entire body of evidence in transparent and accessible form. The metric is comparable within and across outcome categories and can also be compared to the theoretical expectations. To facilitate further analyses, we assign the numeric values 1

/ 0 / -1 to *positive*/*insignificant*/*negative*, which, by taking the mean, allows us to summarise the evidence into a qualitative result *index* that can range from -1 to 1, where positive values imply positive effects on average. We frequently refer to the results classification on the 1 / 0 / -1 scale as *qualitative result score*.

In Table 5 we tabulate the distribution of analyses by selected attributes (as discussed above, one study can include several analyses). While our evidence base covers most world regions to some extent, including the global south, there is a strong concentration of studies from high-income countries and, in particular, from North America. The clear majority of studies have been published in academic journals. The evidence base is diverse with respect to disciplinary background, with economics as the most frequent discipline, accounting for a share of approximately one-fourth. Table A4 in section 3 presents descriptive statistics of the encoded attributes.

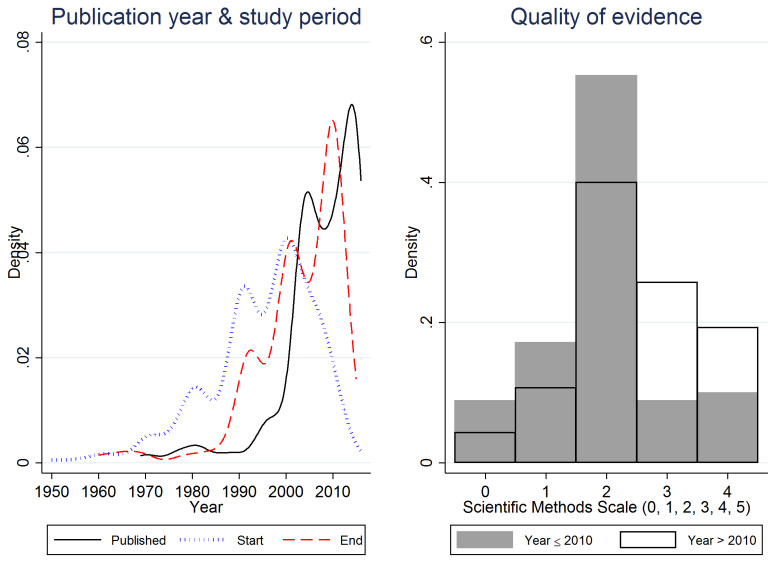
In Figure 3, we illustrate the distribution of publication years, the study period, and the quality of evidence according to the SMS. The evidence, overall, is very recent, with the great majority of studies having been published within the last 15 years, reflecting the growing academic interest in the topic. Most studies use data from the 1980s onwards. A clear majority of studies score two or more on the SMS, which means there is usually a serious attempt to disentangle effects related to 'compactness' from other factors, often including unobserved fixed effects and period effects. Distinguishing between studies published before or after the median year of publication (2009) reveals a progression toward more rigorous methods that score three or four on the SMS. It is worth noting that even when exploiting plausibly exogenous variation (e.g. by using a valid instrument or exploiting a natural experiment) it is often difficult to control for changes in the composition of individuals and firms (sorting). In general, the evidence summarized in our review is, therefore at best understood as describing area-based effects even if the outcomes introduced in section 2.2 are individual-based.

Tab. 5. Distribution of studies by attributes I

World region		Publication		Discipline	
North America	161	Academic Journal	271	Economics	80
Europe	83	Working Paper	45	Planning	55
Asia	47	Book chapter	5	Transport	47
South America	11	-	-	Urban Studies	43
OECD	7	-	-	Regional Studies	37
World	4	-	-	Health	26
Oceania	4	-	-	Economic Geography	14
non-OECD	3	-	-	Energy	11
Africa	1	-	-	Other	8

Notes: Assignment to disciplines based on publication venues.

Fig. 3. Distribution of study period and quality of evidence



Notes: Kernel in the left panel is Gaussian. A small number of analyses with study periods before 1950 are excluded in the left panel to improve readability.

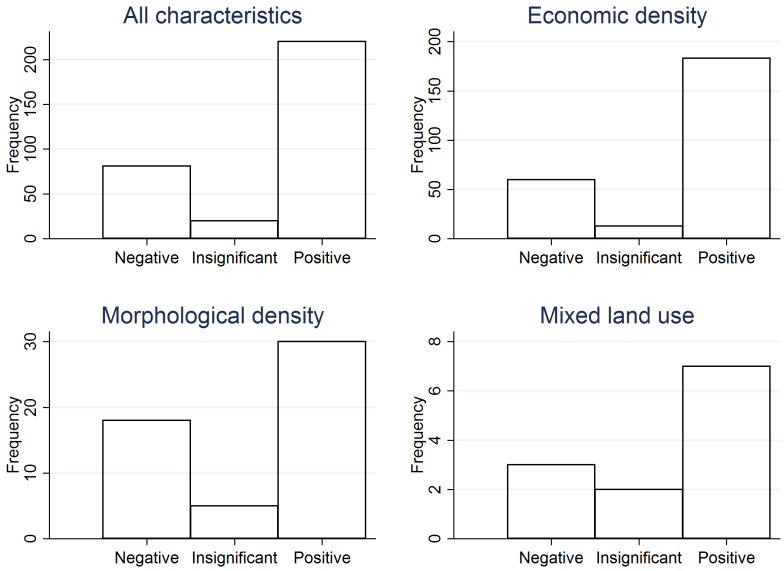
5 Results

5.1 Results by compact city characteristics and outcome categories

In Figure 4, we summarise the distribution of qualitative results concluded in the literature of compact city effects by compact city characteristics. A great majority of more than two-thirds of the analyses in our evidence base found significantly positive effects associated with compact city characteristics. This positive picture is driven by studies on the effects of economic density, which is also the most popular category. While over 70% of the analyses of economic density effects yield significantly positive effects, the same fraction amounts to 56% (morphological density) and 58%

(mixed land use) for the two other classes of characteristics. Overall, the distributions are similar across characteristics, which is in line with a presumably strong correlation of compact city characteristics.

Fig. 4. Distribution of results by qualitative results scale and compact city characteristic



Notes: The category-specific definitions of positive and negative effects from Table 5 have been applied to encode the evidence. Positive and negative results are statistically significant.

In Table 6, we summarise evidence on the effects of compactness by outcome category. We present the percentage of analyses within a category that found positive and significant (pos.), insignificant (ins.) and negative (neg.) results. We also report the number of analyses within each outcome category as well as the average SMS to illustrate the quantity and the quality of the evidence base within each outcome category. To further describe the nature of the evidence base we report the proportion of analyses using data from high-income countries, being published in academic journals, belonging to the economics discipline, using within-city data, as well as the median year of publication.

We find significant heterogeneity in the evidence base across categories, both with respect to the results as well as with respect to the type of analyses. On average, the evidence base clearly suggests positive effects associated with compactness for the outcomes *productivity*, *innovation, services access (amenities)*, *value of space*, *efficiency of public services delivery, social equity, safety, energy efficiency*, and *sustainable mode choice*. For the categories *open space preservation and biodiversi-*

ty, safety, traffic flow, health and *well-being,* the majority of analyses finds negative effects. The evidence is mixed for *job accessibility* and *pollution reduction*.

With the exception of *efficiency of public services delivery* and *traffic flow* all categories have median publication dates within the last 10 years, reflecting considerable ongoing research activity. With respect to the distribution of the other study attributes there is more heterogeneity. As an example, it is notable that economists tend to concentrate on the analysis of *productivity, innovation*, *value of space*, all of which belong to the outcomes where effects tend to be particularly positive. Another notable feature is that the evidence base is generally US- and Euro-centric. Only in the categories *value of space, job accessibility*, and *traffic flow* does a significant share of analyses use data from non-high-income countries. There is also significant heterogeneity with respect to the methods of analysis prevailing within categories. A mean SMS of more than three reflects that most researchers are concerned with identification when analysing the effects of density on *productivity*. In contrast, a mean SMS of 1.6 or 1.0 within the categories *energy efficiency* and open space preservation reflects that the chosen approaches are more descriptive or simulation-based (as is typical for engineering literature). We recommend that the category-specific results reported in Table 8 are interpreted on account of the quantity (N by category), and quality (mean SMS) of the evidence base.

Tab. 6. Evidence summarised by category

			Proportion				Med.	Mean	Result		
ID	Outcome category	N	Poor[a]	Acad.	Econ.	With.	year[b]	SMS	Pos.	Ins.	Neg.
1	Productivity	35	0.11	0.94	0.60	0.14	2011	3.09	94%	3%	3%
2	Innovation	10	0.10	0.90	0.10	0.00	2010	2.40	80%	10%	10%
3	Value of space	24	0.29	0.71	0.54	0.58	2013	2.00	71%	4%	25%
4	Job accessibility	18	0.28	0.72	0.22	0.44	2010	2.00	56%	11%	33%
5	Services access	17	0.18	0.82	0.59	0.53	2015	2.88	76%	6%	18%
6	Efficiency of public services delivery	16	0.00	0.94	0.19	0.00	2003	2.13	75%	13%	13%
7	Social equity	10	0.00	0.90	0.30	0.10	2006	2.60	70%	0%	30%
8	Safety	22	0.05	0.82	0.09	0.82	2015	2.05	77%	0%	23%
9	Open space preservation and biodiversity	7	0.00	0.86	0.00	0.71	2009	1.00	14%	0%	86%
10	Pollution reduction	15	0.53	0.53	0.07	0.60	2013	2.13	53%	0%	47%
11	Energy efficiency	32	0.13	0.97	0.31	0.25	2010	1.47	69%	9%	22%
12	Traffic flow	7	0.29	0.57	0.57	0.29	2009	2.14	29%	14%	57%
13	Sustainable mode choice	76	0.11	0.89	0.03	0.79	2004	2.01	84%	8%	8%
14	Health	16	0.00	1.00	0.00	0.38	2005	2.13	19%	6%	75%
15	Well-being	16	0.00	0.63	0.38	0.25	2008	2.25	19%	6%	75%
	Mean	21	0.14	0.81	0.27	0.39	2009	2.15	59%	6%	35%

Notes: [a] Poor countries include low-income and middle-income countries according to the World Bank definition. [b] Year of publication. Qualitative results scale (positive, insignificant, negative) is a category-characteristics specific and defined in Table 5.

In Table 7 we summarise the evidence by outcome category and compact city characteristic. To allow for a compact presentation despite the higher dimensionality (15 x 3), we assign numeric values to the qualitative results. In particular, we assign values of -1/0/1 to the qualitative results classifications *negative and significant/insignificant/positive and significant*. This auxiliary step allows us to aggregate the qualitative results to category-specific means, which can vary theoretically from -1 (strictly negative) to 1 (strictly positive) and are comparable across categories. We find some interesting heterogeneity in the results patterns within categories, which suggest that the effects of compact city characteristics can qualitatively vary within outcome categories. As an example, the evidence suggests that the *value of space* increases in economic density and morphological density, but is lower in areas of mixed land use. Economic density and mixed land use seem to be associated with shorter trip length (category 4), whereas the opposite is true for morphological density (e.g., walkability). Pollution concentrations seem to be lower in economically dense areas (likely due to lower energy consumption and emissions), but higher in morphologically dense areas (possibly because these 'trap' pollutants). In line with theoretical expectations, economic density and morphological density hinder smooth traffic, while mixed use does the opposite (because a fraction of car trips becomes redundant). These results confirm the theoretical notion that compact city effects are specific to combinations of outcomes and characteristics and any breakdown by outcomes or characteristics comes at the expense of masking important heterogeneity.

Tab. 7. Mean qualitative results scores by outcome-characteristics cells

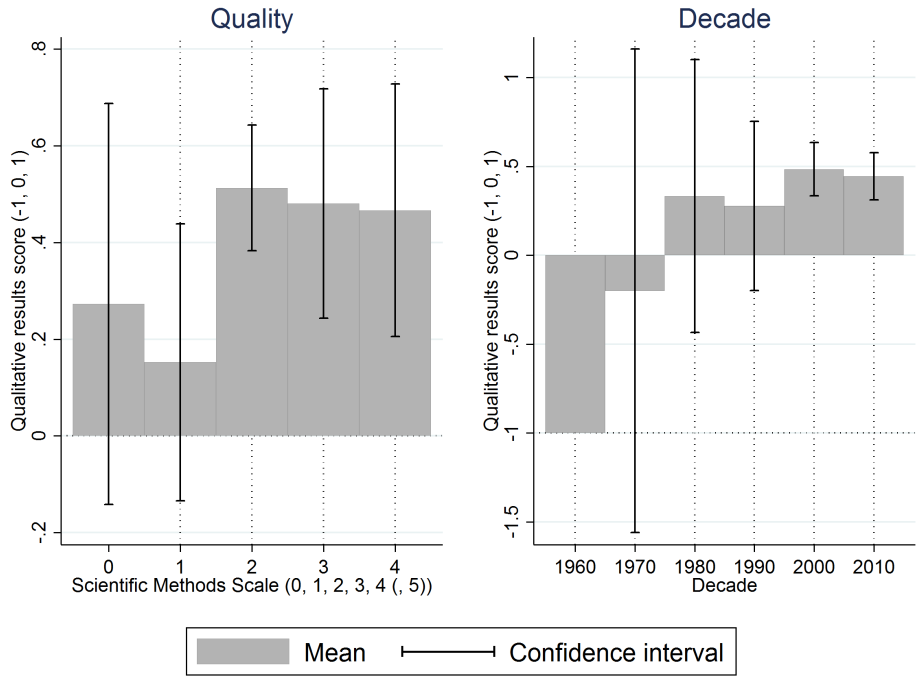
ID	Outcome	Economic density	Morph. density	Mixed land use	Mean
1	Productivity	0.91	-	-	0.91
2	Innovation	0.78	0.00	-	0.39
3	Value of space	0.57	0.63	-1.00	0.07
4	Job accessibility	0.31	-0.33	0.50	0.16
5	Services access	0.53	1.00	-	0.77
6	Efficiency of public services delivery	0.57	1.00	-	0.79
7	Social equity	0.40	-	-	0.40
8	Safety	0.67	0.00	-	0.33
9	Open space preservation and biodiversity	-1.00	-0.60	-	-0.80
10	Pollution reduction	0.33	-1.00	-	-0.33
11	Energy efficiency	0.48	0.38	1.00	0.62
12	Traffic flow	-0.50	-0.50	1.00	0.00
13	Sustainable mode choice	0.77	0.90	0.50	0.72
14	Health	-0.62	-0.33	-	-0.47
15	Well-being	-0.64	0.00	-	-0.32
	Mean	0.24	0.09	0.40	0.21

Notes: Qualitative results scale can take values -1: negative and significant; 0: insignificant; 1: positive, where category-specific definitions of positive and negative are in line with Table 5. Cells contain means of evidence scores across all analysis with the same outcome-characteristics combination.

5.2 Results by study attributes

A standard practice in meta-analytic research is to investigate the sources of heterogeneity in the evidence base. We begin with an exploratory analysis to establish some stylised facts regarding the distribution of qualitative results with respect to selected attributes. The perhaps most interesting feature of a piece of evidence, besides the empirical finding itself, is the rigor of the analysis. In Figure 5 (left panel), we illustrate how the results (qualitative results scores) vary across quality categories (as defined by the SMS). Compactness is more often found to be a positive feature in analyses that employ statistical methods scoring at least two on the SMS, but conditional on crossing this threshold results become slightly less positive. The simplest (exploratory and descriptive) methods scoring zero or one on the SMS are not only significantly less likely to yield a positive finding, the variation in results across analyses is also relatively large (as reflected by the large confidence bands). The right panel similarly aggregates the qualitative results by decade. The main insight is that over time the effects of the compact urban form found in research tend to become more positive. The two panels in Figure 6 are consistent with Figure 3 (right panel) which reveals that more recent analyses tend to use more rigorous methods. The positive time trend in results may be partially driven by the application of more rigorous research techniques, which tend to yield more positive results with less volatility.

Fig. 5. Qualitative results by quality of evidence and publication year

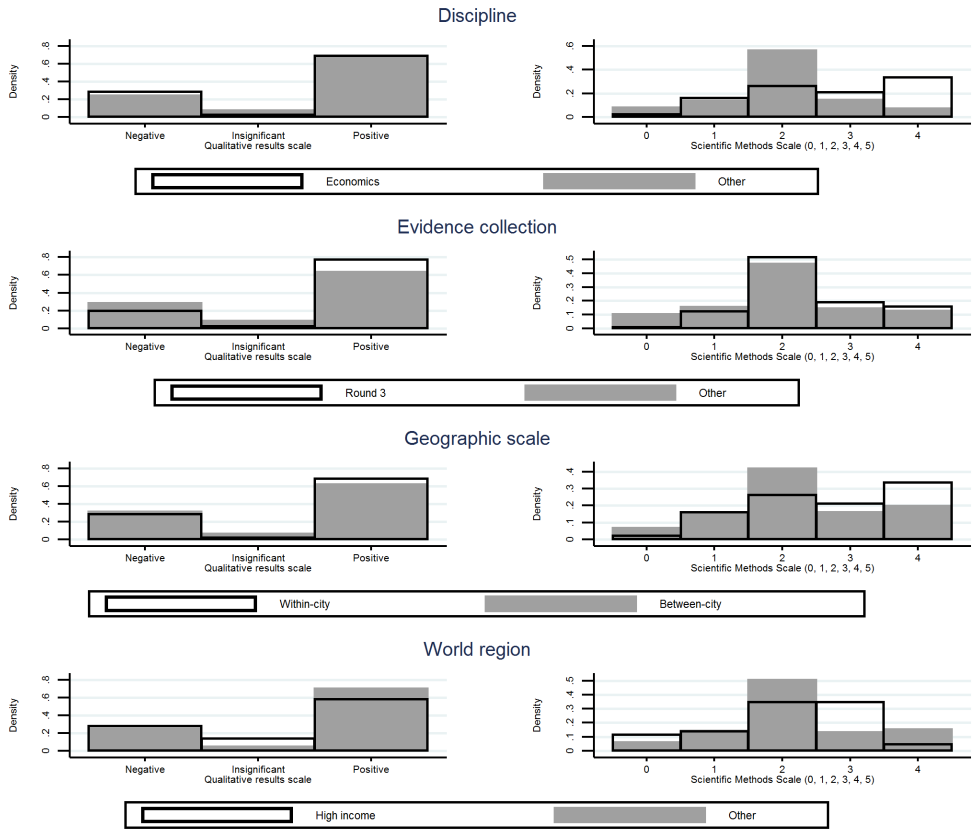


Notes: Unconditional and unweighted means. Confidence interval is at the 95% level.

