Transport infrastructure and urban form: a review of causal evidence*

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Abstract

The link between urban development and transportation is vital for the social, environmental, and economic health of cities. While transport infrastructure is a key driver of urban growth, its effects are complex and context dependent. This review analyzes causal evidence on how highways, urban rail, and bus rapid transit (BRT) shape urban form.

The analysis focuses on floor space prices, population density, and suburbanization, while also considering the significant issues of segregation and displacement. We present results from a critical review, in which the methodology used to measure effects on urban form is thoroughly analyzed, and we select studies that employ robust econometric strategies to identify causal effects by addressing the endogeneity inherent to the relationship between transport and land use.

A major contribution of this work is the review of the main theoretical approaches to answer the question and the critical analysis of available empirical methods. Another significant contribution is to review the segregation and displacement caused by the three different types of transport infrastructure. To our knowledge, this is the first review to thoroughly analyze causal evidence across these distinct dimensions.

A fundamental duality emerges from the findings: while both highway and rail infrastructure can decentralize areas, they create distinct urban forms. Highway decentralization leads to low-density sprawl, whereas rail investments promote structured, polycentric development with dense subcenters. This understanding aids policymakers and urban planners by revealing distributional impacts and emphasizing the need for sustainable, equitable city designs.

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1. Introduction

Urban form is a key factor for social, environmental and economic sustainability in cities. It shapes how people interact, affects the environmental impact of urban development, and influences the efficiency of resource use and economic productivity. The size and density of cities are strongly correlated with their mobility patterns (Stead and Marshall, 2001; Camagni et al., 2002; Ewing and Cervero, 2010), carbon emissions (Glaeser and Kahn, 2010; Falahatkar and Rezaei, 2020; Hong et al., 2022), energy consumption (Chen et al., 2011; Kaza 2020), economic competitiveness and creativity (Bettencourt et al., 2007; Glaeser, 2011; Hamidi and Zandiatashbar, 2019), socio-spatial segregation levels (Gordon and Monastiriotis, 2006; Ewing et al., 2016), population health (Ewing et al., 2003; Genovese et al., 2023; Zhao and Kaestner, 2010) and overall perceived quality of life (Bardham et al., 2015; Mouratidis, 2019). Moreover, urban land cover is a key driver of climate change, affecting water cycles, reducing the soil's capacity to absorb carbon (Seto and Shepherd, 2009), and increasing the distance between food production and consumption (Chen et al., 2020).

Urban form is deeply interlinked with transportation. The location of housing and activities strongly depends on the accessibility provided by the transport system and reacts to changes in its level of service or coverage (Hansen, 1959; Geurs and van Wee, 2004). At the same time, the accessibility a transport system can provide will depend on the spatial distribution of population and activities within a city. This complex relationship lies at the core of several disciplines studying cities and has received wide attention for its relevance to strategic urban planning and public policy.

Transport infrastructure is one of the main elements defining transport supply. The construction of new infrastructure creates or improves accessibility in its vicinity and beyond, making specific locations more attractive and driving the city's growth, whether through expansion, densification, or the relocation of households and firms (Rietveld and Bruinsma, 2012). At the same time, the decision on where to build new transport infrastructure is often based on the location (current, expected or planned) of trip generators and attractors, which define the spatial structure of travel demand. This endogeneity prevents us from concluding that the construction of transport infrastructure is the leading cause of city growth or the only variable defining its shape. Nevertheless, its influence on urban form cannot be denied.

Understanding the impacts of the construction and spatial distribution of different types of transport infrastructure is key to urban planning, given their high construction costs and influence on the urban form and resulting mobility patterns. Moreover, urban planning can be a tool for climate change mitigation if it is oriented toward the evolution of more sustainable cities (Fang et al., 2015). From a transportation perspective, compact or dense cities are likely to facilitate or encourage active mobility (Heinen et al., 2010) and are better suited to the adequate provision of public transport (Ingvardson and Nielsen, 2018). On the other hand, expanded cities (or sprawl areas of a city) are likely to be more car-dependent and to hinder walking, cycling, and public transport provision and use (Newman and Kenworthy, 1989; Mattioli et al., 2020; Blandin et al., 2024). Public transport infrastructure is commonly assumed to induce higher density, while highways and other car-oriented infrastructure are considered to promote sprawl. Nevertheless, transit can also cause expansion or suburbanization (Baum-Snow et al., 2017; Garcia-López et al., 2024). At the same time, highways can induce densification, depending on their location within the city and other factors such as pricing schemes (Yudhistira et al., 2019).

Moreover, the changes in land prices triggered by transport infrastructure add complexity to the underlying urban dynamics in their area of influence. A growing body of research recognizes that the benefits and costs of transportation infrastructure are not distributionally neutral (Mayer and Trevien, 2017). Large-scale projects can create winners and losers, reinforcing or, at times, alleviating pre-existing social inequality patterns. For example, a new metro line will improve a neighborhood's accessibility, benefiting its residents. Still, it may also trigger gentrification that could ultimately expel the most vulnerable segments of its population.

This paper reviews the literature on the relationship between transport infrastructure and key quantifiable aspects of urban form: floor space prices, population density, and population suburbanization. The review also critically examines the evidence on how these projects impact neighborhood composition, welfare, and equity, moving beyond average effects to understand who benefits and who bears the costs of these investments. Given the complexity of urban form and transport infrastructure dynamics, the review focuses on studies that detect and measure causal effects, without aiming to cover all existing literature on the topic. We also provide a comprehensive justification for this decision by detailing the advantages and limitations of several approaches that address the relationship between transport infrastructure and urban form.

The review is organized by infrastructure type (highways, urban rail, and BRT) and by the impact on relevant urban form metrics (land prices, density, suburbanization, and segregation). To the best of our knowledge, this review is the first attempt to analyze empirical evidence of the effect of transport infrastructure on urban form in these dimensions.

The paper is organized as follows. Section 2 analyzes theoretical frameworks, modeling approaches, and empirical strategies developed to understand the impact of transport infrastructure and urban form. Section 3 explains the methodology of our review, the decisions about types of infrastructure and effects, and the econometric methods considered. The paper then reviews the evidence on the impact of transport infrastructure on property prices (Section 4), on density near infrastructure (Section 5), on decentralization and suburbanization (Section 6), and on segregation and displacement (Section 7). Finally, Section 8 summarizes the evidence and discusses policy implications and avenues for future research.

2. Frameworks to understand and measure the relation between transportation and urban form

Several theoretical frameworks and modeling approaches have been developed to understand and forecast the relation between urban form and transport infrastructure. We analyze the most relevant ones here, beginning with the monocentric city model, as the primary building block of modern urban economics. We then move to models that generalize the relationship between urban form and transportation.

2.1 The Monocentric City Model and Its Legacy

The monocentric city model developed by Alonso (1964), Mills (1967), and Muth (1969) is arguably the first conceptual model to provide insight into the relationship between urban form (generally understood as population distribution and density), land use, and transportation. The model provides explicit expressions for equilibrium properties in the absence of regulations and externalities and can deliver several key predictions, mostly about gradients, that are useful as a first-order approach to understanding cities. We briefly review the model in this Section and refer the reader to Brueckner (1987) for a graphical presentation and comparative statics, and to Duranton and Puga (2015) for an exposition of the model's basics and the extensions that have been developed over the years.

The model assumes that all consumption and production within the city occur at a single location, the Central Business District (henceforth, the CBD). Individuals have a fixed income, derive utility from consuming a numeraire good and housing, and must travel to the CBD. The city's extension is endogenous, and land is allocated to the highest bidder. As commuting costs increase with distance from the CBD, the income available for consumption decreases. As a result, the willingness to pay for floor space and land decreases with distance from the CBD in equilibrium. The tradeoff, thus, is between lower housing prices and higher commuting costs. Under this model, households consume more land as transport costs decrease and the city expands outward. The monocentric model's primary contribution is its elegant prediction that a fundamental trade-off between accessibility and space organizes urban spatial structure—a prediction supported by empirical work (see Section 4.2).

The core mechanism driving this result is spatial equilibrium. Households will only choose to live in a less accessible location if they are compensated by cheaper land, which allows them to afford more space. This simple trade-off explains the existence of land price gradients and the basic logic of suburbanization. This foundational concept of a trade-off between commuting costs and land costs remains the building block for virtually all modern urban economics models.

Now, regarding the effect of transport infrastructure on urban form, the monocentric model predicts that reducing commuting costs will extend the city. The intuition is simple: lower transportation costs make more distant locations relatively more attractive. This prediction is consistent with McGrath (2005), who finds that a 10% decrease in transportation costs induces a 2.8% increase in the urban area in the US. Similar results have been found in other contexts, as we detail below (see, e.g., Baum-Snow et al. (2017) for Chinese cities and Garcia-López (2019) for European cities).

A recent study by Liotta et al. (2022) assesses the model's ability to represent cities worldwide using data on population density, rents, dwelling size, land cover, and transport time from 192 cities. The model captures urban structures well, with most cities exhibiting the expected negative rent and density gradients. On average, a 1% decrease in income net of transportation costs leads to a 21% decrease in density and a 3% decrease in rents per m^2; moving 1 km farther from the city center decreases rents by

1.4% and population density by 8.5%. They also show that the model's predictions regarding urbanized areas are verified: cities spread out more when they are wealthier and more populated, and when transportation or farmland rents are lower.

Nevertheless, despite its foundational insights, the monocentric city model operates under several simplifying assumptions that limit its direct applicability.

2.1.1 Limitations of the Monocentric Model

As Duranton and Puga (2015) argue, the city's linearity, the restriction of urban travel to commuting only, and the simplification of the commuting costs are assumptions valid only for expositional purposes. Most of the main results can be generalized to extensions where the assumptions above are relaxed (Duranton and Puga, 2015). However, the static nature of the model, the fixed location of production and jobs, and the homogeneity of individuals oversimplify predictions and results about the urban form.

Furthermore, the model's assumption of homogeneous individuals limits its ability to explain how outcomes might differ for households of varying income levels or sociodemographic backgrounds. This simplification overlooks how factors such as housing market discrimination or pre-existing segregation can fundamentally alter the sorting patterns predicted by the model, leading to disparate impacts from the same reduction in commuting costs.

The model has been extended in many directions to address these simplifying assumptions. Important examples are Kanemoto (1980), Fujita and Ogawa (1982), LeRoy and Sonstelie (1983), Brueckner (1987), Lucas and Rossi-Hansberg (2002), among others, which include congestion externalities, housing production, heterogeneous individuals, multiple transportation modes, and agglomeration forces.