In Figure 6 we further analyse the distribution of the qualitative results with respect to selected attributes. In each case, we also illustrate how the distribution of the quality of evidence varies in the selected attribute because, as shown above, quality appears to be correlated with the qualitative result index. In the first row, we distinguish between analyses published in economics (the most frequent discipline) journals and working paper series and all other disciplines. Economics analyses yield positive effects related to compact urban form marginally more often than others. Economics analyses, on average, also score significantly higher on the SMS – the median SMS for economics analyses is three as opposed to two across the remaining disciplines. The second row analyses the evidence collected in round three of the collection process described in section 3, which includes recommendations from colleagues at various institutions. The proportion of analyses finding positive effects of compact urban form is higher than for the remaining evidence, but the quality of the evidence is also higher. The same pattern is, once again, found with respect to the geographic scale of analyses. Within-city analyses yield slightly more positive results, but the quality of the methods is also higher (third row). Thus, it seems important to hold the quality of the evidence constant when comparing evidence on compact city effects across disciplines, time periods, and outcome categories. For further insights on the tendencies of findings across disciplines see section 5 of the appendix.

As already shown by Table 5, the evidence base we collected is strongly biased toward high-income countries. Only 43 analyses use data from countries that can be assigned to non-high income countries per the World Bank (2015) definition. The studies use data from Brazil, China, Colombia, Egypt, India, Indonesia, Iran, pooled analyses of several countries in Eastern Asia and South America as well as a study which uses non-OECD countries. This relatively small number makes it difficult to separately assess the evidence available for non-high-income countries. However, it is notable that the distribution of qualitative result cores in this relatively small subsample is slightly less positive than in the remaining sample. The average quality of the methods is also somewhat lower in the analyses using data from non-high-income countries.

Fig. 6. Distribution of qualitative result scores and quality of evidence by attributes

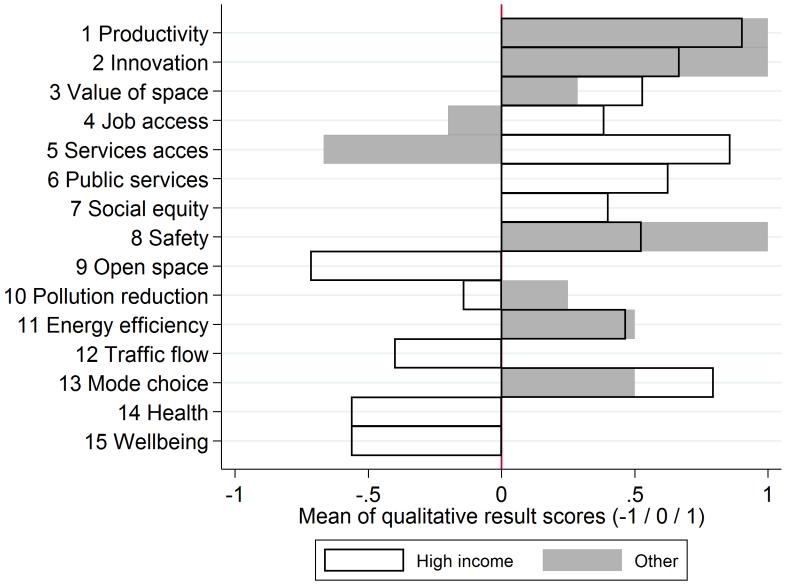


Notes: Category-specific definitions of positive and negative (in Table 1) chosen such that they indicate the positive effects of 'compactness' across all categories. Higher scientific methods scores imply more rigorous methods as defined by WWC. High-income definition from the World Bank.

Using the '-1/0/1' numeric equivalent of the qualitative result scale, we next illustrate the distribution of mean qualitative result scores by category and country income. For several categories, evidence on low-income countries is missing in our evidence base.

The perhaps most notable finding is that the evidence base for non-high-income countries is less favourable for the categories *value of space* and *mode choice* and more negative for *job access* and *services access*, suggesting larger costs of density related to transport (Figure 7). The evidence base for non-high-income countries is also more favourable for the category safety, suggesting a larger presence of 'eyes on the street' (Jacobs 1961). Some care is warranted with the interpretation, however, due to the thin evidence base for non-high-income countries. For a tabulation of further attributes of studies using data from non-high-income countries see section 4 in the appendix.

Fig. 7. Mean of qualitative score by categories and country income



Notes: Unconditional and unweighted means. High-income definition from the World Bank.

5.3 Multivariate analysis of results

The descriptive analysis above reveals several dimensions along which the qualitative results in the evidence base seem to vary. To explore how different attributes are conditionally correlated with the results in the literature we employ two simple multivariate regression models:

$$L_{S,D,E} = F_S a + \mu_D + \eta_{E \neq A} + \varepsilon_{S,D,E} \quad (2a)$$

$$L_{S,D,E} = F_S a + (\mu_D \times \eta_E) + \varepsilon_{S,D,E} \quad (2b)$$

, where $L_{S,C,D} = (-1,0,1)$ is the qualitative result score of an analysis S, concerned with an outcome category $D = (1,2,\dots,15)$ and a compact city characteristic $E = (A, B, C)$, both of which are discussed in more detail in section 2.2. F_S is a vector of study attributes such as the ones considered in the previous section, a is a vector of associated marginal effects, μ_C and η_D are category and characteristics fixed effects, and $\varepsilon_{S,C,D}$ is an error term. Model (2a) is designed to provide estimates of the conditional means of the qualitative result scores by outcome category (the category fixed effects μ_D) treating compact city characteristics analysed as further attributes that are controlled for (with economic density A being the baseline category). Since it is likely that the characteristics (A,B,C) effects are specific to categories (1–15), we use category x characteristics fixed effects ($\mu_D \times \eta_E$) in model 2b. The conditional means are then estimated for each category-characteristics combination.

We choose to report the results from OLS estimations of models (2a) and (2b) here because of the ease of interpretation and the compactness of the presentation. We also infer the marginal effects on the average probability of observing a positive or a negative outcome from multinomial logit models. We note that the results support the interpretations that follow and refer the interested reader to appendix section 4.2 for details.

The estimation results of model (2a) are in Table 8. The first model (1) provides estimates of category-specific conditional means controlling exclusively for compact city characteristics. Model (2), in addition) controls for the study area (non-high-income country data), discipline (economics), geographic scale of analysis (within-city), publication venue (journal), the stage at which a study was added to the evidence base (Round 3), the publication year (a time trend with a zero value in 2000), and the quality of the evidence (SMS dummies, base category SMS=2). With the exception of the time trend, all control variables are encoded as dummy variables that take a value of one if they belong to the listed category, and zero otherwise. Instead of controlling for quality, Model (3) weights observations by the quality of the evidence. The standard practice of weighting observations inversely to standard errors of estimated coefficients is not applicable to and not appropriate for an evidence base as diverse as the one analysed here. More generally, the quality-weighting is desirable because, unlike a standard error of an estimated coefficient, it takes into account the strength of the identification of a result.

The results of the multivariate regressions confirm the notion emerging from the descriptive evidence that there is a positive time trend in the propensity of research finding positive compact city effects. Similarly, our discretionary additions to the evidence base (including recommendations by our networks) are significantly more favourable than the analyses identified in the systematic search. Within-city analyses have a significantly higher propensity of finding positive results than between-city analyses, pointing to a special role of compactness at local level. The results further confirm that the effects of compact urban form tend to be less positive when inferred from data from non-high-income countries. The effects of these attributes are relatively large as they correspond to a shift in the index value of one-tenth (Round 3) to one-sixth (non-high-income, within-city, 25 years) of the index range (-1 to 1). As for the compact city characteristics, the quality-weighted mix-adjusted results in column (3) suggest that mixed land use is generally found to have less positive effects than other compact city characteristics in the empirical literature. The effect on the index is large even compared to the largest attribute effects.

The category effects offer a number of novel insights when compared to the unconditional distributions reported in Table 8. The mean of the (-1/0/1) qualitative result score is not statistically significantly and positive for *value of space*, *job accessibility, services access, social equity, safety, energy efficiency, and sustainable mode choice,* once we control for the characteristics and attribute mix and take into account the evidence quality. *Productivity*, *innovation*, and *public services efficiency* have significantly positive mean index scores and can be regarded as the categories where the positive effects of compact urban form are least controversial. In line with descriptive evidence, *open space preservation*, *traffic flow*, *health,* and *well-being* are the categories where compactness has negative effects. The conditional *pollution reduction* index mean is not statistically significantly different from zero, but is more negative than the descriptive evidence would suggest.

Tab. 8. Multivariate analysis of results I

	(1)		(2)		(3)	
	Result: -1: Negative; 0: Insignificant; 1: Positive					
01 Productivity	0.914***	(0.06)	0.763***	(0.25)	0.721***	(0.20)
02 Innovation	0.707***	(0.21)	0.583**	(0.29)	0.709***	(0.24)
03 Value of space	0.499***	(0.18)	0.283	(0.26)	0.280	(0.24)
04 Job accessibility	0.257	(0.23)	-0.034	(0.26)	-0.006	(0.27)
05 Services access	0.596***	(0.19)	0.244	(0.26)	0.159	(0.23)
06 Efficiency of public services delivery	0.634***	(0.18)	0.432*	(0.24)	0.441**	(0.22)
07 Social equity	0.400	(0.30)	0.265	(0.36)	0.407	(0.30)
08 Safety	0.558***	(0.18)	0.123	(0.24)	0.214	(0.23)
09 Open space preservation and biodiversity	-0.665**	(0.28)	-1.092***	(0.33)	-1.337***	(0.24)
10 Pollution reduction	0.081	(0.26)	-0.283	(0.32)	-0.231	(0.32)
11 Energy efficiency	0.493***	(0.15)	0.205	(0.25)	0.209	(0.24)
12 Traffic flow	-0.236	(0.36)	-0.402	(0.40)	-0.703**	(0.32)
13 Sustainable mode choice	0.789***	(0.07)	0.288	(0.21)	0.275	(0.21)
14 Health	-0.549***	(0.20)	-0.835***	(0.26)	-0.926***	(0.26)
15 Well-being	-0.554***	(0.20)	-0.824***	(0.24)	-0.850***	(0.17)
B Morphological density	-0.069	(0.13)	-0.017	(0.14)	0.072	(0.14)
C Mixed land use	-0.208	(0.28)	-0.181	(0.30)	-0.596*	(0.34)
Non-high-income country			-0.182	(0.15)	-0.253*	(0.15)
Economics			-0.120	(0.14)	-0.089	(0.11)
Within-city			0.333***	(0.11)	0.329***	(0.12)
Academic journal			0.099	(0.14)	0.126	(0.13)
Round 3			0.221**	(0.10)	0.202**	(0.09)
Year - 2000			0.010*	(0.01)	0.005	(0.01)
SMS = 0			-0.016	(0.20)		
SMS = 1			-0.028	(0.17)		
SMS = 3			-0.141	(0.15)		
SMS = 4			-0.033	(0.15)		
Weighted by Quality	-		-		Yes	
Observations	321		321		321	
R2	0.421		0.463		0.524	

Notes: Standard errors in parentheses. Quality weights are proportionate to SMS except for SMS = 0, which receives a weight of 0.5. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

The estimation results of Model (2b) are in Table 9. We only report our preferred specification in which we control for attributes and weight by quality. The results are mostly in line with the unconditional means reported in Table 7. Because of this and due to the great variety of information contained in Table 9, to save space we refrain from discussing every individual effect. We concentrate on the novel findings that emerge from the results and refer to the discussion around Table 7 for other effects that still apply. One of the few novel insights is the effect of morphological density on *innovation*, which is negative and statistically significant. Another important insight arises from the comparison to Table 8. While mixed land use appears as a less favourable compact city characteristic in Table 8, the disaggregation of mixed-use effects by category reveals that the average negative effect is driven by a singular category: *value of space*. In three of the five categories for which mixed-use effects have been investigated, the effects tend to be positive (for two the effects are significant). The important conclusion from Table 9 is that even after controlling for attribute mix and adjusting for quality, the effects of urban compactness are specific to combinations of outcomes and characteristics. With few exceptions, generalising the evidence to averages within outcome categories comes at the cost of losing important information.

Tab. 9. Multivariate analysis of results II

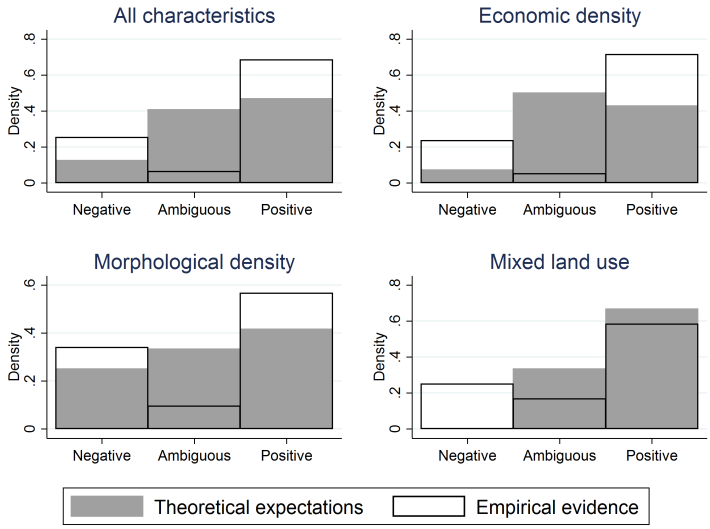
	(1)					
	Result: -1: Negative; 0: Insignificant; 1: Positive					
	A Economic density		B Morph. Density		C Mixed land use	
01 Productivity	0.690***	(0.19)				
02 Innovation	0.728***	(0.25)	-0.432**	(0.19)		
03 Value of space	0.359	(0.26)	0.560**	(0.28)	-1.421***	(0.19)
04 Job accessibility	0.040	(0.28)	-0.637	(0.44)	0.056	(0.28)
05 Services access	0.093	(0.24)	0.548***	(0.17)		
06 Efficiency of public services delivery	0.383	(0.23)	0.845***	(0.13)		
07 Social equity	0.386	(0.30)				
08 Safety	0.338	(0.23)	-0.600	(0.54)		
09 Open space preservation and biodiv.	-1.382***	(0.19)	-1.201***	(0.27)		
10 Pollution reduction	-0.101	(0.35)	-1.394***	(0.19)		
11 Energy efficiency	0.235	(0.25)	0.109	(0.39)	0.509**	(0.18)
12 Traffic flow	-1.040***	(0.26)	-0.259	(0.25)	0.566**	(0.24)
13 Sustainable mode choice	0.207	(0.21)	0.567***	(0.19)	-0.198	(0.46)
14 Health	-0.959***	(0.27)	-0.717	(0.55)		
15 Well-being	-0.934***	(0.17)	-0.134	(0.67)		
Non-high-income country	-0.248*	(0.14)				
Economics	-0.046	(0.11)				
Within-city variation	0.310**	(0.12)				
Academic journal	0.149	(0.13)				
Round 3	0.248***	(0.09)				
Year – 2000	0.002	(0.01)				
Weighted by quality	Yes					
Observations	321					
R^2	0.573					

Notes: Standard errors in parentheses. Quality weights are proportionate to SMS except for SMS = 0, which receives a weight of 0.5. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

5.4 Comparison to theoretical expectations

Figure 8 compares the expected effects of each compact city characteristic (*negative/ambiguous/positive*), derived from our overview of the theoretical literature, with the tendencies (*negative/insignificant/positive*) of the collected empirical evidence. The evidence not only confirms that the effects of compact city characteristics are predominantly positive, but suggests that they are perhaps even more positive than theoretically expected, especially for economic and morphological density. Although no negative effects were derived from mixed land use in the theoretical literature, the evidence suggests that this compact city characteristic is not as positive as many urban theorists would have thought.

Fig. 8. Trends of compact city characteristics: Theoretical vs. Empirical

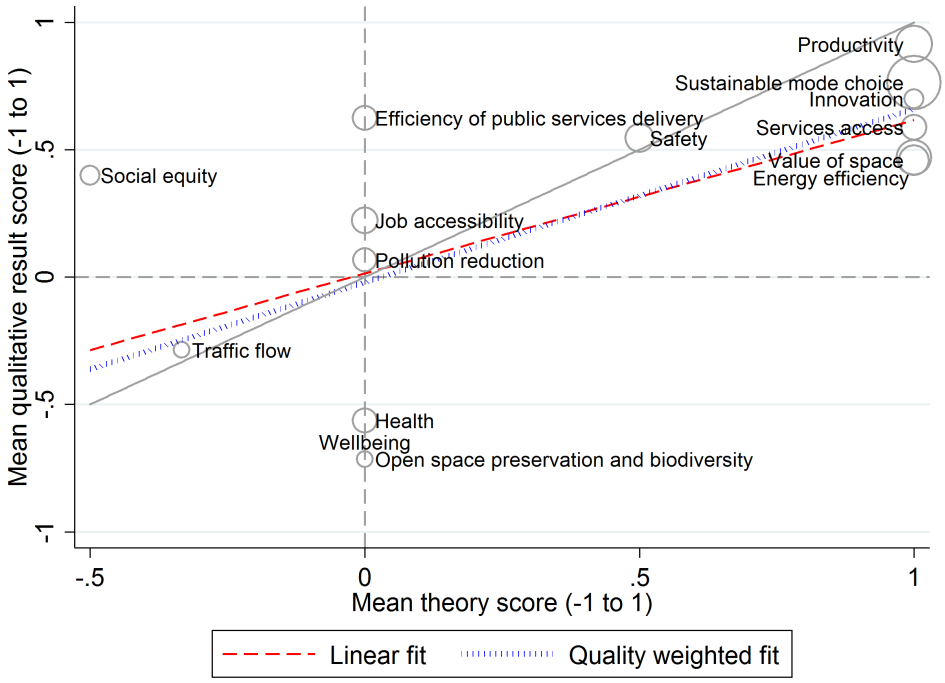


Notes: Empirical results in the category "ambiguous" are those which were found to be statistically insignificant. Figure 8 combines Figures 1 and 4 in sections 2.3 and 5.1 respectively.

In Figure 9, we compare the empirical results in the evidence base to the predictions and expectations prevailing in the theoretical literature. We do this at the level of outcome categories, acknowledging that we lose important information on the within-category effects of different compact city characteristics. For this purpose, we construct a simple index of theoretical expectations based on the qualitative information summarised in Table 3. In line with the qualitative result index, we assign values of -1/0/1 to each outcome-characteristics cell if the expectations are *negative/ambiguous/positive*. We then take the naïve average across characteristics within outcome categories, which results in an index that can range from -1 to 1. We then correlate this index with the quantitative result index, which is the unweighted (dashed fit) and quality weighted (dotted fit) mean of qualitative result scores (also ranging from -1 to 1 as discussed above) within categories.