2.2 Land use change and LUTI models

Land-use change models are frequently used in geography to understand and predict natural and human changes in a territory (see Parker et al., 2003, for a review). Land use and Transport Interaction (LUTI) models are a sub-family of these models, focused on the spatial distribution of activities (e.g., households and firms) in a city, typically with a detailed interest in accessibility as one of the main drivers of relocation and location choice (see Bierlaire et al., 2015; Acheampong and Silva, 2015; Engelberg et al., 2021 and Wegener, 2021 for a review). In this context, accessibility is a quantitative indicator of how transport and land-use systems enable individuals to reach opportunities from each location in a city (Geurs and Van Wee, 2004) and an explanatory variable in location choice (Martinez, 1995). Accessibility is related to transport infrastructure because, generally, infrastructure provision increases overall accessibility in its surroundings. However, accessibility can also be improved by providing closer opportunities.

While implicitly considered in classic urban economic models through distance to the CBD, the correlation between broader definitions of accessibility and changes in urban form was identified long ago (Hansen, 1959) and empirically measured several times (Bhat and Guo, 2007; Schirmer et al., 2014). However, since accessibility can be associated with different types of opportunities, these correlations can be either positive or negative, depending on the type of agent being observed and the mode used to measure accessibility. For example, accessibility provided by public transport can have a positive effect on households without cars but a negative effect on households with several vehicles (Hurtubia and Bierlaire, 2014). Similarly, while access to work opportunities is usually positively correlated with residential location choice (Guo and Bhat, 2007; Lee and Waddell, 2010), the opposite holds for access to industrial zones (Cox and Hurtubia, 2020; 2021).

LUTI models aim to quantify (and eventually predict) how changes in accessibility trigger land-use changes and, consequently, densification or urban expansion. Some LUTI models adopt an approach that solves for an equilibrium (e.g., Martinez, 1996; Anas and Liu, 2007), while others directly microsimulate location choices parsimoniously without solving an equilibrium (e.g., Waddell, 2002; Salvini and Miller, 2005). LUTI models are commonly used to generate forecasts by simulating agent interactions, using elasticities from empirically estimated location-choice models. Typically, these elasticities are estimated using a reduced-form approach, in which the probability of agents choosing a location (or the observed share) is regressed on accessibility measures and other controls using cross-sectional data. For example, Avin et al. (2025) simulate the indirect land-use impacts of a proposed new highway near Portland (US) using a calibrated LUTI model. They calibrate the location parameters using “local expert knowledge and past trends” and iterations to fine-tune parameter settings to resemble past trends, by municipality, observed between 1995 and 2021. With this, they predict land-use changes in response to the highway for 2028 and 2045.

While helpful for evaluating policy or infrastructure scenarios, reduced-form estimates in LUTI models or their simulations generally do not allow for causal inference regarding the influence of infrastructure provision and changes in urban form.

2.3 Economic geography and quantitative spatial models

In contrast to the simulation-based approaches of LUTI models, the field of economic geography and quantitative spatial models focuses on incorporating causal evidence into a general equilibrium analysis. As Redding and Rossi-Hansberg (2017) argue, economic geography is the study of interactions among economic agents across geographic space. Early theoretical research on new economic geography stressed the combination of a taste for variety, increasing returns to scale, and transport costs as mechanisms for agglomeration and, thus, for the emergence of an uneven distribution of economic activity.

A QSM typically considers a city with a finite set of locations, and individuals or households choose their residence and workplace. Their amenities summarize the attractiveness of the locations for residence, and wages offered summarize the attractiveness of the workplace. Many of these studies rely on using Cobb-Douglas or CES utility and production functions to import values from the literature and aggregate expenditure surveys. The decisions are interrelated through the travel cost between the residence and the workplace, and these costs enter the utility function multiplicatively. Therefore, transport infrastructure affects households and firms by altering the origin-destination travel cost matrix.

As Redding and Rossi-Hansberg (2017) summarize, three key features of these models set them apart. First, they connect meaningfully with the observed data, thereby providing quantitative rather than qualitative answers. Second, these models identify the key structural parameters that need to be estimated to undertake such quantifications. Third, and arguably most important, they permit specificity in addressing counterfactual questions: For example, if a highway is built between two city areas in this country, what are the quantitative effects on these locations, population density, prices, and wages?

2.4 Reduced-form econometric approaches.

The previously discussed modeling approaches typically include components that aim to describe the behavior or preferences of the involved agents, which are estimated using econometric techniques. However, econometric models have also been used to measure directly and (if possible) explain the impact of transport infrastructure on the urban form. While the most basic approaches can only measure correlations, recent methodological advances and the availability of new, richer data allow for the estimation of more sophisticated models capable of identifying causal relationships.

The main challenge in measuring the causal effects of transport infrastructure is identifying and isolating endogeneity (the fact that infrastructure is not built at random). For example, when urban growth is planned alongside transport infrastructure, it would be wrong to assume that the observed increase is due solely to infrastructure provision. However, information on the planning process or other dynamics influencing urban growth is often available only in general or detailed terms. Several techniques have been developed to address this shortcoming, which will be briefly described next.

To understand this problem formally, consider a typical specification (Eq. 1) where an outcome P_{it} is regressed on a treatment variable T_{it}; for example, the result can be the average land price or the density in a zone i at a time t and the treatment variable an indicator of whether a new subway station was opened in that zone. The core issue is that the error term, ε_{it}, is likely correlated with the placement of the infrastructure, T_{it}, biasing the estimate of its effect.

$$P_{it} = A + \eta T_{it} + \beta X_{it} + \varepsilon_{it} \qquad (1)$$

Other relevant attributes of the zone are included in the vector X_{it}. The term ε_{it} is a stochastic error following a yet-to-be-defined distribution (usually normal). Parameters A, η and β have to be estimated, which is typically done through least-squares or maximum-likelihood methods.

These methods will yield unbiased estimates only if the error term is uncorrelated with the treatment variable. The lack of correlation can sometimes be addressed by including all relevant attributes in the vector X_{it}. However, in most cases, unobserved variables or attributes correlate with the treatment and the independent variable. Also, reverse causality can be an important source of endogeneity.

A way to deal with unobservable factors is the incorporation of “fixed effects,” that is, including zone-specific (δ_i) and period-specific (θ_t) constants in the specification of Eq. (1). Another possibility, known as “first differences,” is to specify the model to measure the relation between changes (differences) of the relevant variables across periods. Therefore, a model considering both fixed effects and first differences will have the following specification:

$$\Delta P_{it} = A + \eta \Delta T_{it} + \beta \Delta X_{it} + \delta_i + \varepsilon_{it} \qquad (2)$$

Nevertheless, these methods do not guarantee that all unobserved attributes are accounted for. Further improvements in modeling methodologies to account for endogeneity include the use of instrumental variables and the differences-in-differences approach. The latter is based on using panel data to measure the difference over time between treated and untreated (e.g., with and without the development of new transport infrastructure) observations and comparing these differences. The central assumption for this method to deliver causal estimates is the so-called parallel-trend assumption. Before the infrastructure investment, both groups must exhibit no difference in their evolution over time. This typically requires data for a period before treatment.

A complementary method is using instrumental variables. The strategy considers the inclusion of a new variable (Z_{it}), which is correlated with the treatment but not with the outcome. This variable is used in an additional regression, in which the treatment is modeled as a function of it and other zonal attributes.

$$T_{it} = B + \gamma x_{it} + \rho Z_{it} + \mu_{it} \qquad (3a)$$

$$Z_{it} = B + \phi x_{it} + v_{it} \qquad (3b)$$

The most common way to estimate the key parameter γ is to use two-stage least squares (2SLS). In the first stage, Eq. (3b) is estimated by OLS, producing the predicted treatment value. In the second stage, T_{it} is regressed against x_{it} and Z_{it}, yielding the 2SLS estimator γ.

Instrumental variables are commonly employed in urban economics to quantify, for instance, the causal effect of transport infrastructure on different outcomes. As reviewed by Redding and Turner (2015), the literature has followed three main instrumental variables strategies: planned routes, historical routes and the inconsequential place approach. Baum-Snow (2007) pioneered the planned routes IV approach using a 1947 national interstate highway plan to instrument the total number of highways built between 1950 and 1990 in the US. On the other hand, the historical route instrumental variable approach relies on old transportation routes as a source of quasi-random variation in observed infrastructure. Finally, the inconsequential place approach relies on selecting an inconsequential sample in which unobservable attributes do not affect infrastructure placement.

These approaches have been used to study, for example, the impact of providing more lane kilometers on increased vehicle kilometers traveled (Duranton and Turner, 2011; Hsu and Wang, 2014; Hymel, 2019) or the influence of transport infrastructure provision on a city's shape and size, as discussed in this paper below. The challenge, though, is to find a valid instrument, i.e., one that is correlated with the treatment but only affects the outcome through the treatment.

Finally, spatial difference-in-differences (S-DID) leverages time and space by comparing pre-/post-outcomes across locations with different treatment intensities (e.g., distance rings around new stations or ramps), while controlling for area fixed effects and common shocks. By defining treated neighborhoods via proximity thresholds and estimating local treatment effects, S-DID captures, for instance, capitalization while mitigating site-selection bias and anticipatory dynamics. For a methodological analysis, see Butts (2023) and Dubé et al. (2024).

In summary, the instrumental variable method extracts variation in the variable of interest that is unrelated to endogeneity problems. It uses this variation to estimate its causal effect on an outcome measure. Difference-in-differences, on the other hand, relies on finding an adequate control group that approximates the treatment group's path and on the assumption that the treatment is not endogenous. Techniques to find an adequate control group include propensity score matching and spatial thresholds (S-DID). Finally, both strategies can be combined to yield a more credible causal effect.

Having outlined the various econometric techniques, comparing these approaches to location choice models and LUTI models helps clarify their respective strengths and limitations in addressing causality.

2.5 Comparison of approaches

Table 1 provides a schematic summary of the theoretical approaches reviewed here and highlights the fundamental trade-offs in the literature. The monocentric city model offers a strong yet simple theoretical foundation that helps explain the intuition behind many urban phenomena. On the other hand, the LUTI models are centered on reproducing agents' behavior and forecasting, even if causality is imperfect. QSM models focus on quantifying welfare impacts, accounting for changes in the city's labor and housing markets.

3. Methodology and classification for the review

To identify a pool of candidate papers for our review, we primarily used the Scopus and WoS databases, and Google Scholar as a complementary source. As a first step, we searched for papers including "urban form", "transport infrastructure", "Highways", "Freeways", "Rail", "Metro", "Subway", "Bus Rapid Transit", "Land price", "Property price", "Urban density", "City Size", "Suburbanization", "Decentralization", "Urban sprawl", "Displacement", "Segregation", "Transit-Oriented Development" and "Gentrification" in the abstract or as keywords. In a second step, we also considered the articles that cite the relevant literature reviews identified in the first step. Both steps yielded a very large number of papers, which were screened to select those that addressed the relationship between transport infrastructure and urban form (over 100 papers).

In this review, to determine whether a study is relevant to our analysis, we consider three main aspects: the type of infrastructure analyzed, the variables (or type of effect) quantified as outcomes, and the empirical strategy used in the methods. The latter is key to the critical approach we take in our review. While numerous studies explore the link between transport infrastructure and urban form, only a subset uses robust empirical methods to infer causality.

Table 1: Comparison of theoretical approaches.

Dimension	Monocentric city model	LUTI models	Quantitative spatial models (QSM)	Reduced-form econometric models
Primary goal	Provide foundational intuition about urban spatial structure and land rent gradients.	Simulate the future spatial distribution of activities based on transport-land use interactions.	Conduct quantitative, general equilibrium counterfactual analysis of specific policies.	Estimate the direct causal impact of a specific intervention on an outcome, while accounting for endogeneity.
Key assumptions	A single CBD, homogeneous agents, fixed workplaces, and a simple trade-off between housing and commuting costs.	Behavior is driven by empirically estimated elasticities from location choice models.	Multiple locations, heterogeneous agents (via idiosyncratic preferences), and endogenous economic mechanisms.	Statistical assumptions are paramount (e.g., parallel trends for DID, exclusion restriction for IV).
Handling of equilibrium	Models a spatial general equilibrium where utility is equalized across all locations.	Simulation-based approach in which agent interactions yield a forecasted spatial pattern, sometimes a general equilibrium.	Models a general equilibrium incorporating multiple locations, trade, and mobility connections.	Focuses mainly on estimating the direct, partial-equilibrium effect of a "treatment".
Approach to causality	Primarily a theoretical tool that offers qualitative predictions, not empirical causal estimates.	Forecasts are based on correlations and calibrated parameters; they are not designed for causal inference.	Strong emphasis on causality; often uses quasi-experimental estimates to discipline the model's key structural parameters.	Its central focus is to isolate causal effects using quasi-experimental methods such as IV and DID to address endogeneity.
Typical output	Predictions on how city size and price/density gradients change in response to shocks.	"What-if" scenario forecasts urban development patterns under different transport or land-use policies.	A quantitative answer to a specific policy question (e.g., "What is the effect of this new highway?") considering welfare and the labor market.	A statistically estimated causal parameter (e.g., the elasticity of house prices concerning transit proximity).

Our selection methodology yielded a final set of 39 articles for our critical review, which are listed and generally described in Tables A, B, and C in Sections 4, 5, and 6, respectively. The remainder of the section details each aspect of our methodology.

3.1 Types of transport infrastructure

If an investment in transport infrastructure affects transportation costs and/or accessibility, it should impact urban form. We identify three groups that cover most cases and that are well studied in the literature. We use these groups to organize the review and provide clear-cut intuitions.

The first group of infrastructure we analyze is highways, which include urban and interurban highways, whether underground or above ground, with entries and exits within a city's urban limit. The second group is urban rail. We identified several studies that appraised the effects of various types of trains: urban, suburban, interurban, underground, light rail, and combinations. Usually, the train description includes a few details, such as operational differences and service quality. Moreover, in some cities, the system (or a line) is called a subway, even if some portions operate above-ground. To overcome classification difficulties, we include all trains with stops within the urban limit and on exclusive right-of-way in the same category, denoted urban rail, regardless of size, elevation, or fare. Our definition is consistent with Gonzalez-Navarro and Turner (2018), who studied the effects of subways on 632 cities, using "[...] an electric powered urban rail that is completely isolated from interactions with automobile traffic and pedestrians" as a definition.[1]

We also discuss a complementary policy within the urban rail category: Transit-Oriented Development (TOD). TOD is commonly understood as compact, mixed-use development near transit facilities and high-quality walking environments (Newman and Kenworthy, 1996; Lund et al., 2004). The economic impact of a new transit station can be significantly amplified when the investment is paired with a supportive, pedestrian-oriented urban environment.

Finally, a third type of investment in transportation infrastructure is the so-called Bus Rapid Transit (BRT). According to ITDP (2016, page 4), "Bus rapid transit (BRT) is a bus-based system that can achieve high capacity, speed, and service quality at relatively low cost by combining segregated bus lanes that are typically median aligned with off-board fare collection, level boarding, bus priority at intersections, and other quality-of-service elements (such as information technology and strong branding)." We have found significant heterogeneity in the amount of investment and infrastructure built; for example, the Institute for Transportation and Development Policy (ITDP) developed a certification program for BRT corridors across four categories based on their design and operations (ITDP, 2016). Moreover, the effect of the investment in BRT systems depends heavily on complementary policies, or the lack thereof, regarding the bus network operation. For example, Basso et al. (2019) show that a BRT system increases consumer welfare only if the bus fleet and frequency are also increased. Indeed, Gomez-Lobo (2020) shows that the implementation of BRT systems in Colombia, except for Bogotá's TransMilenio, increased travel costs

[1] See Gonzalez-Navarro and Turner (2018), Section 4.4. on page 89.

because it also involved reducing the bus fleet. When reviewing investments in BRT systems, we include information about the quality of the service and infrastructure, if available.

We also explored including cycling infrastructure in our review. However, while several studies report that the presence of nearby bike lanes, paths or trails is positively correlated with property prices (Lindsey et al., 2004; Asabere and Huffman, 2009; Parent and Vom Hofe, 2013; Liu and Chi, 2017; Conrow et al., 2021; Vega et al., 2024) results vary strongly depending on the type or quality of the cycling infrastructure and may even be non-significant for some cases (Dahir and Le, 2025). Moreover, all studies focusing on cycling infrastructure measure correlations using hedonic models and cannot conclude on the causal effect of such facilities on land prices. Therefore, we excluded this type of infrastructure from the literature review.

In summary, we classify the types of infrastructure for the review into three categories: (i) highways, (ii) urban rail, and (iii) BRT systems. Having defined the types of transport infrastructure under review, we now focus on the specific urban form outcomes most frequently studied in relation to these investments.

3.2 Type of effect on the urban form

The term urban form usually refers to a set of variables that determine a city. To compare across studies, we focused on four categories of effects that a transport infrastructure may have. These categories are: (i) residential property prices, (ii) population density in the vicinity of the infrastructure, (iii) population suburbanization, and (iv) displacement and segregation. As discussed below, the four effects are interrelated, but grouping them helps provide a better picture of the evidence.

Even though, strictly speaking, the property prices are not part of the urban form, they are a relevant variable for several reasons. First, it is a primary driver of real estate development (Redding and Turner, 2015). Second, the change in residential property prices due to transportation improvement measures reflects the private valuation of the increased accessibility. Third, due to its nature, it reflects the impacts of infrastructure in the short run.

The impact on the population density around the new infrastructure represents the local effect in the urban form induced by changes in accessibility. Depending on the location of the infrastructure, it could mean consolidating an already developed neighborhood or expanding the city. A rise in land prices and population density near infrastructure is typically observed.

On the other hand, population suburbanization is a global effect, which we interpret as an increase in the share of the population living outside a city's central area. This is closely related to urban expansion, as it reflects the increased attractiveness of the suburbs relative to the center, driven by lower transportation costs. If a regulation imposes a rigid urban limit, suburbanization can be associated with increased population density in the existing suburbs, which is not necessarily expansion. Therefore, suburbanization is a more accurate measure of the willingness to locate far from the CBD. Analogously, a transport investment may induce urban sprawl without suburbanization if the central areas and periphery become more densely populated.

Finally, displacement and segregation refer to the forced movement of people from their homes and communities, a phenomenon often caused by large-scale infrastructure projects. When governments build transport infrastructure, they usually route these projects through existing neighborhoods. This process often involves demolishing residences, compelling individuals and families to relocate. Such forced relocation is not just a simple move; it represents a disruption that can break social networks and inflict long-term psychological and health damages, such as increased mortality rates.

3.3 Econometric methods

As we review in Section 2, there are several approaches to estimate the effect of investment in transport infrastructure on urban form. We focus on the studies that come closer to estimating the causal impact of an actual investment. For this reason, we do not review effects reported by simulated models, such as land-use/transport interaction (LUTI) models. Although they are often used to study the impact of transport infrastructure, they are typically calibrated using exogenous parameter estimation via maximum likelihood with cross-sectional data. For similar reasons, we include the results of the so-called quantitative spatial models of cities, provided there is causal reduced-form evidence.

Our review does not claim to be comprehensive; instead, it focuses on causal evidence, i.e., papers that address the endogeneity issue to some extent. For example, we do not consider studies that use only cross-sectional data, as addressing causality requires at least data before and after the infrastructure is opened (or announced). Tables A, B, and C in Sections 4, 5, and 6, respectively, summarize the studies that fulfill these criteria.

Within the group of papers that address the endogenous location of infrastructure, we differentiate those that use a difference-in-differences (DID) approach, a spatial difference-in-differences (S-DID) approach, and those that include instrumental variables estimated with two-stage least squares (IV or 2SLS). The latter is the primary empirical approach to estimating a causal effect (Redding and Turner, 2015).

The empirical evidence we review primarily comes from reduced-form estimations that use the distance of a geographical unit of analysis (e.g., a block or zone) to the infrastructure as a proxy for accessibility. The distance-based measures define one influence area, e.g., within a certain distance of the infrastructure, and compare outcomes with a control group that is as similar as possible to the treated group before the intervention. Typically, the distance-based approach defines adjacent rings or buffers of distance and measures impacts nonparametrically, using a sufficiently far ring or the rest of the city as the control.

On the other hand, models based on discrete choices within the city, such as LUTI and QSM models, provide a theoretical foundation for a gravity-based measure of accessibility (Martinez, 1995). The idea behind it is that what matters is accessibility to opportunities. These can be measured considering the distance or travel time to all possible destinations, using a decay function that gives more weight to closer opportunities (see, e.g., Anas, 1981, for a general discussion and Anas and Kim, 1996, for an application to a general equilibrium model of a city). Also, opportunities are weighted based on an ad-hoc variable. For instance, in assessing labor-market accessibility, LUTI models commonly weight destinations by the number of jobs or the built-up area of work-related land uses, whereas QSMs weight destinations by average wage. When reviewing the evidence, we distinguish which of the two measures is being used.

While we focus on studies using instrumental variables and difference-in-differences, we discuss how some estimates from simpler linear models compare with the evidence, especially to highlight whether they are consistent with what we consider plausible causal evidence.