We find an evidently positive correlation, which reflects that the theoretical expectations in the compact city literature generally align well with the evidence base. For the categories where theoretical effects are ambiguous, we find that *public services provision* empirically turns out to have positive effects, while the opposite is true for *health*, *well-being* and *open space preservation*. The most notable inconsistency between theory and empirics concerns *social equity*. The theoretical literature predicts negative effects, but the empirical evidence is surprisingly positive. It is worth noting that the empirical results in the evidence base are driven by several within-city scale case studies and that the standard inequality measures in the OECD regional statistics data base tend to increase in density (Ahlfeldt & Pietrostefani 2017) the mechanisms affecting equity dimensions are different on a within-city (segregation) and a between-city (skill complementarity) scale.

Fig. 9. Theoretical expectations vs. empirical findings



Notes: Mean theory score is the within-category mean across the characteristics-specific theoretical expectations illustrated in Figure 2, where *positive* is coded as 1, *ambiguous* is coded as 0, and *negative* is coded as -1. Mean qualitative result score is the within-category mean of the analyses results (in the qualitative results scores defined in section 4) where *positive and significant* is coded as 1, insignificant is coded as 0, and *negative and significant* is coded as -1

6 Conclusion

We provide the first quantitative evidence-review of the effects of compact city characteristics on a broad range of outcomes. In line with theoretical implications, the empirical evidence suggests that

compact urban form generally has positive effects. Of 321 reviewed analyses in 189 studies, 69% report positive effects. The mean result is positive in 11 out of 15 categories. For eight of these 11 categories, the positive mean result is statistically significant. Only three categories, however, pass the same test once we control for the various attributes of the analyses and weight the results by the rigor of the applied methods. Across the entire evidence base, the positive effects of urban compactness on productivity and innovation are the least controversial. There is also some consensus that compact urban form is associated with sustainable transport modes (non-automobile), improved services access (including consumption amenities), lower crime rates, social equity, higher value of space, shorter trip lengths, lower energy consumption, and more efficient provision of local public services. Negative effects are reported for health, subjective well-being, traffic flow (congestion), and open space preservation. Evidence is mixed regarding the effects on pollution concentration. These category-specific tendencies mask significant heterogeneity within categories as the effects of compact city characteristics such as economic density, morphological density, and mixed land use can show qualitatively different results on the same outcome. The evidence is more ambiguous when considered for combinations of the three compact city characteristics and the 15 outcome categories. Of the 33 outcome-characteristics combinations in the evidence base, the mean result is positive for 19 and negative for 14 combinations. Characteristics effects vary qualitatively within six out of 15 outcome categories while all characteristics have positive and negative effects on selected outcomes. A major insight from our theoretical and empirical review is that the effects of compact urban form are best described at the disaggregated level of outcome-characteristics combinations.

The quality and the quantity of the evidence base, however, varies significantly across categories of outcomes and characteristics and is non-existent for several theoretically relevant outcome-characteristics combinations. Compared to the outcome categories productivity and mode choice, the evidence base is thin within most outcome categories and sometimes inconsistent. In particular, more research is required to understand the effects of compact urban form on the outcomes urban green, income inequality, pollution, health, and well-being. In general, the effects of morphological density (characteristics of the built environment) and mixed land use are priority areas for further research.

Finally, we note that the evidence reviewed here, in general, is best suited to infer likely effects of compact city policies at the level of areas, not individuals. The reviewed evidence suggests that places may benefit from such policies in various terms. A positive effect on the area-average of an

individual-level outcome (e.g. productivity, innovation, or well-being), however, does not necessarily imply that people and firms already located in an area will benefit because positive area-based effects may be driven by relocations into the targeted area as well as displacement due to rising rents.

Literature

Ahlfeldt, G.M. & Pietrostefani, E., 2017. The Economic Effect s of Density : A Synthesis. *SERC discussion paper 210*, (January).

Ahlfeldt, G.M., Redding, S.J., Sturm, D.M. & Wolf, N., 2015. The Economics of Density: Evidence from the Berlin Wall. *Econometrica*, 83(6), pp.2127–2189.

Alexander, E., 1993. Density measures: A review and analysis. *Journal of Architectural and Planning Research*, 10(3), pp.181–202.

Angel, S., Sheppard, S.C., Civco, D.L., Buckley, R., Chabaeva, A., Gitlin, L., Kraley, A., Parent, J. & Perlin, M., 2005. *The Dynamics of Global Urban Expansion*, Washington D.C.

Bechle, M.J., Millet, D.B. & Marshall, J.D., 2011. Effects of income and urban form on urban NO2: global evidence from satellites. *Environmental Science and Technology*, 45(11), p.4 914-4 919.

Beer, A., 1994. Spatial inequality and locational disadvantage. *Urban Policy and Research*, 12(3), pp.181–199.

Bonfantini, B., 2013. Centri Storici: infrastrutture per l'urbanità contemporanea. *Territorio*, 64, pp.153–161.

Boyko, C.T. & Cooper, R., 2011. Clarifying and re-conceptualising density. *Progress in Planning*, 76(1), pp.1–61.

Braga, A.A. & Weisburd, D., 2010. *Policing Problem Places: Crime Hot Spots and Effective Prevention*, Oxford & New York: Oxford University Press.

Burgess, R. & Jenks, M., 2002. *Compact cities: sustainable urban forms for developing countries*, London ; New York: E. & F.N. Spon.

Burton, E., 2003. Housing for an Urban Rennaissance. *Housing Studies*, 18(4), pp.537–562.

Burton, E., 2002. Measuring urban compactness in UK towns and cities. *Environment and Planning B: Planning and Design*, 29(2), pp.219–250.

Burton, E., 2000. The Compact City: Just or Just Compact? A Preliminary Analysis. *Urban Studies*, 37(11), pp.1969–2006.

Burton, E., 2001. The Compact City and Social Justice. *Housing, Environment and sustainability*, (April), pp.1–16.

Burton, E., Jenks, M. & Williams, K., 2003. *The compact city: a sustainable urban form?*, London & New York: E & FN Spon.

Carruthers, J.I. & Ulfarsson, G.F., 2003. Urban sprawl and the cost of public services. *Environment and Planning B: Planning and Design*, 30(4), pp.503–522.

Cervero, R. & Duncan, M., 2003. *Walking, Bicycling, and Urban Landscapes: Evidence from the San Francisco Bay Area*,

Cervero, R. & Kockelman, K., 1997. Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research Part D: Transport and Environment*, 2(3), pp.199–219.

Cheshire, P.C., 2006. Resurgent Cities, Urban Myths and Policy Hubris: What We Need to Know.

Urban Studies, 43(8), pp.1231–1246.

Cheshire, P.C. & Hilber, C.A.L., 2008. Office Space Supply Restrictions in Britain: The Political Economy of Market Revenge*. *The Economic Journal*, 118(529), pp.F185–F221.

Chhetri, P., Han, J.H., Chandra, S. & Corcoran, J., 2013. Mapping urban residential density patterns: Compact city model in Melbourne, Australia. *City, Culture and Society*, 4(2), pp.77–85.

Chu, A., Thorne, A. & Guite, H., 2004. The impact on mental well-being of the urban and physical environment: an assessment of the evidence. *Journal of Mental Health Promotion*, 3(2), pp.17–32.

Churchman, A., 1999. Disentangling the Concept of Density. *Journal of Planning Literature*, 13(4), pp.389–411.

Combes, P.-P., Duranton, G., Gobillon, L., Puga, D. & Roux, S., 2012. The Productivity Advantages of Large Cities: Distinguishing Agglomeration From Firm Selection. *Econometrica*, 80(6), pp.2543–2594.

Dantzig, G.B. & Saatay, T.L., 1973. *Compact city : a plan for a liveable urban environment*, San Francisco: Freeman and Co.

Dieleman, F. & Wegener, M., 2004. Compact City and Urban Sprawl. *Built Environment*, 30(4), pp.308–323.

Epple, D., Gordon, B. & Sieg, H., 2010. American Economic Association A New Approach to Estimating the Production Function for Housing. *American Economic Review*, 100(3), pp.905–924.

Ewing, R. & Cervero, R., 2010. Travel and the Built Environment: A Synthesis. *Journal of the American Planning Association*, 76(3), pp.265–294.

Farrington, D.P. & Welsh, B.C., 2008. Effects of improved street lighting on crime: a systematic review. *Campbell Systematic Reviews*, (13), p.59.

Geurs, K. & van Wee, B., 2006. Ex-post evaluation of thirty years of compact urban development in the Netherlands. *Urban Studies*, 43(1), pp.139–160.

Glaeser, E.L., Kolko, J. & Saiz, A., 2001. Consumer city. *Journal of Economic Geography*, 1(1), pp.27–50.

Gleeson, B., 2013. What Role for Social Science in the "Urban Age"? *International Journal of Urban and Regional Research*, 37(5), pp.1839–1851.

Gordon, P. & Richardson, H.W., 1997. Are Compact Cities a Desirable Planning Goal? *Journal of the American Planning Association*, 63(1), pp.95–106.

Helm, D., 2015. *Natural capital : valuing our planet*,

Hitchcock, J., 1994. *A primer on the use of density in land use planning.*, Toronto, Canada.

Holman, N., Mace, A., Paccoud, A. & Sundaresan, J., 2014. Coordinating density; working through conviction, suspicion and pragmatism. *Progress in Planning*, 101, pp.1–38.

IAU-IDF, 2012. *Document d'orientations stratégiques pour le fret en Ile-de-France à l'horizon 2025*, Direction régionale et interdépartementale de l'Équipement et de l'Aménagement d'Île-de-France: Paris.

Ikin, K., Beaty, R.M., Lindenmayer, D.B., Knight, E., Fischer, J. & Manning, A.D., 2013. Pocket parks in a compact city: how do birds respond to increasing residential density? *Landscape Ecology*, 28(1), pp.45–56.

Jacobs, J., 1961. *The death and life of great American cities*, New York: Random House.

Jones, C., Leishman, C., MacDonald, A. & Watkins, D., 2010. "Economic viability." In Springer, ed. *Dimensions of the Sustainable City*. Oxford, UK.

Knox, P.L., 2011. *Cities and design*, New York: Routledge.

Laws, G., 1994. Oppression, knowledge and the built environment. *Political Geography*, 13, pp.7–32.

Marshall, A., 1920. *Principles of Economics; An Introductory Volume*, London, UK: Macmillan and Co.

Maskell, P. & Malmberg, A., 2007. Myopia, knowledge development and cluster evolution. *Journal of Economic Geography*, 7(5), pp.603–618.

Matsumoto, T., 2011. Compact City Policies : Comparative Assessment. In *Compact City Policies: Comparative Assessment, 47th ISOCARP Congress 2011*. pp. 1–12.

Melo, P.C., Graham, D.J. & Brage-Ardao, R., 2013. The productivity of transport infrastructure investment: A meta-analysis of empirical evidence. *Regional Science and Urban Economics*, 43(5), pp.695–706.

Melo, P.C., Graham, D.J. & Noland, R.B., 2009. A meta-analysis of estimates of urban agglomeration economies. *Regional Science and Urban Economics*, 39(3), pp.332–342.

Neuman, M., 2005. The Compact City Fallacy. *Journal of Planning Education and Research*, 25(1), pp.11–26.

O'Toole, R., 2001. *The vanishing automobile and other urban myths : how smart growth will harm American cities*, Thoreau Institute.

OECD, 2010. *Cities and Climate Change*, OECD Publishing.

OECD, 2012. *Compact City Policies: A Comparative Assessment*, OECD Green Growth Studies, OECD Publishing.

Radberg, J., 1996. Towards a theory of good urban form. In *14th conference of the International Association for People- Environment Studies July 30-August 3*. Stockholm: Sweden.

Rode, P., Keim, C., Robazza, G., Viejo, P. & Schofield, J., 2014. Cities and Energy: Urban Morphology and Residential Heat-Energy Demand. *Environment and Planning B: Planning and Design*, 41(1), pp.138–162.

Roo, G. de. & Miller, D., 2000. *Compact cities and sustainable urban development : a critical assessment of policies and plans from an international perspective*, Aldershot Hampshire England ;;Burlington VT: Ashgate.

Rydin, Y., 1992. Environmental dimensions of residential development and the implications for local planning practice. *Journal of Environmental Planning and Management*, 35(1), pp.43–61.

Savage, M., 1988. London School of Economics The Missing Link ? The Relationship between Spatial Mobility and Social Mobility The British Journal of Sociology. *The British Journal of Sociology*, 39(4), pp.554–577.

Schiff, N., 2015. Cities and product variety: Evidence from restaurants*. *Journal of Economic Geography*, 15(6), pp.1085–1123.

Schläpfer, M., Lee, J. & Bettencourt, L.M.A., 2015. Urban Skylines: building heights and shapes as measures of city size. , pp.1–17.

Schwanen, T., Dieleman, F. & Dijst, M., 2004. Policies for urban form and their impact on travel: the Netherlands experience. *Urban Studies*, 41(3), pp.579–603.

Shopping Centre Council of Australia, 2011. *Activity Centres Policy Benefits: Final Report*,

Stanley, T.D., 2001. Wheat From Chaff: Meta-Analysis As Quantitative Literature Review. *Journal of Economic Perspectives*, 15(3), pp.131–150.

Tang, C.K., 2015. Urban Structure and Crime. *Working Paper*.

Thomas, L. & Cousins, W., 1996. A new compact city form: concepts in practice. In M. Jenks, E. Burton, & K. Williams, eds. *The Compact City: A Sustainable Urban Form?*. Oxford, UK.

Thompson, H., 2013. *Green Belt Critique*, Cambridge South Consortium.

Troy, P., 1992. The evolution of government housing policy: The case of new south Wales 1901–41. *Housing Studies*, 7(3), pp.216–233.

Troy, P., 1996. *The perils of urban consolidation*, Sydney, Australia: The Federation Press.

Vorontsova, A.V., Vorontsova, V.L. & Salimgareev, D.V., 2016. The Development of Urban Areas and Spaces with the Mixed Functional Use. *Procedia Engineering*, 150, pp.1996–2000.

What Works Centre for Local Economic Growth (WWC), 2016. *Guide to scoring evidence using the Maryland Scientific Methods Scale*, London, UK.

Williams, K., Jenks, M. & Burton, E., 2000. *Achieving Sustainable Urban Form* Routledge, ed.,

Wilson, G. & Baldassare, M., 1996. Overall "sense of community" in a suburban region: The effects of localism, privacy and urbanization. *Environment and Behavior*, 28(1), pp.27–43.

Wolsink, M., 2016. "Sustainable City" requires "recognition"-The example of environmental education under pressure from the compact city. *Land Use Policy*, 52, pp.174–180.

World Bank, 2010. Cities and climate change: An urgent agenda. Available at: http://web.worldbank.org/ WBSITE/EXTERNAL/TOPICS/EXTURBANDEVELOPMENT/%0AEXTUWM/0,,contentMDK:22781089$pagePK:210058$ piPK:210062$theSitePK:341511,00.html [Accessed March 4, 2017].

World Bank, 2015. New Country Classifications | The Data Blog. Available at: http://blogs.worldbank.org/opendata/new-country-classifications [Accessed October 14, 2016].

World Health Organization (WHO), 2011. *Health co-benefits of climate change mitigation-Transport sector: Health in the green economy*, Geneva, Switzerland.

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Appendix to The compact city in empirical research: A quantitative literature review

Version: June 2017

1 Introduction

This appendix complements the main paper by providing additional detail not reported in the main paper for brevity. Because of the shared evidence base, the description of the evidence collection overlaps with parts of the technical appendix to a companion paper focusing on the analysis of density elasticities (Ahlfeldt & Pietrostefani 2017). This appendix is not designed to replace the reading of the main paper nor the reading of the appendix to our companion paper.

2 Theory

Table A1 provides the sources underlying Table 3 in the main paper. To allow for straightforward cross-reference Table A1 uses the same structure as Table 3.

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Tab. A1. Theoretically expected effects of compact urban development on various outcomes: Sources

	Compact city effects	Compact city characteristics		
#	Outcome category	Residential and employment Density	Morphological Density	Mixed use
1	Productivity	(Marshall 1920; Neuman 2005; OECD 2012)	-	-
2	Innovation	(Jones et al. 2010; Maskell & Malmberg 2007)	-	-
3	Value of space	(Alonso-Mills-Muth model; Rosen and Roback framework)	(Alexander 1993; Churchman 1999; Glaeser et al. 2001; Knox 2011; Epple et al. 2010)	-
4	Job accessibility	(Beer 1994; Laws 1994; Dieleman & Wegener 2004)	(Neuman 2005)	-
5	Services access	(Churchman 1999; Burton 2000; Burton 2002)	(Bonfantini 2013)	(Churchman 1999)
6	Efficiency of public services delivery	(Matsumoto 2011; Troy 1996; Carruthers & Ulfarsson 2003)	(Troy 1992)	-
7	Social equity	(Burton 2000; Savage 1988; Grusky & Fukumoto 1989; Gordon & Richardson 1997; Breheny 1997)	(Radberg 1996)	-
8	Safety	(Burton 2000; Chhetri et al. 2013; Braga & Weisburd 2010; Jacobs 1961)	(Tang 2015; Farrington & Welsh 2008)	
9	Open space preserva-tion and biodiversity	(Neuman 2005; Wolsink 2016)	(Chhetri et al. 2013; Dieleman & Wegener 2004; Ikin et al. 2013; Burton et al. 2003)	-
10	Pollution reduction	(Bechle et al. 2011; Troy 1996)	(Churchman 1999; Troy 1996)	(Bechle et al. 2011; World Health Organization (WHO) 2011)
11	Energy efficiency	-	(Neuman 2005; Gordon & Richardson 1997; Rode et al. 2014)	(OECD 2012)
12	Traffic flow	(Burton et al. 2003; Rydin 1992)	(Churchman 1999)	(Churchman 1999)
13	Sustainable mode choice	(Churchman 1999; Burton 2000; Neuman 2005)	(Thomas & Cousins 1996; Neuman 2005; Churchman 1999)	(Thomas & Cousins 1996; Neuman 2005; Churchman 1999)
14	Health	(Troy 1996; Burton 2000; Matsumoto 2011)	-	-
15	Wellbeing	(Churchman 1999; Wilson & Baldassare 1996; Chu et al. 2004)	(Burton 2000; Hitchcock 1994)	(Churchman 1999; Vorontsova et al. 2016; World Health Organization (WHO) 2011)

Notes: The categories and theoretical channels are potentially non-exhaustive and are restricted to those discussed in the theoretical literature. The direction of the theoretically expected effects are borrowed from that literature. References for each effects-characteristics cell are presented in Table A1 to keep the presentation compact.