4. Property prices

New transportation infrastructure generally increases accessibility to jobs, shops, education, and other amenities. This improvement usually triggers effects, typically an increase in the prices of dwellings and some non-residential buildings in the vicinity of the infrastructure. However, the construction of highways and urban rail lines also produces negative externalities, such as noise and pollution from the increased traffic, that may lower the value of nearby dwellings. Thus, a lower price increase or even a price drop may be observed in properties close enough to be affected by these externalities. In this regard, we review the available evidence on highways and urban rail, highlighting the heterogeneous effects on proximity to ramps/stations, when available.

Table A summarizes the causal impacts of transport infrastructure on property prices. We discuss them in detail below.

4.1 Highway

There is ample evidence about the impacts of highway construction on prices. Most studies use simple methodologies and estimate a version of equation (1). Most of these articles find a positive correlation between highway proximity and floor space prices (e.g., Tchang, 2016; Neelawala et al., 2015; Seo et al., 2014). Other studies deepen the analysis by differentiating properties near the highway from those close (5-15 minutes' drive). The main effect is an increase in prices, but closer to the highway, the effect is lower or even negative sometimes (e.g., Kilpatrick et al., 2007; Kim et al., 2007; Iacono and Levinson, 2011; Chernobai et al., 2011; Allen et al., 2015). Lastly, Ryan (2005) is one of the few who study non-residential properties and report a positive relationship between office and industrial property prices and highway proximity.

Most studies addressing endogenous infrastructure location use a difference-in-differences approach. Levkovich et al. (2016) studied the effect of the announcement and opening of two highways in the Netherlands. They find that housing values in the surrounding residential areas increase between 2% to 4%. Consistent with rational expectations and forward-looking behavior, they find that prices increased before the highway's opening. Complementarily, Paliska et al. (2018) report an 11% price increase in dwellings near a highway in Slovenia, while Theisen and Emblem (2021) report a 5% increase in Norway for dwellings near highways inaugurated in 2009.

Table A. Capitalization into prices near transport infrastructure.

Study	Place and Period	Infrastructure	Treatment	Control group	Price (model)	Effect	Notes
Beenstock et al. (2016)	Israel (1999–2008)	Highway	Travel time to highway (within 70 min)	70 min from the highway	Sales (Hedonic)	+2% immediate; +4% [15–20 min distance]	Inverted-U shape; uses time, not distance.
Cohen and Schaffner (2019)	Germany (2007–2017)	Highway (A38)	Drive-time (within 5 and 15 min.)	The rest of the city	Sales and Rents (Hedonic)	Sales: +11–21% (5–15 min from highway)	Inverted-U shape, smaller effect on rents. 5 min threshold for rent and 15 for sales.
Harris et al. (2024)	Texas	Road upgrades	Distance (within 0.5km)	Properties 0.5-1 km from the project	Sales (Repeat-Sales)	a 1.2% (construction), +1.3% (completion).	
Levkovich et al. (2016)	Netherlands (2000s)	Highway (A30 and A50)	Gravity-based accessibility change (>2.5%)	Accessibility change <1.5%	Sales (Hedonic)	A50: +9% (construction), +15% (opening); A30: −4% (construction), −7% (opening)	A30 had limited accessibility gains
Paliska et al. (2018)	Slovenia (2003-2015)	Highway	Municipality connected by highway	Ad-hoc region	Sales (Hedonic)	+11%	
Theisen and Emblem (2021)	Norway (2003-2013)	Highway	The town is connected by highway	Ad-hoc region	Sales (Hedonic)	+5%	
Ahlfeldt (2013)	London (1995–2008)	Rail (JLE/DLR)	Gravity-based accessibility (within 2km)	The rest of the city	Sales (Hedonic)	1 p.p. accessibility ↑ → +2.5% prices	Robust to alternative control groups.
Billings (2011)	Charlotte (1997–2008)	Light Rail	Distance (within 1.6km)	Planned not-built line	Sales (Hedonic)	Houses: +4%; Condos: +11%	Controls for price gradients.
Diao, Leonard and Sing (2017)	Singapore (2004–2012)	Metro (CCL)	Distance (within 0.6km)	The rest of the city	Sales (Hedonic)	+8.6% [≤0.6 km]	Anticipation ~1y; strongest within 600m
Dubé et al. (2013)	Montreal (1992–2009)	Commuter rail	Rings around stations (within 1.5 km)	The rest of the city	Sales (Hedonic)	+3-10% on average	Largest effect within 0.5km.
Dubé et al. (2018)	Dijon (2001–2014)	Upgrade BRT→LRT	Rings around stations (within 0.6 km)	Properties within 0.6km of pre-existing station	Rents (Hedonic)	+5–8% [0.3–0.5 km] (only center)	Offset announcement-stage negative effect
Gibbons and Machin (2005)	London (1997–2002)	Rail (JLE/DLR)	Decreased proximity and within 2km	Rest of the city	Sales (Hedonic)	+5–6% per km closer	
Gupta et al. (2022)	New York (2003-2019)	Subway	Rectangular area along the corridor	Rest of neighborhood (Upper East Side)	Sales (Hedonic and repeated sales)	+6-10%	Robust to distance-based measures of treatment. Half of the impact is realized during construction

Study	Place and Period	Infrastructure	Treatment	Control group	Price (model)	Effect	Notes
He et al. (2024)	Shenzhen (2016–2020)	Metro	Rings around stations (within 1km)	Planned not built line	Sales and Rents (Hedonic)	Rents: +15–24% [0–0.2 km]; +9–21% [0.2–0.8 km]	Rents more reliable than sales; heterogeneity across lines
Li et al. (2016)	Beijing (2001–2013)	Subway	Per km closer (within 7km)	Rest of the city	Sales (Hedonic)	>+15% per km closer	Heterogeneous with distance
Melser (2020)	Sydney (1990–2017)	Rail (ECRL)	Distance (within 1.5km)	Rest of the city	Rents (Hedonic)	+5–10%	Estimates for rents are more precise than sales
Mohammad et al. (2017)	Dubai (2007-2011)	Urban Rail	Rings around stations (within 1.5)	Rest of the city	Sales (Hedonic)	Maximum effect at 1km: +8% (residential); +40% commercial	Inverted-U shape
Pilgram and West (2018)	Minneapolis (1990-2014)	LRT (Blue Line)	Distance (within 0.8km)	Ad-hoc; between 0.8 and 1.6km; Rest of the city	Sales (Repeat-Sales)	+4–7% within 0.8km	Sensitive across control groups. Only consistent for years immediately after opening.
Yen et al. (2018)	Gold Coast (1996–2016)	LRT	Distance (within 0.8km)	Properties 0.8–1.6 km from the station	Sales (Hedonic)	+12% (announcement); +38–40% (commitment and construction); +45% (opening)	No negative impact within 100m
Acton et al. (2022)	US (1990–2016)	BRT	Distance (within 0.8km)	Matched properties (propensity score)	Sales (Hedonic)	+1–15% (for 3 out of 11 systems)	No or negative effect for dedicated bus lanes
Beaudoin and Tyndall (2023)	Vancouver, WA (2013–2019)	BRT	Walking time (within 20 min)	>30 min	Sales (Hedonic and Repeat-Sales)	+5–7%	Value uplift exceeds construction cost ×6
Dubé et al. (2024)	Québec City (2017–2022)	BRT	Distance (within 0.8km)	Rest of the city	Sales (Repeat-Sales)	+2-20%	Inverted-U with distance: maximum effect +20% at 0.25km.
García-López and Gómez-Hernández (2024)	Medellín (2008–2018)	BRT and Tram	Rings around stations (within 0.9km)	Matched properties (propensity score)	Rents (Hedonic)	Tram: +4% [≤0.3 km]; BRT: −6% [≤0.3 km]	

Note: This table summarizes estimates of the impact of transport infrastructure on property prices. It includes details on location, infrastructure type, treatment and control definitions, modeling approach, and observed price effects, highlighting consistent capitalization and spatial heterogeneity across modes and contexts. Unless otherwise stated, all studies use a DID approach, with the treatment and control definition in columns 4 and 5. Sales refers to property transactions and rents to rental prices.

Levkovich et al. (2016) disentangle the drivers of the positive effect by estimating the impact of the increased accessibility and externalities. The results show a positive valuation for accessibility and a negative impact on noise pollution and traffic intensity. Indeed, when looking at the highways separately, they found that one of them led to a 2-4% decrease in housing values. They conclude that the negative externalities outweigh the positive effects of increased accessibility along that highway.

Consistent with these findings, Beenstock et al. (2016) find that the price impact of a new highway in Israel follows an inverted U-shape, balancing accessibility gains against negative externalities near the road. Indeed, the price impacts begin with a 2% value increase for the houses next to the highway and reach a maximum of 4% for those 15 minutes away by car.

This key finding—that the largest price gains are not immediately adjacent to the highway but slightly farther away—is not unique to this context. In fact, consistent evidence from Germany shows an almost identical pattern, with maximum price uplifts of 11% and 21% for homes 5 to 15 minutes from the highway, respectively, compared to a 5% increase for the closer locations (Cohen and Schaffner, 2019).

Beyond the construction of new infrastructure, there is evidence that upgrading existing roads may have a positive but weaker effect. For example, Harris et al. (2024) found that road construction in Texas positively affected nearby home values, with a 1.2% increase during construction and a 1.3% increase upon completion. While intersection projects showed a slightly higher initial increase (2.1%) than widening projects, this difference was not economically significant, and post-construction increases for both types were small and not statistically significant.

4.2 Urban rail

As with highways, there is strong evidence of a positive correlation between proximity to urban rail stations and prices across various locations. These include studies using data from Madrid (Dorantes et al., 2011), Naples (Pagliara and Papa, 2011), Taiwan (Andersson et al., 2010), New York (Hess and Almeida, 2007), Sunderland (Du and Mulley, 2007), Greece (Efthymiou and Antoniou, 2013), Chile (Agostini and Palmucci, 2008), California (Cervero and Duncan, 2002), and other US cities (Baum-Snow and Kahn, 2000). We are unaware of any study reporting negative price impacts.

Early quasi-experimental studies using a difference-in-differences approach established a clear, positive causal link between proximity to new urban rail and rising property values. For instance, Gibbons and Machin (2005) showed that the expansion of the London Underground increased prices by 2% for each kilometer of reduced distance to a station. Similar evidence from North Carolina documented a 4% price premium for homes within a mile of a new transit line, with an even larger 11% increase for condominiums (Billings, 2011). These studies cemented the consensus that accessibility benefits from rail are capitalized into housing prices.