3 Evidence Base

Table A2 provides the selection of keywords used for the collected of evidence. They are guided by our theory matrix and allow for a transparent and theory-consistent literature search. We run searches that are specific to combinations of outcomes and characteristics. In each case, we use combinations of keywords that relate to the outcome (where appropriate, we use empirically observed variables listed in Table 3) and the compact city characteristic. We usually use the term density in reference to economic density and a more specific term to capture the relevant aspect of morphological density. In several instances, we run more than one search for an outcome-characteristics combination to cover different empirically observed variables and, thus, maximise the evidence base. We note that because this way our search focuses directly on specific features that make cities "compact," we exclude the phrase 'compact city' itself in all searches. Adding related keywords did not improve the search outcome in several trials, which is intuitive given that, by itself, "compactness" is not an empirically observable variable. In total, we consider the 52 keyword combinations (for 32 theoretically relevant outcome-characteristic combinations) summarised in Table A2 which we apply to five databases, resulting in a total of 260 keyword searches.

We note that Google Scholar, unlike the other databases, tends to return a vast number of documents, ordered by potential relevance. In several trials preceding the actual evidence collection, we found that the probability of a paper being relevant for our purposes was marginal after the 50th entry. Therefore, in an attempt to keep the literature search efficient we generally did not consider documents beyond this threshold.

Occasionally, a study contains evidence that is relevant to more than one category in which case it is assigned to multiple categories. We generally refer to such distinct pieces of evidence within our study as *analyses*. We do not double count any publication when reporting the total number of *studies* throughout the paper. Based on the evidence collected in step one (keyword search), we then conduct an analysis of citation trees in the second step of our literature search. In particular, we select a random sample of studies within each category and evaluate to what extent these studies refer to empirically relevant work that was not picked up by our keyword search. For all but two categories, we find that the evidence is reasonably self-contained in the sense that the studies identified by the keyword search tend to cite each other but no other rel-

evant work. Only for *health* and *well-being* did the analysis of citation trees point us to additional literature strands.

Tab. A2. Organization of keyword search

	Compact city effects	Compact city characteristics		
#	Outcome category	Residential and employment Density	Morphological Density	Mixed use
1	Productivity	density; productivity; wages; urban	-	-
		density; productivity; rent; urban	-	-
2	Innovation	density; innovation; patent; urban	-	-
		density; innovation; peer effects, urban	-	-
3	Value of space	density; land value; urban	building height; land value; urban	-
		density; rent; urban	building height; rent; urban	-
		density; prices; urban	building height; prices; urban	-
4	Job accessibility	density; commuting; urban	land border; commuting; urban	-
5	Services access	density; amenity; distance; urban	street; amenity; distance; urban	mixed use; amenity; distance; urban
		density; amenity; consumption; urban	street; amenity; consumption; urban	mixed use; amenity; consumption; urban
6	Eff. of public services	density; public transport delivery; urban	building height; public transport delivery; urban	-
		density; waste; urban	street; waste; urban	-
7	Social equity	density; real wages; urban	building height; real wages; urban	-
		density; segregation; urban	building height; segregation; urban	-
		density; “social mobility”; urban	street; “social mobility”; urban	-
8	Safety	density; crime; rate; urban	building height; crime; urban	-
		density; open; green; space; urban	land border; open; green; space; urban	-
9	Open space	density; green; space; biodiversity; urban	land border; green; space; biodiversity; urban	-
10	Pollution reduction	density; pollution; carbon; urban	building height; pollution; carbon; urban	mixed use; pollution; carbon; urban
		density; pollution; noise; urban	building height; pollution; noise; urban	mixed use; pollution; noise; urban
11	Energy efficiency	-	building height; energy; consumption; urban	mixed use; energy; consumption; urban
12	Traffic flow	density; congestion; road; urban	Street layout; congestion; road; urban	mixed use; congestion; road; urban
13	Mode choice	density; mode; walking; cycling; urban	street; mode; walking; cycling; urban	mixed use; mode; walking; cycling; urban
14	Health	density; health; risk; mortality; urban	-	-
15	Well-being	density; well-being; happiness; perception; urban	space; well-being; perception; urban	mixed use; well-being; perception; urban

Notes: Each outcome- characteristics cell contains one or more (if several rows) combinations of keywords each used in a separate search. In each cell we use a combination of keywords based on effects (related to the outcome category or typically observed variables) and characteristics (related to residential and employment density, morphological density or mixed use). Outcome-characteristics cells map directly to Table 3.

In Table A3 we summarize the collection process of the evidence base. We present the number of studies found by category and the stage at which they were added to the evidence base.

Tab. A3. Evidence collection: Distribution of analyses

#	Outcome	Google Scholar	Web of Science	EconLit	CesIfo	Step 2	Step 3	Total
1	Productivity	11	3	5	0	3	10	32
2	Innovation	4	1	2	1	0	1	9
3	Value of space	6	1	6	1	1	7	22
4	Job accessibility	3	1	3	0	3	5	15
5	Services access	2	0	1	0	0	7	10
6	Efficiency of public services delivery	2	0	1	0	0	3	6
7	Social equity	3	1	0	0	4	1	9
8	Safety	2	3	0	0	3	2	10
9	Open space preservation and biodiversity	4	1	0	0	0	0	5
10	Pollution reduction	2	1	1	0	1	2	7
11	Energy efficiency	5	2	2	0	7	5	21
12	Traffic flow	2	0	1	0	1	1	5
13	Sustainable mode choice	7	2	1	0	8	4	22
14	Health	2	1	0	0	4	1	8
15	Well-being	2	0	1	0	0	5	8
	Total	57	17	24	2	35	54	189

Notes: Google Scholar, Web of Science, EconLit, CesIfo searches all part of evidence collection step one. Step 2 contains results from the analysis of evidence from step 1 and studies which were collected during step one but corresponded to a different outcome to the one suggested by the keyword search they were found with. Step 3 consists of previously known evidence and recommendations by colleagues. See section 3 in the main paper for details.

Table 6 reports the mean and standard deviation of the attributes values of the collected analyses.

Tab. A4. Descriptive statistics of attribute values

Attribute	Mean	S.D.
Non-high-income country [a]	0.13	0.34
Academic journal	0.84	0.36
Economics	0.25	0.43
Within-city	0.46	0.50
Round 3	0.37	0.48
Year of publication	2008	8.40
Quality of evidence	2.20	1.10
Positive & significant [b]	0.69	0.47
Insignificant [b]	0.06	0.24
Negative & significant [b]	0.25	0.44
Qualitative result score [c]	0.43	0.87
N	321	

Notes: [a] Non-high-income include low-income and median-income countries according to the World Bank definition. [b] Qualitative results (positive, insignificant, negative) is a category-characteristics specific and defined in Table 5. [c] Qualitative results scale takes the values of 1 / 0 / -1 for positive / insignificant / negative.

4 Results

4.1 Evidence for non-high-income countries

Table A3 summarises the qualitative evidence for non-high-income countries (World Bank definition) by category. Its structure is identical to Table 6 in the main paper, which summarises the entire evidence base.

Tab. A5. Evidence summarised by category: Non-high-income countries

			Proportion				Med.	Mean	Result		
ID	Outcome category	#	Poor[a]	Acad.	Econ.	With.[b]	year[c]	SMS	Pos.	Ins.	Neg.
1	Productivity	4	1.00	1.00	0.75	0.00	2016	3.00	100%	0%	0%
2	Innovation	1	1.00	1.00	0.00	0.00	2009	4.00	100%	0%	0%
3	Value of space	7	1.00	0.57	0.57	0.71	2015	2.14	57%	14%	29%
4	Job accessibility	5	1.00	0.60	0.40	0.60	2010	1.80	40%	0%	60%
5	Services access	3	1.00	1.00	1.00	0.00	2016	3.00	0%	33%	67%
6	Efficiency of public services delivery	-	-	-	-	-	-	-	.%	.%	.%
7	Social equity	-	-	-	-	-	-	-	.%	.%	.%
8	Safety	1	1.00	1.00	0.00	1.00	2014	0.00	100%	0%	0%
9	Open space preservation and biodiversity	-	-	-	-	-	-	-	.%	.%	.%
10	Pollution reduction	8	1.00	0.63	0.00	0.50	2012	2.25	63%	0%	38%
11	Energy efficiency	4	1.00	0.75	0.00	0.25	2013	0.75	75%	0%	25%
12	Traffic flow	2	1.00	1.00	0.00	0.50	1994	1.50	50%	0%	50%
13	Sustainable mode choice	8	1.00	0.75	0.00	1.00	2014	2.00	50%	50%	0%
14	Health	-	-	-	-	-	-	-	.%	.%	.%
15	Well-being	-	-	-	-	-	-	-	.%	.%	.%
	Mean	4	1.00	0.83	0.27	0.46	2011	2.04	63%	10%	27%

Notes: [a] Poor countries include low-income and middle-income countries according to the World Bank definition. [b] Within-city analyses [c] Year of publication. Qualitative results scale (positive, insignificant, negative) is category-characteristics-specific and is defined in Table 1.

4.2 Multinomial logit models

To facilitate the quantitative interpretation of the qualitative results collected in our evidence review, we have created an index assigns values of -1 / 0 / 1 to *negative and significant* / *insignificant* / *positive and significant* results. One advantage of this index is that it allows summarizing the evidence by mean values as singular summary statistics that can be compared across outcome categories, classes of characteristics, or outcome-characteristics cells. The index is also amenable to a transparent multivariate analysis using OLS. Of course, the index involves a strong symmetry assumption, implying that the effect of moving from a negative and significant (-1) to an insignificant result (0) is similar to moving form an insignificant result to a positive and significant result (1).

Acknowledging the categorical nature of our data, the multinomial logit model allows for a multivariate analysis that avoids this assumption. In in our application of this method, we use the same

set of independent variables as in Tables 8 and 9 of the main paper to predict the probabilities of the different outcomes. Concretely, we model the probability of obtaining a positive (and significant) as well as the probability of obtaining a negative (and significant) result relative to the baseline category of an insignificant result. To allow for an intuitive interpretation, we express the results in terms of the average marginal effects on the probabilities of an outcome.

The results are in Table A6, which corresponds to Table 8, column (3) in the main paper, and in Table A7, which corresponds to Table 9 in the main paper. For the results to be qualitatively consistent with the OLS results reported in the main paper, we expect the marginal effect on the probability of observing a positive outcome to have the same sign as the marginal OLS effect. The opposite should be true for the marginal effect of observing a negative effect. As an example, the OLS results reported in Table 8 suggest that ceteris paribus a within-city study is more likely to yield a positive result, but the results do not distinguish between a lower probability of observing a significant negative result and the higher probability of observing a positive result. The multinomial logit model does exactly this, and in the case of within-city studies reveals that the positive effect is driven by an impact on both ends of the qualitative results scale (there is a negative marginal effect on the probability of a negative outcome and a positive effect on the probability of observing positive outcome). The main cost of the multinomial logit models presented in Table A6 and A7 is the inflated amount of information to be digested by the reader as the number of coefficients doubles. Because there is a strong tendency for the results to be consistent in the way described above, we present the OLS results in the main paper and keep the multinomial logit model results to this appendix to inform the interested reader.

Tab. A6. Multinomial logit models: Average marginal effects I

	(1)			
	Outcome: Negative		Outcome: Positive	
01 Productivity	-0.304**	(0.14)	0.449***	(0.14)
02 Innovation	-0.135	(0.14)	0.365***	(0.14)
03 Value of space	-0.001	(0.09)	0.148	(0.11)
04 Job accessibility	0.101	(0.08)	0.008	(0.09)
05 Services access	0.041	(0.09)	0.021	(0.11)
06 Efficiency of public services delivery	-0.089	(0.10)	0.164	(0.10)
07 Social equity	0.169	(0.11)	0.611***	(0.15)
08 Safety	0.292***	(0.11)	0.461***	(0.15)
09 Open space preservation and biodiversity	0.756***	(0.16)	-0.029	(0.20)
10 Pollution reduction	- 0.389***	(0.11)	0.338**	(0.15)
11 Energy efficiency	0.063	(0.09)	0.095	(0.10)
12 Traffic flow	0.260**	(0.12)	-0.265*	(0.14)
13 Sustainable mode choice	-0.012	(0.09)	0.119	(0.10)
14 Health	0.371***	(0.10)	0.265**	(0.13)
15 Well-being	0.333***	(0.08)	-0.257**	(0.06)
B Morphological density	-0.038	(0.05)	0.038	(0.06)
C Mixed land use	0.188*	(0.10)	-0.267**	(0.11)
Non-high-income country	0.054	(0.06)	-0.131**	(0.06)
Economics	0.078	(0.05)	-0.021	(0.06)
Within-city	-0.127***	(0.05)	0.180***	(0.05)
Academic journal	-0.071	(0.05)	0.044	(0.06)
Round 3	-0.062	(0.05)	0.178***	(0.06)
Year - 2000	-0.005**	(0.00)	-0.000	(0.00)
Observations	321			

Notes: Average marginal effects from weighted (by quality) multinomial logit model. Baseline outcome is insignificant. Model excludes constant to avoid multicollinearity with category effects. Quality weights are proportionate to SMS except for SMS = 0, which receives a weight of 0.5. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Tab. A7. Multinomial logit models: Average marginal effects II

	(1)											
	Outcome: Negative						Outcome: Positive					
	A Economic density		B Morph. Density		C Mixed land use		A Economic density		B Morph. Density		C Mixed land use	
01 Productivity	-0.246*	(0.13)					0.375***	(0.13)				
02 Innovation	0.047	(0.13)	0.009	(0.09)			0.749***	(0.17)	-0.785***	(0.16)		
03 Value of space	0.155	(0.12)	-0.194	(0.15)	2.096***	(0.24)	0.593***	(0.15)	0.292*	(0.16)	-1.941***	(024)
04 Job accessibility	0.108	(0.08)	0.356**	(0.15)	-1.568***	(0.20)	0.021	(0.09)	0.320*	(0.19)	1.416***	(0.21)
05 Services access	0.070	(0.09)	-1.508***	(0.21)			-0.039	(0.10)	2.069***	(0.23)		
06 Efficiency of public services delivery	-0.042	(0.09)	-1.616***	(0.22)			0.112	(0.10)	2.210***	(0.24)		
07 Social equity	0.164	(0.11)					0.580***	(0.15)				
08 Safety	0.234*	(0.12)	0.430***	(0.15)			0.502***	(0.16)	0.285	(0.18)		
09 Open space preservation and biodiv.	2.135***	(0.24)	0.612***	(0.15)			-1.881***	(0.24)	0.097	(0.19)		
10 Pollution reduction	0.315***	(0.11)	2.140***	(0.24)			0.383***	(0.14)	-1.869**	(0.24)		
11 Energy efficiency	0.069	(0.09)	0.079	(0.11)	-1.461***	(0.23)	0.082	(0.10)	0.038	(0.17)	2.058***	
12 Traffic flow	0.508***	(0.14)	1.550***	(0.22)	-1.537***	(0.24)	0.166	(0.18)	-2.101***	(0.24)	2.043***	(0.25)
13 Sustainable mode choice	0.043	(0.08)	-1.671***	(0.19)	0.146	(0.14)	0.060	(0.09)	1.646***	(0.20)	-0.110	(0.16)
14 Health	0.357***	(0.11)	0.467***	(0.15)			-0.287**	(0.13)	0.271	(0.19)		
15 Well-being	0.343***	(0.09)	0.349**	(0.15)			-0.322***	(0.12)	0.380*	(0.20)		
Non-high-income country	0.060	(0.07)					-0.146**	(0.06)				
Economics	0.061	(0.05)					0.015	(0.06)				
Within-city	-0.123***	(0.05)					0.151***	(0.05)				
Academic journal	-0.092*	(0.05)					0.053	(0.06)				
Round 3	-0.078*	(0.04)					0.184***	(0.05)				
Year - 2000	-0.003	(0.00)					0.000	(0.00)				
Observations	321											

Notes: Average marginal effects from weighted (by quality) multinomial logit model. Baseline outcome is insignificant. Model excludes constant to avoid multicollinearity with category effects. Quality weights are proportionate to SMS except for SMS = 0, which receives a weight of 0.5. $^{*}p < 0.1$, $^{**}p < 0.05$, $^{***}p < 0.01$

5 Empirical findings by discipline

The evidence considered in our review stems from a variety of disciplines. In the table below we analyse whether there are tendencies across disciplines to view the effects of compart urban form more or less positively. We find that the results, on average, are more positive in social sciences than in other fields (e.g., health, energy) and are particularly positive in planning and transport. There are no stark differences across social sciences, despite notable differences in the methods used (reflected by the adjusted average SMS in the last column).

Tab. A8. Effects by discipline

	(1) Result: -1: Negative; 0: Insignificant; 1: Positive	(2) Result: -1: Negative; 0: Insignificant; 1: Positive	(5) Quality of Evidence (SMS)	(6) Quality of Evidence (SMS)
Economic Geography	0.818***	1.058***	3.273***	3.549***
	(0.18)	(0.27)	(0.19)	(0.40)
Economics	0.400***	0.841***	2.675***	3.184***
	(0.10)	(0.07)	(0.13)	(0.09)
Energy	0.250	0.729**	1.500***	2.754***
	(0.30)	(0.26)	(0.18)	(0.10)
Health	-0.500**	0.428	2.143***	2.728***
	(0.22)	(0.33)	(0.14)	(0.22)
Other	0.043	0.781***	1.681***	2.266***
	(0.15)	(0.19)	(0.16)	(0.33)
Planning	0.709***	1.259***	1.782***	2.359***
	(0.09)	(0.17)	(0.10)	(0.26)
Regional Studies	0.692***	1.020***	2.346***	2.694***
	(0.13)	(0.12)	(0.19)	(0.26)
Transport	0.674***	1.118***	1.907***	2.553***
	(0.10)	(0.16)	(0.17)	(0.15)
Urban Studies	0.405***	0.923***	2.216***	2.761***
	(0.14)	(0.19)	(0.11)	(0.25)
Category effects	-	Yes	-	Yes
Characteristics effects	-	Yes	-	Yes
N	321	321	321	321
r2	0.299	0.447	0.840	0.861

Notes: Regressions excluding constant to allow for category-specific intercepts. Category effects defined for 15 outcome categories. Characteristics effects defined for three compact city characteristics. Standard errors clustered on category effects where category effects are included. * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$.

6 References

Ahlfeldt, G. & Pietrostefani, E., 2017. The Economic Effect s of Density : A Synthesis. *SERC discussion paper 210*, (January).

Alexander, E., 1993. Density measures: A review and analysis. *Journal of Architectural and Planning Research*, 10(3), pp.181–202.

Bechle, M.J., Millet, D.B. & Marshall, J.D., 2011. Effects of Income and Urban Form on Urban NO_2: Global Evidence from Satellites. *Environmental Science & Technology*, 45(11), pp.4914–4919.