Gibbons and Machin (2005) compare their difference-in-differences estimates with cross-sectional estimates. This comparison helps determine whether and to what extent the estimation of simpler models that use only control variables to address endogeneity is biased. The results show that cross-sectional estimates have a strong upward bias. Estimates are about three times higher, suggesting a positive correlation between prices and infrastructure (i.e., areas with higher land values are more likely to "receive" a subway station).

Bowes and Ihlanfeldt (2001) found significant positive direct effects of rail proximity in affluent areas within 0.25 to 3 miles of a station. The most pronounced effect was observed in the 0.5 to 1-mile radius, 12 miles from the Central Business District (CBD). This suggests that high-income homeowners prioritize transit accessibility, and this premium increases with distance from the CBD. Conversely, beyond 0.25 miles from a station, negative direct effects were primarily confined to low-income neighborhoods. In middle- and high-income neighborhoods, the benefits of reduced commuting costs from transit outweigh any negative externalities.

There is ample evidence about the phenomenon using a DID approach in the literature. For example, Dubé et al. (2013) show that a new subway line in Montreal increased the price of houses within walking distance (1.5km) by 2.6% on average. Li et al. (2016), using subway expansions in Beijing, find that a 1 km reduction in distance to the nearest subway station increases property value by over 15 percent for properties within 3 km of a station. They also report that the effect is heterogeneous concerning distance to the subway. Mohammad et al. (2017) also provide evidence of a positive impact using data from Dubai. They found that the maximum price increase happened between 700 and 900 meters from a station: 13% and 76% for houses and commercial properties, respectively.

Complementary, Yen et al. (2018) find a substantial price increase using Australia's Gold Coast Light Rail announcement and inauguration. They found that for properties between 100 and 400m, prices increased 12% with the announcement and 26% in the final stage. They also see no effect (or even a negative one) for properties within 100 meters of a station, indicating that negative externalities are relevant near the stations. Indeed, the negative impact near stations has been documented in studies that do not address endogeneity (see, e.g., Debrezion et al., 2011; Pan, 2013; Bohman and Nilsson, 2016; AlQuhtani and Anjomani, 2019).

Pilgram and West (2018) study the effect of the METRO Blue Line in Minneapolis, Minnesota, on prices using repeated-sales data. Using a DID approach, they find that initial price premiums can fade quickly over time, hinting at the complexity of these effects. Using a spatial difference-in-differences approach, Diao et al. (2017) study the impact of Singapore's Circle Line (CCL) on housing values. They found that opening the CCL increased housing values by approximately 8.6% in treated neighborhoods within 600 meters of new stations, with anticipation effects observed a year before opening.

Gupta et al. (2022) studied the impact of the Second Avenue subway extension in New York City. Their research focused on how this investment affected commuting times, property prices, and rents. They found that real estate values increased by 6–10% near subway stops compared to other properties in the Upper East Side neighborhood. They also showed that approximately half of the effect occurred during construction, pointing to significant anticipation effects.

Indeed, over the last five years, the long-held consensus of a simple, positive price uplift from urban rail has been substantially revisited. New evidence, including meta-analyses and rigorous quasi-experimental studies, reveals that the impact is highly heterogeneous and contingent on various local factors.

A meta-analysis by Rennert (2022) provides systematic evidence of this heterogeneity, revealing that capitalization effects are contingent on geography and rail type. For example, rail access premiums in East Asia are, on average, 7.4 percentage points lower than in North America. Moreover, commuter rail generates significantly higher premiums than light rail (9.6 percentage points), followed by heavy rail/metro systems, which are 4 percentage points higher than light rail. Furthermore, the analysis shows that public policy can directly mediate market outcomes; rent control policies are associated with a 5.3 percentage point lower premium, indicating that regulatory environments can suppress the capitalization of accessibility benefits. Overall, this marks a critical shift in the literature, moving from asking if transit adds value to asking when, where, and why it does so.

There is also evidence that upgrading service levels may positively affect prices. Dubé et al. (2018) analyze the impact of replacing a Bus Rapid Transit (BRT) system with a Light Rail Transit (LRT) service on real estate prices, specifically apartment transactions in Dijon, France, between 2001 and 2014, using a difference-in-differences (DID) approach. The study considered different project phases and distances to stations and the city center, revealing that the upgrade significantly affected location rents, primarily within 300-500 meters of new stations. While a positive impact was observed in the city center, where passenger usage was highest, areas outside the city center showed mixed results: a negative impact within 300-500 meters of a station and a positive effect between 500-600 meters.

4.2.1 Gravity-based accessibility

As reviewed in Section 2, the theory behind LUTI and QSM models relies on discrete choices by residents, firms and workers (e.g., Ahlfeldt et al. 2015). This generally leads to gravity-based accessibility measures: individuals value access to all destinations, but with an exponential decay function.

A key study by Ahlfeldt (2013) utilized gravity-based employment accessibility to forecast property prices, specifically examining the impact of the Jubilee Line and Docklands Light Railway extensions in Greater London. The study found that models incorporating gravity-based employment potential significantly improved explanatory power compared to distance-based accessibility (e.g., proximity to the nearest station). The study finds that a 1 percentage point increase in employment accessibility raises prices by about 2.5%.

He (2020) used multilevel models to measure MTR network accessibility in Hong Kong and its impact on residential property prices between 2001 and 2011. The results indicate that new rail lines improved accessibility across the region, increasing house price elasticity in all 59 submarkets. This result confirms that public transport accessibility is crucial for transit-oriented cities, and homebuyers will pay more for better access.

Finally, Silva et al. (2025) adopt a gravity-based approach to examine the impact of transport infrastructure on property prices in Santiago. They compute the so-called Commuter Market Access (CMA): a negative exponential function that weights destinations by the average wage rates firms offer. The study deals with the endogenous infrastructure location using instrumental variables based on planned subway lines. They find that, between 2001 and 2010, transport infrastructure investment significantly boosts residential property prices: a 10% increase in Commuter Market Access (CMA) leads to a 14% price surge. A typical subway extension increases CMA 120-130% within 250m of a new station.

4.2.2 Rent vs prices

Melser (2020) challenges the traditional approach of using home prices to assess the impact of new infrastructure on housing values, advocating instead for the use of home rents. The author highlights the "anticipation effects" associated with home prices, in which values can increase significantly before a project's completion. This approach necessitates a longer analytical timeframe, which creates substantial data demands and complicates the fulfillment of the "common trends assumption" crucial for difference-in-differences (DID) analysis.

In their empirical study of Sydney's Epping-to-Chatswood rail link, Melser (2020) found that using rents yielded consistent and robust results. Specifically, they observed a 5-10% rise in rental values near the new train stations, diminishing this effect to zero beyond 1.5 km. While sales prices showed broadly similar results, they were, on average, higher and, more critically, "somewhat unstable" across various models and time periods. The author attributes this instability to the probable failure of the assumption of common trends over the extended period required for price analysis. Consequently, the paper underscores the risks of relying on sales prices. It demonstrates that rents offer a practical, potentially more reliable alternative for quantifying the capitalization effects of new infrastructure.

Further supporting the reliability of rents, He et al. (2024) provide causal evidence regarding the influence of new metro lines on housing prices and rents in Shenzhen, China. This study also concluded that rents served as a more reliable indicator than sales prices, which are susceptible to speculation. For Line 7, prices and rents saw substantial increases (with rents experiencing a 9.4% premium). However, for Line 11, only rents increased significantly (by 16.4%), potentially due to pre-existing speculation and a high housing supply. The study also identified a spatial gradient in the rent premium, with the most significant increases observed near stations (e.g., a 24.4% premium for Line 11 within the 0-200m band).

4.2.3 Transit-Oriented Development

The literature consistently finds that TOD generates larger property value uplifts than transit infrastructure in isolation (Knaap et al., 2001; Cervero and Murakami, 2009; Syabri, 2011; Mathur and Ferrell, 2013). A study by Duncan (2011), for example, compares property prices within 300m of light-rail stations coupled with TOD with those 1.6km away, differentiating neighborhoods by pedestrian quality. He finds that prices in neighborhoods with high-quality pedestrian infrastructure are 11% to 15% higher near the station than 1.6km away. On the other hand, in areas with poor walkability, prices near stations are 7% to 11% lower than at 1.6km.

This synergy arises because good urban design addresses the 'last-mile problem.' TOD effectively expands the station's catchment area by making it safer and more pleasant to walk to and from the station, thereby enhancing its accessibility. The value, therefore, is derived not just from the transit service itself, but from the seamless integration of that service into the community. This highlights a crucial insight for policy: evaluating transit infrastructure in isolation may understate its economic impact, underscoring the importance of integrated planning.

Debrezion et al. (2007) present a meta-analysis that incorporates 57 empirical studies from the 80s and 90s. The authors estimate an average increase of 4.2% in housing prices within a 250 m radius, while commercial property prices increase by 16.4% in the same radius. Beyond this distance, residential prices rose by 2.4% for every 250 m of proximity to the station, whereas for commercial properties the effect was only 0.1%.

In this same study, Debrezion et al. (2007) hypothesize that the effect of implementing urban trains on property prices is mediated by the robustness and demand for the city's public transportation system. The price increase should be lower if the transport network and infrastructure are mainly oriented toward car use, e.g., within a city with a dense highway network. Evidence supporting this hypothesis is provided by Gatzlaff and Smith (1993) for Miami and Forouhar (2016) for Tehran.

4.3 Bus Rapid Transit

BRT systems have demonstrated a positive influence on property values, with a meta-analysis of 23 studies by Zhang and Yen (2020) revealing an approximate 4% increase in land value for systems operational for at least three years. Beaudoin and Tyndall (2023) investigated the impact of a BRT project in Vancouver, Washington, on local real estate prices. Using a difference-in-differences method, their study found a 5%–7% price premium for homes within a 20-minute walk of a BRT station. This indicates that the BRT project generated new real estate value, exceeding its construction costs sixfold. The authors further explore how governments could utilize these future increases in residential property value to finance subsequent BRT projects.

A comparative study by Acton et al. (2022) disaggregates the impacts of BRT systems by design features. They found that 3 of the 11 BRT systems increased residential property values near stations by 1% to 15%; one system decreased values; and the remaining systems experienced no significant change. Importantly, those based on dedicated busways rather than corridors had either a negative or no significant impact on residential property values. This evidence is consistent with the findings of González and Silva (2025) that dedicated bus lanes are ineffective in improving speeds.

Tsivanidis (2023) investigated the effects of Bogotá's TransMilenio, its Bus Rapid Transit (BRT) system. The study utilized a gravity-based measure and estimated reduced-form regressions to determine the elasticity of outcomes concerning Commuting Market Access (CMA). Tsivanidis found that residential cadastral values exhibited elasticities of approximately 0.37–0.38 relative to CMA. The study also employed historical tram and least-cost-path instrumental variables, which produced comparable or even greater effects. It is worth noting that cadastral values are only imperfect proxies for property prices. For example, Lozano-Gracia and Anselin (2012), using data from Bogotá, show that even the best cadastral value models perform poorly and that their predictive performance varies by socio-economic stratum, suggesting relevant biases.

Dubé et al. (2024) applied a DID framework to the implementation of a Bus Rapid Transit (BRT) system in Québec City. To conclude, the decomposition of the average treatment effect based on distance to the CBD and the nearest station provides more nuanced information about how the impact varies across space (and time). Houses within 250-650m of a station and 2,500m of the CBD exhibit a statistically significant inverted U-shaped price premium. This peaks at 12.1% for houses 350m from a station in the CBD, decreasing to 1% at 650m. While a positive premium exists for stations farther from the CBD, it is not statistically significant.

A 2024 study by Garcia-López and Gómez-Hernández examined the impact of Medellín's Metroplús (BRT) and Tranvía (tramway) on housing rental prices from 2008 to 2018. Using a difference-in-differences method, they found that proximity to Metroplús negatively affected rental prices, whereas proximity to Tranvía had a positive impact, particularly within 300 meters of stations. The authors suggest that Metroplús's negative externalities (e.g., traffic, noise) may have outweighed its benefits, whereas the tramway's positive effects may stem from improved amenities and downtown connectivity.

5. Population density in the vicinity of the infrastructure

In this section, we discuss studies about population density in the vicinity of the infrastructure, including impacts on related local outcomes, such as residential floor space. Table B summarizes the causal evidence.

5.1 Highway

The first article to study and develop the Planned Route instrumental variable discussed in Section 2.4 was Baum-Snow (2007). He analyzes suburbanization in the US using a 1947 plan for the US Interstate Highway network as an instrument for the actual network. Subsequent studies have continued to use IVs to estimate the causal effect of highways on population density near the infrastructure. The finding that highways spur population density growth in their immediate vicinity is robust across diverse international contexts, particularly in suburban areas.

Table B. Changes in local density around infrastructure.

Study	Place and period	Infrastructure	Identification	Treatment definition	Outcome	Scale	Impact	Heterogeneity	Timing	Notes
García-López (2012)	Barcelona (1986–2001)	Highway	19th-c. Railroad plan	Δ km to nearest highway	Population density growth	Region-wide	+3-7% per km closer	Stronger in suburbs	Post-Opening	Highways reallocate growth along corridors.
García-López et al. (2015)	Spain (1960–2011)	Highway	Historical routes	Proximity to new rays	Population density/growth	National (77 MAs)	Positive along new highways	Across cities	Long-run. (51 yrs.)	Consistent with suburbanization findings.
Yudhistira et al. (2019)	Jakarta (1990–2014)	Highway	Least-cost paths	Proximity to ramps	Population density	Metropolitan Area	+4% per km closer (suburbs)	No effect in core	Post-Opening	Localized to the periphery.
Zhao et al. (2017)	Beijing (2000–2010)	Urban Rail	1957 subway plan	Reduced distance	Population growth	Metro-wide	+3% per km closer	Inner suburbs only	Post-Opening	
		Expressway					No impact	Non		Low car ownership may mute effects.
García-López et al. (2017)	Paris (1968–2010)	Rail	19th-c. Railroad plan	Rail access to CBDs	Employment subcenters	Metro-wide	More subcenters with rail	Stronger where TOD allowed	Staged openings	Polycentricity.
Tsivanidis (2023)	Bogotá (1998–2014)	BRT (TransMilenio)	Historical tram and least-cost paths	Log CMA	Residential population	City-wide	Residential sorting by skill level	Small skill heterogeneity	Post-Opening	QSM sufficient-statistics approach.
Bocarejo et al. (2013)	Bogotá (2001-2008)	BRT (Transmilenio)	No IV DID instead	≤500 m from BRT line	Population density	City-wide	+10%	n.a.	Post-Opening	BRT did not induce a significant increase in commercial or residential floor space.
Hodgson (2018)	American West (19th c.–2010)	Railway	Least-cost paths	≤5 km of a railroad	Post office survival	Regional	+7–12 pp likelihood of survival	n.a.	Long-run (>100 yrs)	Uses post office survival as a proxy for long-term economic density and agglomeration.
Silva et al. (2025)	Santiago (2001–2010)	Highways and Urban Rail	Planned subway lines and highway	Commuter Market Access (CMA)	Residential floor space and units	Metropolitan Area	Positive	Effects vary by zoning and socioeconomic status	Post-Opening	Uses housing development as a proxy for population density.

Note: This table presents causal evidence on how transport infrastructure influences population and employment density in its vicinity. Identification strategies are based on Instrumental Variables unless otherwise stated. It includes treatment definitions and observed impacts, emphasizing the role of accessibility improvements in shaping local urban form. Post-Opening refers to a few years after opening, unlike the long run, which is decades after.

The finding that highways spur population density growth in their immediate vicinity is robust across diverse international contexts, particularly in suburban areas. For instance, studies in Spain document an 8% increase in local population growth for each kilometer closer to a highway (Garcia-López, 2012; Garcia-López et al., 2015), while similar densification, albeit at a smaller 4% magnitude, has been observed in Jakarta's suburbs (Yudhistira et al., 2019). This effect is not universal, however. Research from the Beijing Metropolitan Area, for example, found no significant population growth from expressway expansion, a result the authors attribute to the city's low motorization rates and the relative unattractiveness of its suburbs (Zhao et al., 2017).

A study by Levkovich, Rouwendal, and van Ommeren (2020) in the Netherlands found that post-1960s highway expansions significantly increased population in peripheral municipalities but not in suburban areas. This "leapfrog" pattern, diverging from typical suburbanization, was driven by strict planning policies such as the 'Green Heart' and buffer zones, which limited development near city centers. The effect peaked between 1970 and 1980, after which a new equilibrium was reached.

Complementary to this, Silva et al. (2025) examine the impact of highways and urban rail on residential floor space and housing units in Santiago between 2001 and 2010. They use the gravity-based Commuter Market Access measure using wages as destination weights. While these outcomes are not population density, they constitute a good proxy. Silva et al. find that between 2001 and 2010, improved Commuter Market Access due to highways is highly heterogeneous across zoning regulation and socioeconomic status. In most areas, unit development occurs across all regulatory levels, with a more sizable impact on residential floor space where regulation allows multifamily housing. By contrast, transport infrastructure increases units and floor space in the top socioeconomic quintile when regulation is less permissive, indicating limited multi-family housing development.

5.2 Urban rail

Garcia-López (2012) is among the first to employ an IV approach to study the effects of urban rail infrastructure on population density. He finds that census tracts in Barcelona's suburbs (suburban subcenters and non-central suburban areas) near rail stations experience greater population density growth. Being 1 kilometer closer to the station implies increases of 8% and 25% in population density for subcenters and non-central suburban areas, respectively. He finds that the effect is insignificant for central business district census tracts.

In a similar study, Garcia-López et al. (2017) show that the RER network in Paris increased employment and population density around stations. Using historical instruments, the study shows that getting 1km closer to an RER station raises, on average, employment by 2 percent and population by 1 percent. These figures are much more significant for non-central municipalities within 5km of an employment subcenter, reaching 12% and 9%.

Yudhistira et al. (2019) also used an IV approach to examine the effect of railways on population density in Jakarta. They differentiated the results by dividing the metropolitan area into central Jakarta, city suburbs, and the suburban regions farther away. They find that only in the farther-out suburbs, which are on average 41 km from the city center, being 1 km closer to a railway station has a significant effect, estimated to be a 1.3-1.7% increase in population density. Similar results are found by Zhao et al. (2017) using Beijing data. They find that the IV estimates imply a 2.7% population growth for each kilometer reduced to the nearest subway station. When disaggregated by part of the city, the effect is more significant in the inner and outer suburbs.

5.2.1 Related outcomes

Some articles explore the impacts of urban rail on variables that reflect or are strongly associated with population density. We review them as they are relevant to understand local density effects.

Garcia-López et al. (2017) find that a rail station in Paris increases the probability of a suburban municipality becoming a subcenter by 5-10%. They also report that a 10% increase in municipality proximity to a suburban rail station increases its probability of being part of a sub-center by 3 to 5%. Hodgson (2018) provides evidence of agglomeration by studying the effect of railway stations on the probability that a late 19th-century post office survives to 2010. He finds that being within 5 km of the railroad increases the likelihood that a post office is still functioning in 2010 by 7-12 percentage points relative to post offices located more than 50 km from the railroad.

Silva et al. (2025) studied the impact of highways and urban rail in Santiago between 2001 and 2010 using the Commuter Market Access measure. They find that housing unit development has larger implications for residential floor space when regulation allows multifamily housing, except in areas where most residents belong to the top socioeconomic quintile. They find that transport infrastructure increases units and floor space when regulation is less permissive, indicating muted multi-family housing development.

González-Navarro and Turner (2018) use satellite data from the 632 largest cities in the world and light intensity as a proxy for economic activity. They find that cities with larger subway systems have a flatter light gradient; moreover, they show that density declines much more slowly along subway lines than along other radial transport infrastructures emanating from the city center.

5.3 BRT

The evidence about the impact of BRT infrastructure on density is scarce. Bocarejo et al. (2013), using a simple DID approach, show that Transmilenio increased population density within 500m of BRT by approximately 10% relative to the rest of the city. Regarding changes in land use, they report that the BRT did not induce a greater increase in built areas for commercial, office, or residential use.

6. Decentralization and suburbanization

The foundational finding that highways reduce population densities in central cities and facilitate suburban growth is robust and consistently supported by recent evidence reviews. Table C summarizes the causal impacts on decentralization and suburbanization that are discussed in this section.

Table C. Suburbanization/centralization effects at the metropolitan scale.