Beer, A., 1994. Spatial inequality and locational disadvantage. *Urban Policy and Research*, 12(3),

pp.181–199.
Bonfantini, B., 2013. Centri Storici: infrastrutture per l'urbanità contemporanea. *Territorio*, 64, pp.153–161.
Braga, A.A. & Weisburd, D., 2010. *Policing Problem Places: Crime Hot Spots and Effective Prevention*, Oxford & New York: Oxford University Press.
Breheny, M., 1997. Urban compaction: feasible and acceptable? *Cities*, 97(4), pp.209–217.
Burton, E., 2002. Measuring urban compactness in UK towns and cities. *Environment and Planning B: Planning and Design*, 29(2), pp.219–250.
Burton, E., 2000. The Compact City: Just or Just Compact? A Preliminary Analysis. *Urban Studies*, 37(11), pp.1969–2006.
Burton, E., Jenks, M. & Williams, K., 2003. *The compact city: a sustainable urban form?*, London & New York: E & FN Spon.
Carruthers, J.I. & Ulfarsson, G.F., 2003. Urban sprawl and the cost of public services. *Environment and Planning B: Planning and Design*, 30(4), pp.503–522.
Chhetri, P., Han, J.H., Chandra, S. & Corcoran, J., 2013. Mapping urban residential density patterns: Compact city model in Melbourne, Australia. *City, Culture and Society*, 4(2), pp.77–85.
Chu, A., Thorne, A. & Guite, H., 2004. The impact on mental well-being of the urban and physical environment: an assessment of the evidence. *Journal of Mental Health Promotion*, 3(2), pp.17–32.
Churchman, A., 1999. Disentangling the Concept of Density. *Journal of Planning Literature*, 13(4), pp.389–411.
Dieleman, F. & Wegener, M., 2004. Compact City and Urban Sprawl. *Built Environment*, 30(4), pp.308–323.
Epple, D., Gordon, B. & Sieg, H., 2010. American Economic Association A New Approach to Estimating the Production Function for Housing. *American Economic Review*, 100(3), pp.905–924.
Farrington, D.P. & Welsh, B.C., 2008. Effects of improved street lighting on crime: a systematic review. *Campbell Systematic Reviews*, (13), p.59.
Glaeser, E.L., Kolko, J. & Saiz, A., 2001. Consumer city. *Journal of Economic Geography*, 1(1), pp.27–50.
Gordon, P. & Richardson, H.W., 1997. Are Compact Cities a Desirable Planning Goal? *Journal of the American Planning Association*, 63(1), pp.95–106.
Grusky, D.B. & Fukumoto, I.K., 1989. Social History Update : A Sociological Approach to Historical Social Mobility. *Journal of Social History*, 23(1), pp.221–232.
Hitchcock, J., 1994. *A primer on the use of density in land use planning.*, Toronto, Canada.
Ikin, K., Beaty, R.M., Lindenmayer, D.B., Knight, E., Fischer, J. & Manning, A.D., 2013. Pocket parks in a compact city: how do birds respond to increasing residential density? *Landscape Ecology*, 28(1), pp.45–56.
Jacobs, J., 1961. *The death and life of great American cities*, New York: Random House.
Jones, C., Leishman, C., MacDonald, A. & Watkins, D., 2010. "Economic viability." In Springer, ed. *Dimensions of the Sustainable City*. Oxford, UK.
Knox, P.L., 2011. *Cities and design*, New York: Routledge.
Laws, G., 1994. Oppression, knowledge and the built environment. *Political Geography*, 13, pp.7–32.
Marshall, A., 1920. *Principles of Economics; An Introductory Volume*, London, UK: Macmillan and Co.
Maskell, P. & Malmberg, A., 2007. Myopia, knowledge development and cluster evolution. *Journal of Economic Geography*, 7(5), pp.603–618.
Matsumoto, T., 2011. Compact City Policies : Comparative Assessment. In *Compact City Policies: Comparative Assessment, 47th ISOCARP Congress 2011*. pp. 1–12.
Neuman, M., 2005. The Compact City Fallacy. *Journal of Planning Education and Research*, 25(1), pp.11–26.
OECD, 2012. *Compact City Policies: A Comparative Assessment*, OECD Green Growth Studies, OECD Publishing.
Radberg, J., 1996. Towards a theory of good urban form. In *14th conference of the International Association for People- Environment Studies July 30-August 3*. Stockholm: Sweden.
Rode, P., Keim, C., Robazza, G., Viejo, P. & Schofield, J., 2014. Cities and Energy: Urban Morphology

and Residential Heat-Energy Demand. *Environment and Planning B: Planning and Design*, 41(1), pp.138–162.

Rydin, Y., 1992. Environmental dimensions of residential development and the implications for local planning practice. *Journal of Environmental Planning and Management*, 35(1), pp.43–61.

Savage, M., 1988. London School of Economics The Missing Link ? The Relationship between Spatial Mobility and Social Mobility The British Journal of Sociology. *The British Journal of Sociology*, 39(4), pp.554–577.

Tang, C.K., 2015. Urban Structure and Crime. *Working Paper*.

Thomas, L. & Cousins, W., 1996. A new compact city form: concepts in practice. In M. Jenks, E. Burton, & K. Williams, eds. *The Compact City: A Sustainable Urban Form?*. Oxford, UK.

Troy, P., 1992. The evolution of government housing policy: The case of new south Wales 1901–41. *Housing Studies*, 7(3), pp.216–233.

Troy, P., 1996. *The perils of urban consolidation*, Sydney, Australia: The Federation Press.

Vorontsova, A.V., Vorontsova, V.L. & Salimgareev, D.V., 2016. The Development of Urban Areas and Spaces with the Mixed Functional Use. *Procedia Engineering*, 150, pp.1996–2000.

Wilson, G. & Baldassare, M., 1996. Overall "sense of community" in a suburban region: The effects of localism, privacy and urbanization. *Environment and Behavior*, 28(1), pp.27–43.

Wolsink, M., 2016. "Sustainable City" requires "recognition"-The example of environmental education under pressure from the compact city. *Land Use Policy*, 52, pp.174–180.

World Health Organization (WHO), 2011. *Health co-benefits of climate change mitigation-Transport sector: Health in the green economy*, Geneva, Switzerland.

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Studies reviewed in The compact city in empirical research: A quantitative evidence review

Version: June 2017

Summary of study attributes

ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
P1	Abel et al.	2012	a	1	Labour productivity	PD	US	OLS IV	4	1	3.00%
P2	Ananat et al.	2013	a	1	Wages	ED	US	OLS FE	2	1	.
P3	Andersson et al.	2014	a	1	Wages	ED	Sweden	panel FE	3	1	1.00%
P4	Andersson et al.	2016	a	1	Wages	ED	Sweden	panel	3	1	3.00%
P5	Baldwin et al.	2010	a	1	Labour productivity	ED	Canada	FD, GMM, IV	3	1	.
P6	Barde	2010	a	1	Wages	ED	France	CrossSec, IV	4	1	3.50%
P7	Ciccone	2002	a	1	Labour productivity	ED	Europe	FE, IV	4	1	4.50%
P8	Ciccone & Hall	1996	a	1	Total factor productivity	ED	US	OLS IV	3	1	6.00%
P9	Combes et al.	2008	a	1	Wages	ED	France	panel IV	4	1	3.00%
P10	Dekle & Eaton	1999	a	1	Wages	ED	Japan	panel FE	3	1	1.00%
P11	Drennan & Kelly	2011	a	1	Rent	PD	US	panel FE	3	1	.
P12	Echeverri-Carroll & Ayala	2011	a	1	Wages	PD	US	OLS IV	4	1	3.05%
P13	Garate & Pennington-Cross	2013	a	1	Retail sales	PD	Chile	panel IV	4	0	.

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ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
P14	Glaeser et al.	2006	a	1	Wages	HD	US	panel	3	1	.
P15	Graham	2007	a	1	Labour productivity	ED	UK	GLS CONTR	2	1	4.02%
P16	Graham et al.	2010	a	1	Labour productivity	ED	UK	panel GMM	3	1	9.05%
P17	Larsson	2014	a	1	Wages	ED	Sweden	panel IV	3	1	1.00%
P18	Rosenthal & Strange	2008	a	1	Wages	ED	US	OLS, GMM, IV	4	1	4.50%
P19	Morikawa	2011	a	1	Total factor productivity	PD	Japan	panel	2	1	11.00%
P20	Tabuchi	1986	a	1	Labour productivity	PD	Japan	CrossSec IV	4	1	6.15%
P21	Faberman & Freedman	2016	a	1	Wages	PD	US	panel IV	3	1	6.98%
P22	Barufi et al.	2016	a	1	Wages	ED	Brazil	panel IV	3	1	7.30%
P23	Ahlfeldt et al.	2015	a	1	Total factor productivity	ED	Germany	DID, GMM	4	1	8.00%
P24	Ahlfeldt & Feddersen	2015	a	1	Labour productivity	ED	Germany	DID IV	4	1	3.80%
P25	Combes et al.	2012	a	1	Total factor productivity	ED	France	panel IV	4	1	3.20%
P26	Ahlfeldt & Wendland	2013	a	1	Total factor productivity	SPP	Germany	panel FE	3	1	5.90%
P27	Fu	2007	a	1	Wages	ED	US	CrossSec FE	2	1	3.70%
P28	Henderson	2003	a	1	Labour productivity	ED	US	panel IV	3	1	.
P29	Cheshire & Magrini	2009	a	1	GDP per capita	PD	Europe	CrossSec FE	2	-1	.
P30	Rappaport	2008	a	1	Total factor productivity	PD	US	CGEM	1	1	15.00%
P31	Chauvin et al.	2016	a	1	Wages	PD	US	panel IV	3	1	5.00%
P32	Chauvin et al.	2016	a	1	Wages	PD	Brazil	panel IV	3	1	2.60%
P33	Chauvin et al.	2016	a	1	Wages	PD	China	panel IV	3	1	20.00%
P34	Chauvin et al.	2016	a	1	Wages	PD	India	panel IV	3	1	7.50%
P35	Albouy & Lue	2015	a	1	Wages	PD	US	OLS CONTR	2	1	9.80%
I1	Antonelli	1987	a	2	Ratio patenting firms	ED	Italy	OLS CONTR	2	-1	.
I2	Carlino et al.	2007	a	2	Patents/capita	ED	US	OLS IV	4	1	20.00%
I3	Echeverri-Carroll & Ayala	2011	a	2	Patents/capita	PD	US	OLS IV	4	1	5.04%
I4	Gonçalves & Almeida	2009	a	2	Ratio patenting firms	ED	Brazil	OLS IV	4	1	.
I5	Knudsen et al.	2007	a	2	Patents/capita	ED	US	OLS CONTR	2	1	.
I6	Lobo et al.	2013	a	2	Patents	PS	OECD	OLS	1	1	.
I7	Lobo et al.	2013	a	2	Patents	PS	US	OLS	1	1	.
I8	Sedgley & Elmslie	2011	a	2	Patents	PD	US	panel FE	3	1	.

ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
I9	Wilhelmsson	2009	a	2	Inventor networking	ED	Sweden	panel FE	3	1	.
I10	Spencer	2015	b	2	Creative Firm location	SDI	Canada	DESC	0	0	.
VS1	Amato	1969	a	3	Land value	PD	Colombia	DESC	0	-1	.
VS2	Amato	1970	a	3	Land value	PD	South America	DESC	0	-1	.
VS3	Brueckner et al.	2016	b	3	Land value	FAR	China	panel IV	3	1	.
VS4	Brueckner et al.	2016	b	3	Land value	FAR	China	panel IV	3	1	.
VS5	Ding	2013	b	3	House prices	FAR	China	NLLS IV	3	1	.
VS6	Fitriani	2015	a	3	Land value	PD	Indonesia	OLS SLX	3	1	.
VS7	Kholodilin & Ulbricht	2015	a	3	House prices	PD	Europe	OLS QR	2	1	25.00%
VS8	Kim & Sohn	2002	b	3	Land use density	SC	Japan	COR	1	1	.
VS9	Lynch & Rasmussen	2004	a	3	House prices	PD	US	OLS CONTR	2	-1	-1.79%
VS10	Miles	2012	a	3	House prices	PD	UK	DESC	0	1	.
VS11	Ottensmann	1977	a	3	Land value	PS	US	OLS	1	1	.
VS12	Ottensmann	1977	b	3	Land value	HD	US	OLS	1	-1	.
VS13	Palm et al.	2014	a	3	Rent	PD	US	OLS FE	2	1	4.50%
VS14	Stankowski & Trenton	1972	a	3	Land use density	PD	US	DESC	0	1	.
VS15	Ahlfeldt & Mcmillen	2015	b	3	House prices	BH	US	LWR IV	3	1	.
VS16	Xiao et al.	2016	b	3	House prices	SC	China	FD, FE	3	0	.
VS17	Aurand	2010	c	3	# Affordable housing units	MX	US	OLS CONTR	2	-1	.
VS18	Sivitanidou	1995	b	3	Rent	FAR	US	OLS FE	2	1	.
VS19	Combes et al.	2013	a	3	House prices	PD	France	OLS IV	2	1	21.00%
VS20	Ahlfeldt, Moeller, et al.	2015	a	3	House prices	PD	Germany	SPVAR IV	4	1	4.65%
VS21	Song & Knaap	2004	c	3	House prices	PD	US	OLS IV	4	-1	-1.70%
VS22	Ahlfeldt & Wendland	2013	a	3	Rent	SPP	Germany	panel FE	3	1	7.00%
VS23	Liu et al.	2016	a	3	Rent	ED	US	OLS FE	2	1	10.00%
VS24	Albouy & Lue	2015	a	3	House prices	PD	US	OLS CONTR	2	1	26.80%
JA1	Bertaud & Brueckner	2005	b	4	Commuting cost	FAR	India	OLS	1	1	.
JA2	Boussauw et al.	2012	c	4	Distance to work	MX	Belgium	OLS, SL, SE	2	0	.
JA3	Boussauw et al.	2012	a	4	Distance to work	ED	Belgium	OLS, SL, SE	2	-1	.

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JA4	Murphy	2009	c	4	Commuting cost	ED	Ireland	CrossSec	1	1	.
JA5	Shunfeng	1994	a	4	Distance to work	ED	US	OLS, NLLS	2	0	.
JA6	Veneri	2010	a	4	Av. Commuting time	PD	Italy	OLS, ML	2	-1	-2.12%
JA7	Yang et al.	2012	a	4	Commuting time reduction	PD	China	OLS CONTR	2	-1	-20.85%
JA8	Zhao et al.	2010	a	4	Commuting within periphery	PD	China	LOGIT	2	1	.
JA9	Pouyanne	2004	a	4	Commuting length reduction	PD	France	OLS, LOGIT	2	1	20.65%
JA10	Pouyanne	2004	a	4	Commuting length reduction	ED	France	OLS, LOGIT	2	1	11.04%
JA11	Chatman	2003	a	4	Commercial trip length red.	ED	US	LOGIT, TOBIT	2	1	23.27%
JA12	Barter	2000	b	4	VKT	UB	Eastern Asia	DESC	0	-1	.
JA13	Duranton & Turner	2015	a	4	VKT	PD	US	panel IV	4	1	8.50%
JA14	Harari	2015	b	4	Av. Commuting length	PD	India	panel IV	4	-1	.
JA15	Albouy & Lue	2015	a	4	Commuting cost red.	PD	US	LPROB	2	-1	-0.40%
JA16	Cervero & Kockelman	1997	a	4	VMT	ED	US	LOGIT	2	1	24.70%
JA17	Cervero & Kockelman	1997	a	4	VMT (non-work trip)	ED	US	LOGIT	2	1	6.30%
JA18	Brownstone & Thomas	2013	a	4	Red. total vehicle mileage/year	HD	US	OLS	2	1	12.22%
SA1	Alperovich	1980	a	5	Level of amenities	PD	Israel	OLS CONTR	2	1	.
SA2	Alperovich	1980	b	5	Level of amenities	BD	Israel	OLS CONTR	2	1	.
SA3	Aquino & Gainza	2014	b	5	Commercial activity	BD	Chile	OLS CONTR	2	1	.
SA4	Rappaport	2008	a	5	Level of amenities	PD	US	CGEM	1	1	.
SA5	Ahlfeldt, Redding, et al.	2015	a	5	Quality of life	ED	Germany	DID, GMM	4	1	15.00%
SA6	Schiff	2015	a	5	Cuisine variety	PD	US	OLS IV	4	1	18.50%
SA7	Couture	2016	a	5	Restaurant prices	PD	US	OLS LOGIT IV	4	1	8.00%
SA8	Couture	2016	a	5	Restaurant prices	PD	US	OLS LOGIT IV	4	1	16.00%
SA9	Albouy	2008	a	5	Quality of life	PD	US	OLS FE	2	1	2.00%
SA10	Albouy & Lue	2015	a	5	Quality of life	PD	US	OLS CONTR	2	1	3.10%
SA11	Chauvin et al.	2016	a	5	Real wages	PD	US	panel IV	3	-1	-2.00%
SA12	Chauvin et al.	2016	a	5	Real wages	PD	Brazil	panel IV	3	0	-1.00%
SA13	Chauvin et al.	2016	a	5	Real wages	PD	China	panel IV	3	-1	-5.20%

ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
SA14	Chauvin et al.	2016	a	5	Real wages	PD	India	panel IV	3	-1	-6.90%
SA15	Levinson	2008	a	5	Rail station density	PD	UK	panel	3	1	0.23%
SA16	Levinson	2008	a	5	Underground station density	PD	UK	panel	3	1	0.27%
SA17	Ahlfeldt et al.	2015	a	5	Underground station density	PD	Germany	SPVAR IV	4	1	3.50%
PS1	Carruthers & Ulfarsson	2003	a	6	Red. total spending	PD	US	CrossSec FE	2	1	14.40%
PS2	Carruthers & Ulfarsson	2003	a	6	Red. spending capital	PD	US	CrossSec FE	2	1	14.40%
PS3	Carruthers & Ulfarsson	2003	a	6	Red. spending roadways	PD	US	CrossSec FE	2	1	28.80%
PS4	Carruthers & Ulfarsson	2003	a	6	Red. spending transport	PD	US	CrossSec FE	2	-1	-48.00%
PS5	Carruthers & Ulfarsson	2003	a	6	Red. spending sewerage	PD	US	CrossSec FE	2	0	-14.40%
PS6	Carruthers & Ulfarsson	2003	a	6	Red. spending trash	PD	US	CrossSec FE	2	0	9.60%
PS7	Carruthers & Ulfarsson	2003	a	6	Red. spending police	PD	US	CrossSec FE	2	1	9.60%
PS8	Carruthers & Ulfarsson	2003	a	6	Red. spending education	PD	US	CrossSec FE	2	1	19.20%
PS9	Carruthers & Ulfarsson	2003	b	6	Red. total spending	GAR	US	CrossSec FE	2	1	1.95%
PS10	Ladd	1994	a	6	Change per capita spending	PD	US	CrossSec FE	2	-1	-3.02%
PS11	Speir & Stephenson	2002	b	6	Red. water & sewer costs	BD	US	DESC	0	1	.
PS12	Ahlfeldt et al.	2016	a	6	Broadband cost	PD	UK	panel RDD	4	1	.
PS13	Kolko	2012	a	6	Broadband availab.	PD	US	panel IV	4	1	.
PS14	Prieto et al.	2015	a	6	Water supply cost per capita	PD	Spain	LOGIT	2	1	39.70%
PS15	Prieto et al.	2015	a	6	Sewage cost per capita	PD	Spain	LOGIT	2	1	50.70%
PS16	Prieto et al.	2015	a	6	Paving cost per capita	PD	Spain	LOGIT	2	1	81.20%
SE1	Ananat et al.	2013	a	7	Red. in black-white wage gap	ED	US	OLS FE	2	-1	-0.33%
SE2	Bond Huie & Frisbie	2000	a	7	Ratio black/white residents	PD	US	OLS	2	-1	.
SE3	Galster & Cutsinger	2007	a	7	Dissimilarity index	PD	US	OLS CONTR	2	1	256.75%
SE4	Maloutas	2004	a	7	Migrant numbers	PD	Greece	DESC	0	1	.
SE5	Pendall & Carruthers	2003	a	7	Dissimilarity index	PD	US	CrossSec FE	2	-1	.
SE6	Rothwell	2011	a	7	Dissimilarity index	PD	US	CrossSec IV	4	1	39.20%
SE7	Rothwell & Massey	2010	a	7	Red. Gini coefficient	PD	US	CrossSec IV	4	1	456.35%
SE8	Rothwell & Massey	2009	a	7	Dissimilarity index	PD	US	CrossSec IV	4	1	32.61%
SE9	Wheeler	2004	a	7	Red. 90th vs. 10th decile	PD	US	GLS IV	4	1	17.00%
SE10	Fogarty & Garofalo	1980	a	7	Income equality	PD	US	OLS CONTR	2	1	.

ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
SF1	Ardian et al.	2014	a	8	Crime rate	PD	Iran	CORR	0	1	.
SF2	Browning et al.	2010	a	8	Red. homicide	ED	US	OLS	3	1	.
SF3	Browning et al.	2010	a	8	Assault rates	ED	US	OLS	3	1	.
SF4	Browning et al.	2010	a	8	Robbery rates	ED	US	OLS	3	-1	.
SF5	Chang	2011	b	8	Burglary rate	INT	South Korea	CORR	1	1	.
SF6	Mladenka & Hill	1976	a	8	Crime rate	PD	US	OLS	1	-1	.
SF7	Nakaya & Yano	2010	a	8	Assault rates	PD	Japan	DESC	0	-1	.
SF8	Newman & Franck	1982	b	8	Crime rate	BH	US	CORR	1	1	.
SF9	Raleigh & Galster	2015	a	8	Red. assault	PD	US	OLS CONTR	2	1	35.62%
SF10	Raleigh & Galster	2015	a	8	Red. robbery	PD	US	OLS CONTR	2	1	82.88%
SF11	Raleigh & Galster	2015	a	8	Red. violence	PD	US	OLS CONTR	2	1	52.34%
SF12	Raleigh & Galster	2015	a	8	Red. burglary	PD	US	OLS CONTR	2	1	34.17%
SF13	Raleigh & Galster	2015	a	8	Red. vandalism	PD	US	OLS CONTR	2	1	35.62%
SF14	Raleigh & Galster	2015	a	8	Red. narcotics	PD	US	OLS CONTR	2	1	81.42%
SF15	Raleigh & Galster	2015	a	8	Vehicle theft	PD	US	OLS CONTR	2	1	27.63%
SF16	Raleigh & Galster	2015	a	8	Property theft	PD	US	OLS CONTR	2	1	45.80%
SF17	Raleigh & Galster	2015	b	8	Crime rate	VC	US	OLS CONTR	2	-1	.
SF18	Sampson	1983	b	8	Robbery	BD	US	CORR	1	-1	.
SF19	Tang	2015	a	8	Red. assault	PD	UK	panel	3	1	8.45%
SF20	Tang	2015	a	8	Property theft	PD	UK	panel	3	1	9.02%
SF21	Twinam	2016	a	8	Red. robbery	PD	US	panel IV	4	1	46.79%
SF22	Twinam	2016	a	8	Red. assault	PD	US	panel IV	4	1	53.14%
OG1	Blair	1996	b	9	Bird biodiversity	ULU	US	DESC (CCA)	0	1	.
OG2	Lewis et al.	2009	b	9	Open space conservation	HD	US	PROBIT	2	-1	.
OG3	Lin et al.	2015	b	9	Foliage Projection Cover	HD	Australia	OLS	1	-1	-6.00%
OG4	Tratalos et al.	2007	a	9	Cover of green space	HD	UK	OLS CONTR	1	-1	.
OG5	Tratalos et al.	2007	b	9	Cover of green space	BD	UK	OLS CONTR	1	-1	.
OG6	Aquino & Gainza	2014	a	9	Cover of green space	BD	Chile	OLS CONTR	2	-1	.
OG7	Wong & Chen	2010	b	9	Cover of green space	BD	Singapore	DESC	0	-1	.
PO1	Eeftens et al.	2013	b	10	Air pollution level	FAR	Netherlands	OLS	1	-1	.

ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
PO2	Tang & Wang	2007	b	10	Red. CO2 concentration	HD	China	CORR	1	-1	-23.00%
PO3	Hatt et al.	2004	b	10	TSS concentrations	SDI	Australia	CORR	1	-1	.
PO4	Salomons & Berghauser Pont	2012	a	10	Red. Noise	PD	Netherlands	CORR	1	1	4.00%
PO5	Albouy & Stuart	2014	a	10	Red. Pollution (particulates)	PD	US	NLLS CONTR	2	-1	-15.00%
PO6	Sarzynski	2012	a	10	Red. Nox m. metric tons	PD	World	CrossSec	2	1	43.80%
PO7	Sarzynski	2012	a	10	Red. VOCs m. metric tons	PD	World	CrossSec	2	1	33.00%
PO8	Sarzynski	2012	a	10	Red. CO m. metric tons	PD	World	CrossSec	2	1	22.80%
PO9	Sarzynski	2012	a	10	Red. SO2 m. metric tons	PD	World	CrossSec	2	1	37.60%
PO10	Hilber & Palmer	2014	a	10	Red. NOx µg/m3	PD	OECD	panel FE	3	1	23.82%
PO11	Hilber & Palmer	2014	a	10	Red. SOx µg/m3	PD	OECD	panel FE	3	1	200.80%
PO12	Hilber & Palmer	2014	a	10	Red. PM10 µg/m3	PD	OECD	panel FE	3	-1	-47.40%
PO13	Hilber & Palmer	2014	a	10	Red. NOx µg/m3	PD	non-OECD	panel FE	3	-1	-78.16%
PO14	Hilber & Palmer	2014	a	10	Red. SOx µg/m3	PD	non-OECD	panel FE	3	-1	-183.67%
PO15	Hilber & Palmer	2014	a	10	Red. PM10 µg/m3	PD	non-OECD	panel FE	3	1	34.82%
EN1	Norman et al.	2006	b	11	Red. CO2 emissions	HD	Canada	CORR	1	1	8.90%
EN2	Hong & Shen	2013	a	11	Red. CO2 transport	PD	US	OLS IV	4	1	31.00%
EN3	Barter	2000	a	11	Red. Emission/capita	PD	Eastern Asia	DESC	0	1	29.40%
EN4	Aguiléra & Voisin	2014	c	11	CO2 emissions commutes	MX	France	COR	1	1	.
EN5	Aguilera & Voisin	2014	a	11	Total CO2 emissions	ED	France	COR	1	1	.
EN6	Veneri	2010	a	11	Env. impact of mobility index	PD	Italy	OLS, ML	2	1	.
EN7	Su	2011	b	11	Gasoline consumption	FSDI	US	OLS CONTR	2	-1	-9.20%
EN8	Su	2011	a	11	Gasoline consumption	PD	US	OLS CONTR	2	1	6.80%
EN9	Travisi et al.	2010	b	11	Env. impact reduction	PD	Italy	pooled WLS	3	1	0.92%
EN10	Mindali et al.	2004	a	11	Energy consumption	ED	US	CORR	0	0	.
EN11	Mindali et al.	2004	a	11	Energy consumption	ED	Europe	CORR	0	1	.
EN12	Cirilli & Veneri	2014	a	11	CO2 emissions commutes	PD	Italy	OLS IV	4	1	23.46%
EN13	Breheny	1995	a	11	CO2 emissions commutes	PD	UK	DESC	0	-1	.
EN14	Holden & Norland	2005	a	11	Red. domestic energy	HD	Norway	OLS	2	1	11.00%
EN15	Howard et al.	2012	a	11	Building energy consumption	PD	US	DESC	1	0	.
EN16	Larson & Yezer	2015	b	11	Urban Energy Footprint	BD	US	N/A	2	-1	.

ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
EN17	Osman et al.	2016	a	11	Red. gasoline consumption	PD	Egypt	OLS	1	1	3.54%
EN18	Ratti et al.	2005	b	11	Building energy consumption	BH	Europe	LT model	1	0	.
EN19	Cho & Choi	2014	a	11	NO2 averages	PD	South Korea	panel FE	3	-1	.
EN20	Raupach et al.	2010	a	11	Total CO2 emissions	PD	World	CORR	1	-1	.
EN21	Muñiz & Galindo	2005	a	11	Red. ecological footprint	PD	Spain	OLS	2	1	36.48%
EN22	Brownstone & Thomas	2013	a	11	Red. gasoline consumption	HD	US	OLS	2	1	14.40%
EN23	Larson et al.	2012	b	11	Red. residential energy	FACAP	US	OLS	2	1	3.38%
EN24	Larson et al.	2012	b	11	Red. residential energy	FACAP	US	OLS	2	1	4.67%
EN25	Glaeser & Kahn	2010	a	11	Red. gasoline consumption	PD	US	CORR	1	1	3.20%
EN26	Glaeser & Kahn	2010	a	11	Red. gasoline consumption	PD	US	CORR	1	1	9.74%
EN27	Glaeser & Kahn	2010	a	11	CO2 private driving	PD	US	CORR	1	1	8.21%
EN28	Glaeser & Kahn	2010	a	11	CO2 public transport	PD	US	CORR	1	-1	-36.85%
EN29	Glaeser & Kahn	2010	a	11	CO2 heating	PD	US	CORR	1	-1	-3.39%
EN30	Glaeser & Kahn	2010	a	11	CO2 electricity	PD	US	CORR	1	1	6.82%
EN31	Glaeser & Kahn	2010	a	11	CO2 Total	PD	US	CORR	1	1	5.27%
EN32	Resch et al.	2016	b	11	Energy/capita	FACAP	World	VBSA	1	1	.
EN33	Newman & Kenworthy	1989	a	12	Gasoline consumption	PD	World	LOGIT	1	1	.
C1	Barter	2000	b	12	Road length/capita	ASDI	US	DESC	0	-1	.
C2	Graham et al.	2014	b	12	Traffic volume	SC	US	panel PSM	3	0	.
C3	Maitra et al.	1999	a	12	Congestion level	RDC	India	CORR	2	-1	.
C4	McDonald	2009	c	12	Traffic volume index	PD	US	MC	1	1	.
C5	Duranton & Turner	2015	a	12	Travel speed	PD	US	panel IV	4	-1	-11.00%
C6	Couture	2016	a	12	Travel speed	PD	US	OLS IV	4	-1	-13.00%
MC1	Zahabi et al.	2016	a	13	Cycling choice	PD	Canada	Panel LOGIT	3	1	.
MC2	Zahabi et al.	2016	b	13	Cycling choice	SC	Canada	Panel LOGIT	3	1	.
MC3	Brown et al.	2014	b	13	Walking choice	UB	US	LOGIT	2	1	.
MC4	Cervero & Duncan	2003	a	13	Walking choice	ED	US	LOGIT	2	1	.
MC5	Cervero & Duncan	2003	a	13	Car share	ED	US	LOGIT	2	-1	.
MC6	Cervero et al.	2006	b	13	Walking choice	SDI	Colombia	LOGIT	2	1	.
MC7	Cervero et al.	2006	b	13	Cycling choice	SDI	Colombia	LOGIT	2	1	.

ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
MC8	Chatman	2003	c	13	Driving choice	ED	US	LOGIT TOBIT	2	1	43.73%
MC9	de Sa & Ardern	2014	a	13	Walking/cycling choice	PD	Canada	LOGIT	2	1	10.93%
MC10	Frank et al.	2008	a	13	Transit choice (work trip)	PD	US	LOGIT	2	1	26.00%
MC11	Frank et al.	2008	a	13	Cycle choice (work trip)	PD	US	LOGIT	2	1	84.00%
MC12	Frank et al.	2008	a	13	Walk choice (work trip)	PD	US	LOGIT	2	1	43.00%
MC13	Frank et al.	2008	a	13	Transit choice (non-work trip)	PD	US	LOGIT	2	1	24.00%
MC14	Frank et al.	2008	a	13	Cycle choice (non-work trip)	PD	US	LOGIT	2	-1	-8.00%
MC15	Frank et al.	2008	b	13	Walk choice (non-work trip)	PD	US	LOGIT	2	1	28.00%
MC16	Giles-Corti et al.	2011	b	13	Walking choice	SC	Australia	LOGIT	2	1	.
MC17	Kaplan et al.	2016	b	13	Walking/cycling choice	SC	Denmark	Heckman	4	1	.
MC18	Krizek & Johnson	2006	c	13	Walking choice	MX	US	LOGIT	1	1	.
MC19	Larsen et al.	2009	a	13	Walking choice	PD	US	LOGIT	2	-1	.
MC20	McMillan	2007	b	13	Walking/cycling choice	SDI	US	LOGIT	2	0	.
MC21	McMillan	2007	c	13	Walking/cycling choice	MX	US	LOGIT	2	1	.
MC22	Nielsen et al.	2013	a	13	Cycle distance	PD	Denmark	Heckman	4	-1	-8.70%
MC23	Nielsen et al.	2013	c	13	Cycle distance	MX	Denmark	Heckman	4	-1	.
MC24	Saelens et al.	2003	a	13	Walking/cycling choice	ED	US	DESC	0	1	.
MC25	Saelens et al.	2003	c	13	Walking/cycling choice	MX	US	DESC	0	1	.
MC26	Vance & Hedel	2007	a	13	Kilometres driven	ED	Germany	PROBIT IV	4	1	.
MC27	Vance & Hedel	2007	c	13	Kilometres driven	SDI	Germany	PROBIT IV	4	0	.
MC28	Zhao	2014	a	13	Walking choice	PD	China	LOGIT	2	0	0.13%
MC29	Zhao	2014	a	13	Cycling choice	PD	China	LOGIT	2	0	0.34%
MC30	Zhao	2014	a	13	Walking choice	ED	China	LOGIT	2	0	4.18%
MC31	Zhao	2014	a	13	Cycling choice	ED	China	LOGIT	2	0	12.65%
MC32	Zhao	2014	b	13	Cycling choice	SDI	China	LOGIT	2	1	.
MC33	Zhao	2014	b	13	Cycling choice	SDI	China	LOGIT	2	1	.
MC34	Aguiléra & Voisin	2014	a	13	Walking choice	ED	France	COR	0	1	.
MC35	Aguilera & Voisin	2014	a	13	Public transport choice	ED	France	COR	0	1	.
MC36	Aguilera & Voisin	2014	a	13	Driving choice	ED	France	COR	0	1	.
MC37	Cervero	1996	a	13	Public transport choice	PD	US	PROBIT	2	1	.

ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
MC38	Cervero	1996	a	13	Walking/cycling choice	PD	US	PROBIT	2	1	.
MC39	Pouyanne	2004	a	13	Car share rate	PD	France	OLS, LOGIT	2	-1	-2.10%
MC40	Pouyanne	2004	a	13	Public transport choice	PD	France	OLS, LOGIT	2	1	42.03%
MC41	Pouyanne	2004	a	13	Walking choice	PD	France	OLS, LOGIT	2	1	43.90%
MC42	Pouyanne	2004	a	13	Cycling choice	PD	France	OLS, LOGIT	2	1	201.43%
MC43	Chao & Qing	2011	a	13	Walking choice	PD	US	OLS CONTR	2	1	15.73%
MC44	Bento et al.	2005	a	13	Driving choice	PD	US	LOGIT	2	1	.
MC45	Bento et al.	2005	a	13	Public transport choice	PD	US	LOGIT	2	1	.
MC46	Zhang	2004	a	13	Transit choice (work trip)	PD	US	LOGIT	2	1	11.80%
MC47	Zhang	2004	a	13	Walk choice (work trip)	PD	US	LOGIT	2	1	10.50%
MC48	Zhang	2004	a	13	Driving choice (work trip)	PD	US	LOGIT	2	1	4.40%
MC49	Zhang	2004	a	13	Car share (work trip)	PD	US	LOGIT	2	1	7.10%
MC50	Zhang	2004	a	13	Public transport choice	PD	US	LOGIT	2	1	12.60%
MC51	Zhang	2004	a	13	Driving choice	PD	US	LOGIT	2	1	4.00%
MC52	Zhang	2004	a	13	Walking/cycling choice	PD	US	LOGIT	2	1	6.00%
MC53	Zhang	2004	a	13	Car share red.	PD	US	LOGIT	2	1	3.30%
MC54	Zhang	2004	a	13	Transit choice (work trip)	ED	US	LOGIT	2	1	9.00%
MC55	Zhang	2004	a	13	Driving choice (work trip)	ED	US	LOGIT	2	1	3.10%
MC56	Zhang	2004	a	13	Walking/cycling (work trip)	ED	US	LOGIT	2	1	2.60%
MC57	Zhang	2004	a	13	Car share red. (work trip)	ED	US	LOGIT	2	1	4.40%
MC58	Zhang	2004	a	13	Public transport choice	ED	US	LOGIT	2	1	0.40%
MC59	Zhang	2004	a	13	Driving choice	ED	US	LOGIT	2	1	0.10%
MC60	Zhang	2004	a	13	Walking/cycling choice	ED	US	LOGIT	2	1	0.40%
MC61	Zhang	2004	a	13	Car share red.	ED	US	LOGIT	2	1	0.30%
MC62	Zhang	2004	a	13	Transit choice (work trip)	PD	Hong Kong	LOGIT	2	1	0.50%
MC63	Zhang	2004	a	13	Driving choice (work trip)	PD	Hong Kong	LOGIT	2	1	3.90%
MC64	Zhang	2004	a	13	Taxi red.	PD	Hong Kong	LOGIT	2	1	2.60%
MC65	Zhang	2004	a	13	Public transport choice	PD	Hong Kong	LOGIT	2	1	1.40%
MC66	Zhang	2004	a	13	Driving choice red.	PD	Hong Kong	LOGIT	2	1	11.00%
MC67	Zhang	2004	a	13	Taxi red.	PD	Hong Kong	LOGIT	2	1	12.80%

ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
MC68	Zhang	2004	a	13	Transit choice (work trip)	ED	Hong Kong	LOGIT	2	1	1.10%
MC69	Zhang	2004	a	13	Driving choice (work trip)	ED	Hong Kong	LOGIT	2	1	7.70%
MC70	Zhang	2004	a	13	Taxi red.	ED	Hong Kong	LOGIT	2	1	11.80%
MC71	Zhang	2004	a	13	Public transport choice	ED	Hong Kong	LOGIT	2	1	0.60%
MC72	Zhang	2004	a	13	Driving choice	ED	Hong Kong	LOGIT	2	1	7.00%
MC73	Zhang	2004	a	13	Taxi red.	ED	Hong Kong	LOGIT	2	1	2.40%
MC74	Cervero & Kockelman	1997	a	13	Non-personal vehicle	ED	US	LOGIT	2	1	9.80%
MC75	Cervero & Kockelman	1997	a	13	Non-pers. vehicle (non work)	ED	US	LOGIT	2	1	8.40%
MC76	Cervero & Kockelman	1997	a	13	Non-pers. vehicle (work trip)	ED	US	LOGIT	2	1	11.30%
H1	Chaix et al.	2006	a	14	IHD risk red.	PD	Sweden	Panel LOGIT	3	-1	-29.86%
H2	Chaix et al.	2006	a	14	Lung cancer risk red.	PD	Sweden	Panel LOGIT	3	-1	-19.49%
H3	Chaix et al.	2006	a	14	Pulmonary disease red.	PD	Sweden	Panel LOGIT	3	-1	-57.79%
H4	Fecht et al.	2016	a	14	Premature mortalities	PD	UK	CrossSec	2	-1	-29.00%
H5	Fecht et al.	2016	b	14	Premature mortalities	SDI	UK	CrossSec	2	-1	-50.00%
H6	Maantay & Maroko	2015	b	14	Mental health disorder	VC	UK	OLS, SAR, GWR	2	1	.
H7	Melis et al.	2015	a	14	Red. metal health prescriptions	PD	Italy	OLS, panel	2	0	1.27%
H8	Graham & Glaister	2003	a	14	Pedestrian casualty red.	PD	UK	LOGLIN	2	1	52.90%
H9	Graham & Glaister	2003	a	14	Pedestrian casualty red.	ED	UK	LOGLIN	2	-1	-82.60%
H10	Graham & Glaister	2003	a	14	KSI reduction	PD	UK	LOGLIN	2	1	39.90%
H11	Graham & Glaister	2003	a	14	KSI reduction	ED	UK	LOGLIN	2	-1	-5.10%
H12	Graham & Glaister	2003	a	14	Pedestrian casualty red.	SDI	UK	LOGLIN	2	-1	.
H13	Guite et al.	2006	b	14	Mental health score	PD	UK	LOGIT	2	-1	.
H14	Howe et al.	1993	a	14	Red. all cancer rate	PD	US	COR	1	-1	-5.50%
H15	Mahoney et al.	1990	a	14	Mortality red. (all cancers)	PD	US	LOGIT	2	-1	-3.80%
H16	Reijneveld et al.	1999	a	14	Mortality red.	PD	Netherlands	LOGLIN	2	-1	-9.06%
WB1	Tu & Lin	2008	a	15	Environmental quality	PD	Taiwan	LOGIT	1	1	.
WB2	Brueckner & Largey	2006	a	15	Social contacts	PD	US	PROBIT IV	4	-1	-1.59%
WB3	Brueckner & Largey	2006	a	15	Visit neighbour/week	PD	US	PROBIT IV	4	-1	-4.46%
WB4	Brueckner & Largey	2006	a	15	# people can confide in	PD	US	PROBIT IV	4	-1	-0.56%

ID	Author	Year	Cause	Cat.	Outcome	Density	Country	Model	SMS	Qual.	Elasticity
WB5	Brueckner & Largey	2006	a	15	# close friends	PD	US	PROBIT IV	4	-1	-0.81%
WB6	Brueckner & Largey	2006	a	15	# times attends club meeting	PD	US	PROBIT IV	4	-1	-7.96%
WB7	Harvey et al.	2015	b	15	Perceived safety	FAR	US	OLS, LOGIT	2	1	6.90%
WB8	Fassio et al.	2013	a	15	Self-rep. social satisfaction	PD	Italy	COR	1	-1	-42.32%
WB9	Fassio et al.	2013	a	15	Self-rep. env. health	PD	Italy	COR	1	-1	-33.84%
WB10	Fassio et al.	2013	a	15	Self-rep. physical health	PD	Italy	COR	1	-1	-13.80%
WB11	Fassio et al.	2013	a	15	Self-rep. psychological status	PD	Italy	COR	1	-1	-31.89%
WB12	Walton et al.	2008	a	15	Relaxing life	PD	New Zealand	COR	1	0	.
WB13	Brown et al.	2015	a	15	Life satisfaction	PD	OECD	PROBIT	2	-1	.
WB14	Brereton et al.	2008	a	15	Sel-rep. well-being	PD	Ireland	OLS	2	1	.
WB15	Glaeser et al.	2016	a	15	Sel-rep. well-being	PD	US	panel	3	-1	-0.37%
WB16	Newman & Franck	1982	b	15	Fear of crime	BH	US	CORR	1	-1	.

Legend

Cause		Density		Maryland Scientific Method Scale (WWC)		Qual. Result Classification	
a	Residential and employment density	PD	Population density	0	Descriptive data	1	Positive
b	Morphological density	PS	Population size	1	Correlations, cross-sectional no control variables	0	Insignificant
c	Mixed Use	ED	Employment or other economic density	2	Cross-sectional, adequate control variables	1	Negative
Category		SPP	Spillover potential	3	Panel data methods		
1	Productivity	FACAP	Floor area per capita	4	Instrumental variables, RDD		
2	Innovation	INT	Intelligibility: high degree of movement	5	Randomised control trials		
3	Value of space	SC	Street connectivity/configuration				
4	Job accessibility	BH	Building height				
5	Services access	BD	Building density				
6	Efficiency of public services delivery	SDI	Street density/intersection				
7	Social equity	GAR	Geographic area reduction				
8	Safety	FAR	Floor area ration and related measures				
9	Open space preservation and biodiversity	VC	Vacant land				
10	Pollution reduction	ULU	Urban land use				
11	Energy efficiency	UB	Urban boundary				
12	Traffic flow	RDC	Road capacity				
13	Sustainable mode choice	FSDI	Freeway density				
14	Health	ASDI	Arterial street density				
15	Wellbeing	HD	Development density				
		MX	Mixed Use				

Full Bibliography

Abel, J.R., Dey, I. & Gabe, T.M., 2012. Productivity and the density of Human Capital. *Journal of Regional Science*, 52(4), pp.562–586.

Aguiléra, A. & Voisin, M., 2014. Urban form, commuting patterns and CO2 emissions: What differences between the municipality's residents and its jobs? *Transportation Research Part A: Policy and Practice*, 69, pp.243–251.

Ahlfeldt, G.M., Redding, S.J., et al., 2015. The Economics of Density : Evidence from the Berlin Wall. *Econometrica*, 83(6), pp.2127–2189.

Ahlfeldt, G.M. & Feddersen, A., 2015. *From Periphery to Core : Measuring Agglomeration Effects Using High-Speed Rail*,

Ahlfeldt, G.M., Koutroumpis, P. & Valletti, T., 2016. Speed 2.0. *Working Paper*, (January).

Ahlfeldt, G.M. & Mcmillen, D.P., 2015. *The Vertical City : The Price of Land and the Height of Buildings in Chicago 1870-2010*,

Ahlfeldt, G.M., Moeller, K. & Wendland, N., 2015. Chicken or egg? The PVAR econometrics of transportation. *Journal of Economic Geography*, 15(6), pp.1169–1193.

Ahlfeldt, G.M. & Wendland, N., 2013. How polycentric is a monocentric city ? Centers, spillovers and hysteresis. *Journal of Economic Geography*, 13(September 2012), pp.53–83.

Albouy, D., 2008. Are Big Cities Bad Places to Live? Estimating Quality of Life across Metropolitan Areas. *National Bureau of Economic Research Working Paper Series*, No. 14472.

Albouy, D. & Lue, B., 2015. Driving to opportunity: Local rents, wages, commuting, and sub-metropolitan quality of life. *Journal of Urban Economics*, 89, pp.74–92.

Albouy, D. & Stuart, B., 2014. Urban Population and Amenities. *National Bureau of Economic Research, Inc, NBER Working Papers: 19919*.

Alperovich, G., 1980. Neighbourhood amenities and their impact on density gradients. *Annals of Regional Science*, 14(2).

Amato, P.W., 1970. A Comparison: Population Densities, Land Values and Socioeconomic Class in Four Latin American Cities. *Land Economics*, 46(4), pp.447–455.

Amato, P.W., 1969. Population Densities, Land Values, and Socioeconomic Class in Bogota, Colombia. *Land Economics*, 45(1), pp.66–73.

Ananat, E., Fu, S. & Ross, S.L., 2013. Race-Specific Agglomeration Economies: Social Distance and the Black-White Wage Gap. *NBER Working Paper 18933 (National Bureau of Economic Research)*, pp.13–24.

Andersson, M., Klaesson, J. & Larsson, J.P., 2016. How Local are Spatial Density Externalities ? Neighbourhood Effects in Agglomeration Economies. *Regional Studies*, 50(6), pp.1082–1095.

Andersson, M., Klaesson, J. & Larsson, J.P., 2014. The sources of the urban wage premium by worker skills : Spatial sorting or agglomeration economies ? *Papers in Regional Science*, 93(4), pp.727–747.

Antonelli, C., 1987. The Determinants of the Distribution of Innovative Activity in a Metropolitan Area: The Case of Turin. *Regional Studies*, 21(2), pp.85–93.

Aquino, F.L. & Gainza, X., 2014. Understanding density in an uneven city, Santiago de Chile: Implications for social and environmental sustainability. *Sustainability*, 6(9), pp.5876–5897.

Ardian, N. et al., 2014. The Spatial Analysis of Hot Spots in Urban Areas of Iran. The Case Study: Yazd. *REVISTA DE CERCETARE SI INTERVENTIE SOCIALA*, 44, pp.103–116.

Aurand, A., 2010. Density, Housing Types and Mixed Land Use : Smart Tools for Affordable Housing ? *Urban Studies*, 47(October 2008), pp.1015–1036.

Baldwin, J.R., Brown, W.M. & Rigby, D.L., 2010. Agglomeration economies: Microdata panel estimates from Canadian manufacturing. *Journal of Regional Science*, 50(5), pp.915–934.

Barde, S., 2010. Increasing Returns and the Spatial Structure of French Wages. *Spatial Economic Analysis*, 5(1), p.73.

Barter, P.A., 2000. Transport Dilemmas in Dense Urban Areas: Examples from Eastern Asia. In *Compact Cities: Sustainable Urban Forms for Developing Countries*. London & New York: SPON Press.

Barufi, A.M.B., Haddad, E.A. & Nijkamp, P., 2016. Industrial scope of agglomeration economies in Brazil. *Annals of Regional Science*, 56(3), pp.707–755.

Bento, A. et al., 2005. The Effects of Urban Spatial Structure on Travel Demand in the United States. *Review of Economics and Statistics*, 87(3), pp.466–478.

Bertaud, A. & Brueckner, J.K., 2005. Analyzing building-height restrictions: predicted impacts and welfare costs.

Regional Science and Urban Economics, 35, pp.109–125.
Blair, R.B., 1996. Land use and avian species diversity along an urban gradient. *Ecological Applications*, 6(2), pp.506–519.
Bond Huie, S.A. & Frisbie, P.W., 2000. Southern Demographic Association The Components of Density and the Dimensions of Residential Segregation. *Population Research and Policy Review*, 19, pp.505–524.
Boussauw, K., Neutens, T. & Witlox, F., 2012. Relationship between Spatial Proximity and Travel-to-Work Distance: The Effect of the Compact City. *Regional Studies*, 46(6), pp.687–706.
Breheny, M., 1995. The compact city and transport energy consumption. *Transactions of the Institute of British Geographers*, 20(1), pp.81–101.
Brereton, F., Clinch, J.P. & Ferreira, S., 2008. Happiness, geography and the environment. *Ecological Economics*, 65(2), pp.386–396.
Brown, S.C. et al., 2014. Walking and proximity to the urban growth boundary and central business district. *American Journal of Preventive Medicine*, 47(4), pp.481–486.
Brown, Z.S., Oueslati, W. & Silva, J., 2015. Exploring the Effect of Urban Structure on Individual Well-Being. *OECD Environment working papers*, (95), p.35.
Browning, C.R. et al., 2010. Commercial Density, Residential Concentration, and Crime: Land Use Patterns and Violence in Neighborhood Context. *Journal of Research in Crime and Delinquency*, 47(3), pp.329–357.
Brownstone, D. & Thomas, F.G., 2013. The impact of residential density on vehicle usage and fuel consumption: Evidence from national samples. *Energy Economics*, 40(1), pp.196–206.
Brueckner, J.K. et al., 2016. *Measuring the Stringency of Land-Use Regulation : The Case of China's Building-Height Limits*,
Brueckner, J.K. & Largey, A.G., 2006. Social interaction and urban sprawl. *CESifo WP*, 1843(1), pp.18–34.
Carlino, G.A., Chatterjee, S. & Hunt, R.M., 2007. Urban density and the rate of invention. *Journal of Urban Economics*, 61(3), pp.389–419.
Carruthers, J.I. & Ulfarsson, G.F., 2003. Urban sprawl and the cost of public services. *Environment and Planning B: Planning and Design*, 30(4), pp.503–522.
Cervero, R. et al., 2006. *Influences of Built Environments on Walking and Cycling: Lessons from Bogotá*,
Cervero, R., 1996. Mixed land-uses and commuting: Evidence from the American housing survey. *Transportation Research Part A: Policy and Practice*, 30(5 PART A), pp.361–377.
Cervero, R. & Duncan, M., 2003. *Walking, Bicycling, and Urban Landscapes: Evidence from the San Francisco Bay Area*,
Cervero, R. & Kockelman, K., 1997. Travel demand and the 3Ds: Density, diversity, and design. *Transportation Research Part D: Transport and Environment*, 2(3), pp.199–219.
Chaix, B. et al., 2006. Disentangling contextual effects on cause-specific mortality in a longitudinal 23-year follow-up study: Impact of population density or socioeconomic environment? *International Journal of Epidemiology*, 35(3), pp.633–643.
Chang, D., 2011. Social Crime or Spatial Crime? Exploring the Effects of Social, Economical, and Spatial Factors on Burglary Rates. *Environment and Behavior*, 43(1), pp.26–52.
Chao, L. & Qing, S., 2011. An empirical analysis of the influence of urban form on household travel and energy consumption. *Computers, Environment and Urban Systems*, 35(5), pp.347–357.
Chatman, D., 2003. How Density and Mixed Uses at the Workplace Affect Personal Commercial Travel and Commute Mode Choice. *Transportation Research Record*, 1831(3), pp.193–201.
Chauvin, J.P. et al., 2016. What is different about urbanization in rich and poor countries? Cities in Brazil, China, India and the United States. *Journal of Urban Economics*, pp.1–33.
Cheshire, P. & Magrini, S., 2009. Urban growth drivers in a Europe of sticky people and implicit boundaries. *Journal of Economic Geography*, 9(1), pp.85–115.
Cho, H.-S. & Choi, M., 2014. Effects of Compact Urban Development on Air Pollution: Empirical Evidence from Korea. *Sustainability*, 6(9), pp.5968–5982.
Ciccone, A., 2002. Agglomeration effects in Europe. *European Economic Review*, 46(2), pp.213–227.
Ciccone, A. & Hall, R.E., 1996. Productivity and the Density of Economic Activity Productivity and the Density of Economic Activity. *The American Economic Review*, 86(1), pp.54–70.
Cirilli, A. & Veneri, P., 2014. Spatial Structure and Carbon Dioxide (CO2) Emissions Due to Commuting: An Analysis of Italian Urban Areas. *Regional Studies*, 48(12), pp.1993–2005.
Combes, P.-P. et al., 2012. The Productivity Advantages of Large Cities: Distinguishing Agglomeration From Firm Selection. *Econometrica*, 80(6), pp.2543–2594.
Combes, P.-P., Duranton, G. & Gobillon, L., 2008. Spatial wage disparities: Sorting matters! *Journal of Urban Economics*, 63(2), pp.723–742.
Combes, P., Duranton, G. & Gobillon, L., 2013. The Costs of Agglomeration : Land Prices in French Cities.