Study	City / Years	Infrastructure	Instrument	Unit of analysis	Outcome	Metric	Elasticity / Effect size	Timing	Notes
Baum-Snow (2007)	US MSAs (1950–1990)	Highways / rays	1947 Highway Plan	MSA / central city	Central-city population level and share	Highway rays	Each additional highway → −18% pop; −9% share	Long-Run (40 yrs)	Counterfactual growth absent interstates.
García-López et al. (2015)	Spain (1960–2011)	Highways / radial rays	Historical routes	Metro areas	Central-city pop. and suburban pop.	Rays; ramp access	−8% to −9% central-city; +≈20% suburban per additional ray	Long-Run (51 yrs)	EU evidence.
Baum-Snow et al. (2017)	China (1990–2010)	Highways and ring roads; rail	Historical treaty port network	Prefecture cities	Central-city pop.; industrial GDP	Radials; ring roads	Radial: −≈4% central-city; ring: −≈20%; radial rail: −20% industrial GDP	Long-Run (20 yrs)	Stronger in coast/central.
Levkovich et al. (2020)	Netherlands (1970–2000)	Highway expansion	Roman roads	Municipalities	Population growth	Rays / SD increase	One st dev. highway extent +7–10% peripheral growth	Long-Run (30 yrs)	Leapfrog
García-López (2019)	EU cities (1990–2012)	Highways / stock (km)	Roman roads	Cities	Sprawl index (area, fragmentation, isolation)	Highway km stock	+10% highways → +1.1% area; +2% lots; +25 pp isolation; −0.6% density	Long-Run (22 yrs)	Highways explain sizable land expansion/fragmentation.
González-Navarro and Turner (2018)	632 cities (1950-2010)	Urban rail	Geology (bedrock depth)	Cities	Population growth, decentralization	Rail network	No effect on urban population growth. Decentralization (small relative to radial highways)	Long-Run (60 yrs)	Decentralization measured via light-based indices
García-López et al. (2024)	Europe (1990–2015)	Transport access (roads/rail)	Historical networks	Cities	Suburbanization metrics	Access index	Transport improves suburban growth	Long-Run (25 yrs)	Continent-wide evidence.
Ahlfeldt and Wendland (2011)	Berlin (1890–1936)	Urban rail	Least-cost path	Commercial land plots	Decentralization	Reduced travel time to the CBD	Reduced travel times explain ~72% of decentralization	Long-Run (46 yrs)	Measures decentralization via changes in commercial land values. Flattening of the land value gradient

Note: This table compiles long-run evidence on how transport infrastructure affects the spatial distribution of population and economic activity across metropolitan areas. It focuses on decentralization trends driven by highways and rail, using instrumental variable strategies to isolate causal effects.

6.1 Highway

As discussed above, Baum-Snow (2007) pioneered the study of the effects of highways on the suburbanization of cities using instrumental variables. He analyzed the impact of highway provision in the US Metropolitan areas (MSAs) between 1950 and 1990. The main finding is that each new highway led to an 18% decrease in central city population. Baum-Snow (2007) also finds that an additional ray causes approximately a 9 percent decline in the central city population. Further calculations based on his estimations show that, instead of decreasing by 17%, the aggregate central city population would have increased by 8 percent if the interstate highway system had not been built.

Building on the seminal work of Baum-Snow, recent research has expanded the evidence and used new quantitative spatial models to clarify the precise role of highways in the suburbanization of population and employment.

Garcia-López (2012) extends Baum-Snow's (2007) results, showing that Barcelona's highways led to suburbanization. Garcia-López et al. (2015) deepen the understanding by analyzing the effect of highways on the suburbanization of Spain's 77 largest metropolitan areas. The main findings are that each radial highway caused an 8–9% decline in central city population (between 1960 and 2011) and a 20% increase in the suburban population in the same period.

Consistent with previous studies, but using China as a case study, Baum-Snow et al. (2017) find that each radial highway moves 4% of the central city population to the suburbs. Furthermore, additional ring-road capacity reduced the city's population by about 20%.

In the Netherlands, Levkovich et al. (2020) find that a standard deviation increase in highway ray provision accelerates population growth in the periphery by 7%. Importantly, they find that restrictions on urban development in some peripheral regions can shift the population that would otherwise have been in those areas to sectors farther away. In other words, the regulation generates a 'leapfrog' development pattern in which suburban growth bypasses development-restricted areas and expands into more distant peripheral regions.

Garcia-Lopez's (2019) comprehensive analysis examines the effects of highways on urban sprawl. The study utilizes Corine Land Cover data and highway network information for 579 European cities across 1990, 2000, and 2012. Urban sprawl is assessed through three key dimensions: residential land expansion, land fragmentation into separate lots, and isolation of new developments (measured by the percentage of surrounding undeveloped land). To address endogeneity in highway construction, the study employs an instrumental variables (IV) strategy, using the length of ancient Roman roads as the primary instrument. This leverages the historical tendency for modern infrastructure to follow older routes, which are otherwise uncorrelated with contemporary land development patterns.

Garcia-Lopez's findings indicate that highways significantly contribute to residential sprawl. Specifically, a 10% increase in highway stock (km) leads to a 1.1% increase in residential land area, a 2% increase in residential lots, and a 25 percentage-point rise in the share of undeveloped land surrounding residential areas over 20 years. This expansion also results in a 0.6% reduction in residential density. The author estimates that highway construction between 1990 and 2012 was responsible for at least a quarter of the observed growth in residential areas and a third of the increase in fragmentation during that time. The paper suggests that policies to control sprawl should include road pricing mechanisms or the strategic placement of highway access ramps to guide development patterns.

Finally, there is significantly less evidence on the suburbanization of employment. Baum-Snow (2020) studies the impact of highways on the joint spatial distributions of population and employment using the same empirical strategy as Baum-Snow (2007). He finds that while each radial highway decentralized approximately 15% of the central city's working population to suburbs, only 5% of the jobs were displaced.

These results confirm that highways contribute to residential sprawl by expanding cities with new, more fragmented, and isolated land developments.

6.2 Urban rail

Consistent with the findings on population density, recent studies confirm that urban rail also acts as a decentralizing force, though its effects are generally smaller than those of highways. A critical emerging theme is the potential for rail-induced suburbanization to create unintended negative consequences, such as increasing overall car dependence.

The global study by González-Navarro and Turner (2018) remains the key large-scale evidence on this topic, finding that doubling a city's subway supply causes a modest decentralization of economic activity. This effect is smaller than that documented for highways. Specifically, they build a panel dataset of population and centralization measures using satellite nightlight data and the subway network for the 632 largest cities in the world. With a strategy based on IVs, they find that doubling the supply of urban trains would generate 2.2% of population decentralization, while an additional radial line would generate 0.5%.

Heblich et al. (2020), structurally estimating a quantitative model of urban economics for London, find that the technological change introduced by steam rail enabled the first large-scale separation of homes and workplaces. They find that the population in London's historic center at night fell from 130,000 in 1831 to less than 14,000 in 1921. At the same time, the number of people present on the day more than doubles due to faster train travel.

Studying Berlin from 1890 to 1936, Ahlfeldt and Wendland (2011) analyze the impact of the urban railway system on the city's spatial structure using a historical dataset of commercial land values. They document a significant decentralization process, finding that the land-value gradient flattened considerably; the premium for being 1 kilometer closer to the CBD fell from 75.5% in 1890 to 35.9% in 1936. The authors use an instrumental variables (IV) strategy based on the least-cost path to establish a causal link. The study's central conclusion is that the railway was the primary driver of decentralization.

Three articles can compare the effects of urban rail with those brought by highways. First, Garcia-López (2012) finds that urban railway lines densify more in the CBD than in the subcenters or periphery and generate less suburbanization than radial highways. Interestingly, Baum-Snow et al. (2017) find that urban railway systems in China mainly decentralize economic activity, as measured by industrial GDP, and do not significantly affect the central city population. The authors estimate, using IV, that radial train lines displace about 20% of central-city industrial GDP.

Garcia-López et al. (2024) investigate the impact of highway and railroad improvements on population suburbanization in European cities from 1961 to 2011. They investigate the same 579 cities across 29 European countries as Garcia-López (2019). To establish causal inference, the researchers employed historical instruments. Their findings indicate that highways, but not railroads, were a significant factor in suburbanization, with each additional highway ray leading to a 5-percentage point decrease in the central city population share. New railroads, conversely, showed no discernible impact. The study also reveals heterogeneous patterns influenced by the timing of the investment, city size and density, and geographical location.

7. Segregation and displacement

Transport infrastructure can generate both physical and economic displacement. Physical displacement occurs when construction requires the expropriation or demolition of homes, often disrupting communities and imposing long-term social and health costs. Economic displacement, by contrast, arises indirectly through rising property values and rents—effects documented in Section 4—making neighborhoods unaffordable for lower-income residents. While these outcomes reflect market responses to improved accessibility, they raise critical equity concerns about who benefits and who is pushed out. This section reviews the empirical literature on these impacts, focusing on highways, urban rail, and BRT systems.

7.1 Highway

A recent strand of literature has focused on investigating the individual negative impacts from highway construction in terms of displacement, segregation, long-term adverse effects (e.g., mortality rates) and to what extent they explain the well-documented central-city population decline.

The literature about the US highway system is more abundant, with three articles standing out:

- Brinkman and Lin (2024) studied reduced-form population and income responses in a 1950–2010 panel of 64 U.S. metros and quantified freeway disamenities with a quantitative GE spatial model for Chicago.
- Weiwu (2024) builds a GE spatial framework that embeds empirical estimates from disaggregated 1960–1970 Census microdata for 25 cities to study the distributional incidence of Interstate highways.

- Valenzuela-Casasempere (2025, Job Market Paper) provides micro-evidence on individual harms from highway construction using linked records that follow 1940 Census residents into 1995–2005 mortality.

These studies provide a multifaceted view of the harms caused by highway construction, ranging from broad neighborhood-level disamenities to severe individual-level health outcomes.

Brinkman and Lin (2024) focus on quantifying the scale of freeway disamenities and find that they are a major driver of central-city population decline. Their estimates suggest that negative externalities, such as noise and pollution, reduce local amenities by about 18% and account for roughly one-third of the population loss in central cities. The welfare impact is significant; fully mitigating these disamenities would yield an estimated 5.6% gain.

Building on this, Weiwu (2024) examines the distributional incidence of these impacts, revealing stark racial disparities. The study shows how pre-existing segregation and institutional constraints meant that the costs of highways were disproportionately borne by Black households, who experienced smaller gains or even net welfare losses compared to White residents.

At the most granular level, Valenzuela-Casasempere (2025) documents the direct and tragic human cost of displacement. By tracking individuals over decades, the study finds that those whose homes were demolished for highway construction died approximately three months earlier than their peers. This increased mortality is explained mainly by forced relocation to neighborhoods with lower socioeconomic status, underscoring a severe, long-term harm that would have raised the Interstate system's construction costs by an estimated 10% if internalized.

Complementary evidence has also confirmed the barrier effect, leveraging massive, geolocated online social network data (Aiello et al., 2025). This research demonstrates a significant and consistent decrease in social connectivity across highways in all 50 of the largest U.S. cities. This effect is particularly strong over short distances and in areas with a history of racial segregation.

Causal evidence on the long-term impacts of highway-induced displacement is scarce elsewhere. We mention studies on the issue in other countries, acknowledging that much research remains to be done.

In Europe, descriptive evidence shows that highways generate opposition, displacement and segregation. Examples in Europe include Birmingham's Inner Ring Road (O'Farrell, 2020), Berlin's A100 motorway (Soederberg, 2025), and Paris' Boulevard Périphérique (Bourgeois et al., 2022).

There is also descriptive evidence on highways and displacement in India (Negi and Ganguly, 2011), and on informal settlements located in the periphery, close to the urban fringe and primary highways in Bogotá and São Paulo (Morales, 2023).

7.2 Urban Rail

While the literature extensively documents the positive impact of urban rail and BRT on property values, a more critical perspective reveals that these gains are not universally beneficial. The same market forces that drive land value uplift can also trigger gentrification, leading to what can be termed economic displacement. Unlike the direct, physical displacement caused by highway construction, this process is more subtle. As new, high-quality transit makes a neighborhood more attractive, rising rents and property values can render it unaffordable for incumbent residents, often lower-income. This transforms the positive outcome of increased property values into a significant equity challenge, potentially displacing the very communities the transit investment was meant to serve.

Mayer and Trevien's (2017) work in Paris provides empirical evidence of this dynamic. Analyzing the impact of the RER system, they found that while the new rail lines spurred an 8.8% increase in employment near stations, they also fundamentally altered the local population. The areas around new stations saw a significant increase in the concentration of high-skilled professionals and managers, a classic indicator of gentrification. This finding illustrates a crucial policy tension: the success of a transit project in generating economic activity and land value can simultaneously displace vulnerable populations and alter a neighborhood's social fabric, complicating the narrative of public transit as an unambiguous urban good.

Using the Panel Study on Income Dynamics (PSID) from 1970 to 2014, two studies tracked residents' movements from new transit neighborhoods across the United States. Delmelle and Nilsson (2020) investigated the displacement hypothesis, which suggests that lower-income residents disproportionately move out just before or after a new transit station opens. Their national-scale findings provided no significant support for this hypothesis. At the same time, lower-income residents were more likely to move; those in new transit neighborhoods were not significantly more likely to relocate. This held for renters and homebuyers across different decades, with various definitions of 'transit neighborhood'.

In a follow-up analysis, Nilsson and Delmelle (2020) examined the neighborhood relocation choices of those who moved out of new transit areas to understand the broader impact of transit stations on metropolitan sorting patterns. Their analysis revealed some unequal sorting outcomes: middle- and higher-income homeowners who moved out were more likely to relocate to neighborhoods with a higher income composition, whereas lower-income homeowners and renters did not experience a higher probability of neighborhood upgrading based on income.

Lee and Tan (2024) studied the impact of Singapore's Downtown Line opening, utilizing transit farecard data. Their findings indicate a significant increase in welfare for high-income workers, with minimal gains for low-income workers. While access to consumption opportunities improved for everyone, low-income jobs in non-tradable sectors shifted to less desirable workplaces.

7.3 Bus Rapid Transit

Causal evidence about segregation and displacement induced by BRT systems is scarce. This shortage is likely due to several reasons. One is that BRT systems have been implemented more recently than highways and urban rail, and displacement and segregation are long-term effects. Another is that these systems are more prevalent in low-income countries, where data on the spatial distribution of income and employment are more challenging to obtain.

Mwesigwa et al. (2024) investigated the accessibility and equity of Dar es Salaam's BRT system in Tanzania. Their descriptive findings revealed considerable disparities in access to BRT stops and stations across different socioeconomic groups, with the most affluent populations benefiting disproportionately. This trend was consistent throughout all phases of the BRT network, indicating that system enhancements primarily served wealthier residents. As new phases were introduced, the ongoing rise in the Multidimensional Poverty Index (MPI) in areas not covered by the BRT further underscored the need to address equity issues within the system.

A study by Tsivanidis (2023) on Bogotá's TransMilenio BRT system found that the infrastructure increased wages and prompted residential sorting, with high-skilled workers relocating to neighborhoods that gained better market access. While the project generated overall welfare gains, the study estimates these benefits were not shared equally, resulting in a mild 0.55% increase in welfare inequality. This disparity arose from competing factors: although low-skilled workers benefited from higher usage of the improved transit, high-skilled workers reaped larger net benefits because the overall impact depended on workers' ability to substitute between different jobs and homes, as well as the extent to which wages were depressed by a larger pool of commuters, forces that ultimately favored the high-skilled group.

The study by Brown (2016) of Los Angeles' Orange Line between 2000 and 2013 revealed significant neighborhood changes within a ½-mile radius of the BRT stations, compared to areas 2 and 5 miles away. While racial-ethnic demographics remained stable, increased home values, rents, and educational attainment suggest economic shifts and gentrification. Areas with lower initial rents and incomes, and higher renter-occupied housing in 2000, experienced greater change by 2013.

8. Summary, discussion, and conclusions

Tables A-C summarize the causal evidence reviewed in this paper. Table A summarizes the evidence of price capitalization due to transport infrastructure. Table B does the same for impacts in local density around infrastructure, and Table C focuses on suburbanization and decentralization at the city level. The cumulative evidence highlights the diverse effects of transport infrastructure on urban development.

Table A shows consistent capitalization of transport access into property prices, with rail and metro systems generally yielding stronger effects than highways. These effects' magnitude and spatial extent often follow an inverted-U pattern, peaking within 0.2—0.8 km of infrastructure, and are frequently observed even before project completion, suggesting anticipatory market behavior.

Table B complements this by showing that infrastructure also shapes local density patterns. Highways tend to redistribute population growth toward suburban corridors, while urban rail fosters polycentric development and employment subcenters, particularly when supported by land-use policies. BRT systems exhibit more variable outcomes, with some studies highlighting residential sorting rather than density increases.

At the metropolitan scale (Table C), the long-run effects of infrastructure are evident in patterns of suburbanization and decentralization. Highways consistently reduce central-city population shares and promote peripheral growth, while rail infrastructure has more nuanced impacts—sometimes reinforcing decentralization through improved accessibility, but not uniformly driving population growth. These results suggest that while transport infrastructure is a powerful tool for shaping urban form, its effects depend on mode, geography, and complementary planning frameworks.

Our review reveals a fundamental duality: while both road and rail infrastructure can lead to decentralization, the resulting urban form differs starkly. Highway-led decentralization consistently correlates with low-density sprawl, whereas rail investments tend to foster a more structured, polycentric urban form by creating dense subcenters.

Policy implications

The reported increase in property prices due to transportation provides a compelling rationale for implementing land-value capture (LVC) mechanisms as part of public transport funding strategies. As outlined in the OECD/ITF background paper (ITF, 2024), LVC instruments—such as infrastructure levies, developer obligations, and strategic land management—can help governments recover some of the unearned gains accruing to landowners and investors. Doing so enhances funding capacity and promotes equity by aligning private benefits with public costs.

However, the wide variation we find in value uplift underscores the need for tailored LVC approaches. Policymakers must consider the timing, spatial distribution, and magnitude of uplift when designing LVC schemes. For example, if a significant share of the value uplift occurs *before* opening, then LVC mechanisms based on transaction taxes at the time of sale might be too late. In such cases, LVC needs to be implemented *concurrently* with the project planning to capture the anticipation wedge. Ultimately, the evidence from Table A supports the view that LVC is feasible and desirable—provided it is implemented with attention to context, equity, and long-term urban development goals.

Moreover, the broader urban implications of transport infrastructure—particularly its role in shaping decentralization patterns—deserve attention. When decentralization is driven by rail or metro investments that connect peripheral towns to the urban core, it often fosters the emergence of subcenters with localized amenities and employment opportunities. These nodes support more sustainable mobility patterns, as residents can rely on public transport and active modes for daily activities. In contrast, decentralization driven by highways tends to result in low-density sprawl, with limited subcenter development and high car dependency.

Section 7 explores the significant, and often negative, social equity consequences of large-scale transportation projects, particularly concerning displacement and segregation. For highways, the evidence points to direct physical displacement caused by construction, with severe long-term consequences. Research from the United States shows that individuals whose homes were demolished for highway projects experienced increased mortality rates, mainly due to forced relocation to areas with lower socioeconomic status (Valenzuela-Casasempere, 2025). Furthermore, these projects have been shown to harm minority communities disproportionately, reinforcing pre-existing segregation and creating physical barriers that reduce social connectivity (Weiwu, 2024).

In contrast to the direct displacement caused by highways, urban rail and Bus Rapid Transit (BRT) systems are associated with a more subtle "economic displacement" driven by gentrification and sorting. The increased accessibility and attractiveness of neighborhoods near new transit stations lead to rising property values and rents, making these areas unaffordable for existing, often lower-income, residents. Studies from cities like Paris and Bogotá show that areas around new rail and BRT stations experience an influx of higher-skilled professionals, increasing welfare inequality (Mayer and Trevien, 2017; Tsivanidis, 2023). However, other large-scale studies in the U.S. have not found significant evidence that lower-income residents are more likely to move out of neighborhoods with a new transit station.

Importantly, our findings reveal that anticipation effects may be strong, which implies that equity considerations cannot be an afterthought. For any new major transport infrastructure project, policy should move beyond a simple cost-benefit analysis to include an equity analysis. This requires proactive anti-displacement strategies to ensure that accessibility benefits are shared broadly and do not come at the cost of displacing vulnerable communities.

Limitations and Future Research

Our review is not systematic but instead focuses on the robust causal literature; however, the findings are primarily concentrated in North America and Europe. Future work is needed to test whether these findings generalize to the rapidly urbanizing cities of the Global South. We propose avenues for future research based on the gaps identified in our study.

First, a more rigorous and extensive body of causal evidence on the mechanisms and magnitude of transit-induced economic displacement is urgently needed. Second, cross-country studies that exploit variation in land-use regulations could shed light on how policy can effectively mitigate highway-induced sprawl. Finally, applying the quasi-experimental methods reviewed here to understand the impact of emerging technologies, such as electric and autonomous vehicles, and ridesharing, on urban form will be critical for the next generation of urban and transportation scholarship.

Declaration of generative AI and AI-assisted technologies in the manuscript preparation process.

Statement: During the preparation of this work, the author(s) used Gemini and ChatGPT to identify typos, detect articles that were cited but not in the reference list and vice versa, and improve grammar. After using this tool, the authors reviewed and edited the content as needed and take full responsibility for the content of the published article.

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