Working Paper, (7027), p.28.
Couture, V., 2016. Valuing the Consumption Benefits of Urban Density. *Working Paper: Univeristy of California, Berkeley*, (September).
Dekle, R. & Eaton, J., 1999. Agglomeration and Land Rents: Evidence from the Prefectures. *Journal of Urban Economics*, 46(2), pp.200–214.
Ding, C., 2013. Building height restrictions,land development and economic costs. *Land Use Policy*, 30(1), pp.485–495.
Drennan, M.P. & Kelly, H.F., 2011. Measuring urban agglomeration economies with office rents. *Journal of Economic Geography*, 11(3), pp.481–507.
Duranton, G. & Turner, M.A., 2015. Urban form and driving: Evidence from US cities. *Working Paper*.
Echeverri-Carroll, E.L. & Ayala, S.G., 2011. Urban Wages : Does City Size Matter ? *Urban Studies*, 48(2), pp.253–271.
Eeftens, M. et al., 2013. Quantifying urban street configuration for improvements in air pollution models. *Atmospheric Environment*, 72, pp.1–9.
Faberman, R.J. & Freedman, M., 2016. The urban density premium across establishments. *Journal of Urban Economics*, 93, pp.71–84.
Fassio, O., Rollero, C. & De Piccoli, N., 2013. Health, Quality of Life and Population Density: A Preliminary Study on 'Contextualized' Quality of Life. *Social Indicators Research*, 110(2), pp.479–488.
Fecht, D. et al., 2016. Associations between urban metrics and mortality rates in England. *Environmental health : a global access science source*, 15 Suppl 1(Suppl 1), p.34.
Fitriani, R., 2015. Spatial Extent of Land Use Externalities in the Jakarta Fringe: Spatial Econometric Analysis. *Review of Urban and Regional Development studies*, 27(3).
Fogarty, M. & Garofalo, G., 1980. Urban size and the amenity structure of cities. *Journal of Urban Economics*, 361, pp.350–361.
Frank, L. et al., 2008. Urban form, travel time, and cost relationships with tour complexity and mode choice. *Transportation*, 35(1), pp.37–54.
Fu, S., 2007. Smart Café Cities: Testing human capital externalities in the Boston metropolitan area. *Journal of Urban Economics*, 61(1), pp.86–111.
Galster, G. & Cutsinger, J., 2007. Racial Settlement and Metropolitan Land-Use Patterns: Does Sprawl Abet Black-White segregation? *Urban Geography*, 28(6), pp.516–553.
Garate, S. & Pennington-Cross, A., 2013. Measuring the Impact of Agglomeration on Productivity: Evidence from Chilean Retailers. *Urban Studies*, 51(June 2014), pp.1–19.
Giles-Corti, B. et al., 2011. School site and the potential to walk to school: The impact of street connectivity and traffic exposure in school neighborhoods. *Health and Place*, 17(2), pp.545–550.
Glaeser, E.L., Gottlieb, J.D. & Ziv, O., 2016. Unhappy Cities. *Journal of Labor Economics*, 34(2), pp.S129–S182.
Glaeser, E.L., Gyourko, J. & Saks, R.E., 2006. Urban growth and housing supply. *Journal of Economic Geography*, 6(1), pp.71–89.
Glaeser, E.L. & Kahn, M.E., 2010. The greenness of cities: Carbon dioxide emissions and urban development. *Journal of Urban Economics*, 67(3), pp.404–418.
Gonçalves, E. & Almeida, E., 2009. Innovation and Spatial Knowledge Spillovers: Evidence from Brazilian Patent Data. *Regional Studies*, 43(4), pp.513–528.
Graham, D.J., 2007. Agglomeration, productivity and transport investment. *Journal of Transport Economics and Policy*, 41(3), pp.317–343.
Graham, D.J. et al., 2014. Quantifying Causal Effects of Road Network Capacity Expansions on Traffic Volume and Density via a Mixed Model Propensity Score Estimator. *Journal of the American Statistical Association*, 109(508), pp.1440–1449.
Graham, D.J. et al., 2010. Testing for causality between productivity and agglomeration economies. *Journal of Regional Science*, 50(5), pp.935–951.
Graham, D.J. & Glaister, S., 2003. Spatial Variation in Road Pedestrian Casualties: The Role of Urban Scale, Density and Land-use Mix. *Urban Studies*, 40(8), pp.1591–1607.
Guite, H.F., Clark, C. & Ackrill, G., 2006. The impact of the physical and urban environment on mental well-being. *Public Health*, 120(12), pp.1117–1126.
Harari, M., 2015. *Cities in Bad Shape : Urban Geometry in India*,
Harvey, C. et al., 2015. Effects of skeletal streetscape design on perceived safety. *Landscape and Urban Planning*, 142, pp.18–28.
Hatt, B.E. et al., 2004. The influence of urban density and drainage infrastructure on the concentrations and loads of pollutants in small streams. *Environmental Management*, 34(1), pp.112–124.
Henderson, V.J., 2003. Marshall's scale economies. *Journal of Urban Economics*, 53(1), pp.1–28.

Hilber, C.A.L. & Palmer, C., 2014. Urban Development and Air Pollution: Evidence from a Global Panel of Cities. *SSRN Electronic Journal*, (175).
Holden, E. & Norland, I., 2005. Three challenges for the compact city as a sustainable urban form: Household consumption of energy and transport in eight residential areas in the greater Oslo Region. *Urban Studies*, 42(12), pp.2145–2166.
Hong, J. & Shen, Q., 2013. Residential density and transportation emissions : Examining the connection by addressing spatial autocorrelation and self-selection. *Transportation Research Part D*, 22, pp.75–79.
Howard, B. et al., 2012. Spatial distribution of urban building energy consumption by end use. *Energy and Buildings*, 45, pp.141–151.
Howe, H.L., Keller, J.E. & Lehnherr, M., 1993. Relation between Population Density and Cancer Incidence, Illinois, 1986-1990. *American Journal of Epidemiology*, 138(1), pp.29–36.
Kaplan, S., Nielsen, T.A.S. & Prato, C.G., 2016. Walking, cycling and the urban form: A Heckman selection model of active travel mode and distance by young adolescents. *Transportation Research Part D: Transport and Environment*, 44, pp.55–65.
Kholodilin, K.A. & Ulbricht, D., 2015. Urban house prices: A tale of 48 cities. *Economics*, 9.
Kim, H.-K. & Sohn, D.W., 2002. An analysis of the relationship between land use density of office buildings and urban street configuration: Case studies of two areas in Seoul by space syntax analysis. *Cities*, 19(6), pp.409–418.
Knudsen, B. et al., 2007. *Urban density, creativity, and innovation*,
Kolko, J., 2012. Broadband and local growth. *Journal of Urban Economics*, 71(1), pp.100–113.
Krizek, K. & Johnson, P.J., 2006. Proximity to Trails and Retail: Effects on Urban Cycling and Walking. *Journal of the American Planning Association*, 72(1), pp.33–42.
Ladd, H.F., 1994. Fiscal impacts of local population growth: A conceptual and empirical analysis. *Regional Science and Urban Economics*, 24(6), pp.661–686.
Larsen, K. et al., 2009. The influence of the physical environment and sociodemographic characteristics on children's mode of travel to and from school. *American Journal of Public Health*, 99(3), pp.520–526.
Larson, W., Liu, F. & Yezer, A., 2012. Energy footprint of the city: Effects of urban land use and transportation policies. *Journal of Urban Economics*, 72(2–3), pp.147–159.
Larson, W. & Yezer, A., 2015. The energy implications of city size and density. *Journal of Urban Economics*, 90, pp.35–49.
Larsson, J.P., 2014. The neighborhood or the region? Reassessing the density-wage relationship using geocoded data. *Annals of Regional Science*, 52(2), pp.367–384.
Levinson, D., 2008. Density and dispersion: The co-development of land use and rail in London. *Journal of Economic Geography*, 8(1), pp.55–77.
Lewis, D.J., Provencher, B. & Butsic, V., 2009. The dynamic effects of open-space conservation policies on residential development density. *Journal of Environmental Economics and Management*, 57(3), pp.239–252.
Lin, B., Meyers, J. & Barnett, G., 2015. Understanding the potential loss and inequities of green space distribution with urban densification. *Urban Forestry and Urban Greening*, 14(4), pp.952–958.
Liu, C.H., Rosenthal, S.S. & Strange, W.C., 2016. *The Vertical City: Rent Gradients and Spatial Structure*,
Lobo, J., Strumsky, D. & Rothwell, J., 2013. Scaling of patenting with urban population size: Evidence from global metropolitan areas. *Scientometrics*, 96(3), pp.819–828.
Lynch, A.K. & Rasmussen, D.W., 2004. Proximity, Neighbourhood and the Efficacy of Exclusion. *Urban Studies*, 41(2), pp.285–98.
Maantay, J. & Maroko, A., 2015. 'At-risk' places: inequities in the distribution of environmental stressors and prescription rates of mental health medications in Glasgow, Scotland. *Environmental Research Letters*, 10(11), p.115003.
Mahoney, M.C. et al., 1990. Population density and cancer incidence differentials in New York State, 1978-82. *International Journal of Epidemiology*, 19(3), pp.483–490.
Maitra, B., Sikdar, P.K. & Dhingra, S.L., 1999. Modeling Congestion on Urban Roads and of Assessing Level of Service. *Journal of Transportation Engineering*, 125(6), pp.508–514.
Maloutas, T., 2004. Segregation and residential mobility. Spatially entrapped social mobility and its impact on segregation in Athens. *European Urban and Regional Studies*, 11(3), pp.195–211.
McDonald, J.F., 2009. Calibration of a monocentric city model with mixed land use and congestion. *Regional Science and Urban Economics*, 39(1), pp.90–96.
McMillan, T.E., 2007. The relative influence of urban form on a child's travel mode to school. *Transportation Research Part A: Policy and Practice*, 41(1), pp.69–79.
Melis, G. et al., 2015. The effects of the urban built environment on mental health: A cohort study in a large

northern Italian city. *International Journal of Environmental Research and Public Health*, 12(11), pp.14898–14915.
Miles, D., 2012. Population Density, House Prices and Mortgage Design. *Scottish Journal of Political Economy*, 59(5), pp.444–466.
Mindali, O., Raveh, A. & Salomon, I., 2004. Urban density and energy consumption: A new look at old statistics. *Transportation Research Part A: Policy and Practice*, 38(2), pp.143–162.
Mladenka, K.R. & Hill, K.Q., 1976. A reexamination of the etiologu of urban crime. *Crimonoly*, 13(4), pp.491–506.
Morikawa, M., 2011. Economies of Density and Productivity in Service Industries: An Analysis of Personal Service Industries Based on Establishment-Level Data. *Review of Economics and Statistics*, 93(1), pp.179–192.
Muñiz, I. & Galindo, A., 2005. Urban form and the ecological footprint of commuting. The case of Barcelona. *Ecological Economics*, 55(4), pp.499–514.
Murphy, E., 2009. Excess commuting and modal choice. *Transportation Research Part A: Policy and Practice*, 43(8), pp.735–743.
Nakaya, T. & Yano, K., 2010. Visualising crime clusters in a space-time cube: An exploratory data-analysis approach using space-time kernel density estimation and scan statistics. *Transactions in GIS*, 14(3), pp.223–239.
Newman, O. & Franck, K.A., 1982. The Effects of Building Size on Personal Crime and Fear of Crime. *Population and Environment*, 5(4), pp.203–220.
Newman, P. & Kenworthy, J., 1989. *Cities and automobile dependence : a sourcebook*, Aldershot : Avebury Technical.
Nielsen, T.A.S. et al., 2013. Environmental correlates of cycling: Evaluating urban form and location effects based on Danish micro-data. *Transportation Research Part D: Transport and Environment*, 22, p.4044.
Norman, J., MacLean, H. & Kennedy, C., 2006. Comparing high and low residential density: life-cycle analysis of energy use and greenhouse gas emissions. *J Urban Plann Dev*, 132(1), pp.10–21.
Osman, T., Divigalpitiya, P. & Osman, M.M., 2016. The impact of Built Environment Characteristics on Metropolitans Energy Consumption: An Example of Greater Cairo Metropolitan Region. *Buildings*, 6(2), p.12.
Ottensmann, J.R., 1977. Urban Sprawl , Land Values and the Density of Development. *Land Economic*, 53(4), pp.389–399.
Palm, M. et al., 2014. The trade-offs between population density and households' transportation-housing costs. *Transport Policy*, 36, pp.160–172.
Pendall, R. & Carruthers, J.I., 2003. Does density exascerbate income segregation. *Housing Policy Debate*, 14(4), pp.541–589.
Pouyanne, G., 2004. *Urban Form and Travel Patterns*,
Prieto, Á.M., Zofío, J.L. & Álvarez, I., 2015. Cost economies, urban patterns and population density: The case of public infrastructure for basic utilities. *Papers in Regional Science*, 94(4), pp.795–816.
Raleigh, E. & Galster, G., 2015. Neighborhood Disinvestment, Abandonment, And Crime Dynamics. *Journal of Urban Affairs*, 37(4), pp.367–396.
Rappaport, J., 2008a. A productivity model of city crowdedness. *Journal of Urban Economics*, 63(2), pp.715–722.
Rappaport, J., 2008b. Consumption amenities and city population density. *Regional Science and Urban Economics*, 38, pp.533–552.
Ratti, C., Baker, N. & Steemers, K., 2005. Energy consumption and urban texture. *Energy and Buildings*, 37(7), pp.762–776.
Raupach, M.R., Rayner, P.J. & Paget, M., 2010. Regional variations in spatial structure of nightlights, population density and fossil-fuel CO2 emissions. *Energy Policy*, 38(9), pp.4756–4764.
Reijneveld, S.A., Verheij, R.A. & de Bakker, D.H., 1999. Relative importance of urbanicity, ethnicity and socioeconomic factors regarding area mortality differences. *Journal of epidemiology and community health*, 53(7), pp.444–5.
Resch, E. et al., 2016. Impact of urban density and building height on energy use in cities. *Energy Procedia*.
Rosenthal, S.S. & Strange, W.C., 2008. The attenuation of human capital spillovers. *Journal of Urban Economics*, 64(2), pp.373–389.
Rothwell, J. & Massey, D.S., 2009. The Effect of Density Zoning on Racial Segregation in U.S. Urban Areas. *Urban Affairs Review*, 44(6), pp.779–806.
Rothwell, J.T., 2011. Racial enclaves and density zoning: The institutionalized segregation of racial minorities in the United States. *American Law and Economics Review*, 13(1), pp.290–358.
de Sa, E. & Ardern, C.I., 2014. Associations between the built environment, total, recreational, and transit-related physical activity. *BMC public health*, 14(1), p.693.

Saelens, B.E., Sallis, J.F. & Frank, L.D., 2003. Environmental correlates of walking and cycling: findings from the transportation, urban design, and planning literatures. *Annals of behavioral medicine: a publication of the Society of Behavioral Medicine*, 25(2), pp.80–91.
Salomons, E.M. & Berghauser Pont, M., 2012. Urban traffic noise and the relation to urban density, form, and traffic elasticity. *Landscape and Urban Planning*, 108(1), pp.2–16.
Sampson, R.J., 1983. Structural Density and Criminal Victimization. *Criminology*, 21(2), pp.276–293.
Sarzynski, A., 2012. Bigger Is Not Always Better: A Comparative Analysis of Cities and their Air Pollution Impact. *Urban Studies*, 49(14), pp.3121–3138.
Schiff, N., 2015. Cities and product variety: Evidence from restaurants*. *Journal of Economic Geography*, 15(6), pp.1085–1123.
Sedgley, N. & Elmslie, B., 2011. Do We Still Need Cities? Evidence on Rates of Innovation from Count Data Models of Metropolitan Statistical Area Patents. *American Journal of Economics and Sociology*, 70(1), pp.86–108.
Shunfeng, S., 1994. *Does Generalizing Density Functions Better Explain Urban Commuting? Some Evidence from the Los Angeles Region*,
Sivitanidou, R., 1995. Urban Spatial Variations in Office-Commercial Rents: The Role of Spatial Amenities and Commercial Zoning. *Journal of Urban Economics*, 38(1), pp.23–49.
Song, Y. & Knaap, G.J., 2004. Measuring the effects of mixed land uses on housing values. *Regional Science and Urban Economics*, 34(6), pp.663–680.
Speir, C. & Stephenson, K., 2002. Does Sprawl Cost Us All?: Isolating the Effects of Housing Patterns on Public Water and Sewer Costs. *Journal of the American Planning Association*, 68(1), pp.56–70.
Spencer, G.M., 2015. Knowledge Neighbourhoods : Urban Form and Evolutionary Economic Geography. *Regional Studies*, 49(5), pp.883–898.
Stankowski, S.J. & Trenton, N.J., 1972. Population Density as an Indirect Indicator of Urban and Suburban Land-Surface Modifications. In *U.S. Geological Survey Professional Paper*.
Su, Q., 2011. The effect of population density, road network density, and congestion on household gasoline consumption in U.S. urban areas. *Energy Economics*, 33(3), pp.445–452.
Tabuchi, T., 1986. Urban agglomeration, capital augmenting technology, and labor market equilibrium. *Journal of Urban Economics*, 20(2), pp.211–228.
Tang, C.K., 2015. Urban Structure and Crime. *Working Paper*.
Tang, U.W. & Wang, Z.S., 2007. Influences of urban forms on traffic-induced noise and air pollution: Results from a modelling system. *Environmental Modelling and Software*, 22(12), pp.1750–1764.
Tratalos, J. et al., 2007. Urban form, biodiversity potential and ecosystem services. *Landscape and Urban Planning*, 83(4), pp.308–317.
Travisi, C.M., Camagni, R. & Nijkamp, P., 2010. Impacts of urban sprawl and commuting: a modelling study for Italy. *Journal of Transport Geography*, 18(3), pp.382–392.
Tu, K.J. & Lin, L.T., 2008. Evaluative structure of perceived residential environment quality in high-density and mixed-use urban settings: An exploratory study on Taipei City. *Landscape and Urban Planning*, 87(3), pp.157–171.
Twinam, T., 2016. *Danger Zone: Local government Land use Regulation and Neighbourhood Crime*,
Vance, C. & Hedel, R., 2007. The impact of urban form on automobile travel: Disentangling causation from correlation. *Transportation*, 34(5), pp.575–588.
Veneri, P., 2010. Urban polycentricity and the costs of commuting: Evidence from Italian metropolitan areas. *Growth and Change*, 41(3), pp.403–429.
Walton, D., Murray, S.J. & Thomas, J.A., 2008. Relationships between population density and the perceived quality of neighbourhood. *Social Indicators Research*, 89(3), pp.405–420.
Wheeler, C.H., 2004. Wage inequality and urban density. *Journal of Economic Geography*, 4(4), pp.421–437.
Wilhelmsson, M., 2009. The spatial distribution of inventor networks. *Annals of Regional Science*, 43(3 SPEC. ISS.), pp.645–668.
Wong, N.-H. & Chen, Y., 2010. The Role of Urban Greenery in High-Density cities. In *Designing High-density Cities for Social and Environmental Sustainability*. London, Sterling VA: Earthscan.
Xiao, Y., Webster, C. & Orford, S., 2016. Identifying house price effects of changes in urban street configuration : An empirical study in Nanjing, China. *Urban Studies*, 53(1), pp.112–131.
Yang, J. et al., 2012. Transport Impacts of Clustered Development in Beijing: Compact Development versus Overconcentration. *Urban Studies*, 49(5), pp.1315–1331.
Zahabi, S.A. et al., 2016. Exploring the link between the neighborhood typologies, bicycle infrastructure and commuting cycling over time and the potential impact on commuter GHG emissions. *Transportation Research Part D*, 47, pp.89–103.

Zhang, M., 2004. The role of land use in travel mode choice - Evidence from Boston and Hong kong. *Journal of the American Planning Association*, 70(3), pp.344–360.

Zhao, P., 2014. The Impact of the Built Environment on Bicycle Commuting: Evidence from Beijing. *Urban Studies*, 51(5), pp.1019–1037.

Zhao, P., Luë, B. & de Roo, G., 2010. Urban expansion and transportation: The impact of urban form on commuting patterns on the city fringe of Beijing. *Environment and Planning A*, 42(10), pp.2467–2486.

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