# How does traffic, or the fear of it, affect housing affordability?

## Examining the effect of Traffic Impact Analysis on Housing Production and Affordability

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**16. Abstract**

Traffic impact analysis (TIA), which estimates the traffic impacts of proposed land development, tends to bias against higher density developments in urban areas where traffic is often congested and travel alternatives plentiful. This has important implications for housing supply and affordability, suburban sprawl, and private vehicle dependence. We examine the understudied implication of TIA on housing by drawing on empirical evidence from distinct bodies of research in the transportation and land use planning literatures to describe the mechanisms through which TIA may affect housing market conditions. We conclude that TIAs likely have negative effects on urban housing production and affordability.


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**ABSTRACT**

Traffic impact analysis (TIA), which estimates the traffic impacts of proposed land development, tends to bias against higher density developments in urban areas where traffic is often congested and travel alternatives plentiful. This has important implications for housing supply and affordability, suburban sprawl, and private vehicle dependence. We examine the understudied implication of TIA on housing by drawing on empirical evidence from distinct bodies of research in the transportation and land use planning literatures to describe the mechanisms through which TIA may affect housing market conditions. We conclude that TIAs likely have negative effects on urban housing production and affordability.

**Keyword**: traffic impact analysis, housing affordability, traffic congestion

Means and Ends

People generally travel, not for the joy of moving about, but in order to access opportunities -- to work, learn, eat, heal, socialize, exercise, worship, and more. Transportation systems, then, have little meaning apart from the land uses where trips begin and end. So analyzing transportation systems apart from land use systems is incomplete, and misleading. For example, vehicle speeds are low and traffic delays frequent on the streets of San Francisco, compared to rural New Mexico where speeds are high and delays rare. But the time required to reach emergency medical care in San Francisco is usually much lower than in rural New Mexico, because ERs are more numerous and proximate in The City, despite the heavy traffic. Thus, analyzing ER access between these two places by considering only average vehicle speeds and delays would obviously be incomplete -- like trying to determine the area of a rectangle knowing only the height but not width.

Yet a mainstay of traditional land use and transportation planning practice entails just this sort of transparently incomplete analysis. Traffic impact analysis (TIA), which local governments large and small regularly employ to determine the "traffic impact" of new or expanded development, forecasts vehicle trips generated from and attracted to proposed developments, typically without considering how those new developments affect the relative arrangement of land uses and access to them more broadly. For example, multi-unit housing added near an urban job center offers better access to jobs and other urban amenities because of its close proximity to potential destinations, and in addition may reduce overall motor vehicle trips (as some may choose to walk, bike, scooter, or take public transit to nearby destinations) as well as the trip lengths for those who drive, relative to housing built on the suburban fringe. But TIAs typically consider only the effects of the development on nearby traffic levels, and not on overall vehicle travel. As a result, the multi-unit housing proposal in an already built-up (and likely traffic congested) urban area will be forecast

to have more negative effects on nearby vehicle travel than the exurban housing proposal. Consequently, the former is more likely to be scaled back, assessed mitigation fees to fund transportation improvements, or killed altogether than the latter, despite its potential accessibility and auto-travel-reducing benefits.

This process, then, has important implications for urban housing production and affordability, suburban sprawl, vehicle travel, and travel by other means. Planning and transportation scholars have focused increasingly on the latter three of these in recent years, but have given the effect of TIAs on housing production and affordability far less attention. This review addresses this gap in the literature by weaving studies of land development, housing, and transportation together in order to present both a circumstantial case for TIAs reducing housing supply and affordability in many US urban areas, and a call for more research on this understudied link. We do this first by contrasting the concept of mobility, the theoretical basis for TIA, and the concept of accessibility, about which a great deal has been published in recent years. Second, we suggest how TIA, and the larger mobility paradigm, likely contribute to the housing affordability crisis. We describe three mechanisms by which TIAs can affect housing supply and affordability and support each with empirical evidence from the literature. We then discuss how the shift to the accessibility paradigm may alter the link between traffic impact studies and housing affordability. Lastly, we highlight the lack of studies that directly examine this issue and recommend next steps of empirical research.

To answer our primary research question -- how do TIAs affect housing affordability? -- we initially used search terms that were various combinations of “traffic impact analysis,” “development approval,” “housing affordability,” and “anti-development movements” in both TRID (Transportation Research International Documentation) and Google Scholar. The results of these searches made clear that the link between TIA and housing supply and affordability was

lightly studied and, when it has been addressed, TIA has been tangential to research on the biases of trip generation analysis, the effect of impact fees on housing markets broadly, the role of environmental reviews, and the California Environmental Quality Act (CEQA) in particular, in the development approval process, and residents' concerns and motivations in local development politics. Such studies nonetheless provide important evidence relevant to our research question. We then conducted separate searches for each of these bodies of research, using search terms such as "bias of traffic impact analysis," "impact fees and housing," "environmental review/CEQA and development approval," and "traffic and development approval." We also relied on snowballing to find the sources cited in the pieces reviewed, though again, most do not focus directly on the link between TIA and housing. While we reviewed many more pieces than are cited here, we ultimately cited only the empirical works that provide at least tangential evidence relevant to our research question. In the end, we include 67 books and articles in this review.

## Two frameworks of transportation and land use planning

Transportation systems enable the movement of people and goods among different land uses of cities, which in turn enables the interactions, exchanges, and transactions that are essential to the economic and social functions of urban areas. At the core of the relationship between land use and transportation is the concept of access: travel enables people to access important opportunities and resources, and it enables firms to access materials, labor, suppliers, distributors, and customers. It follows logically that access can be enhanced by enabling people and goods to move about on transportation networks. Mobility is thus often defined as the potential for, the ease of, or the ability of moving around (Hansen 1959; Handy 2005). While mobility is an important means of access, it is not the only one; information and telecommunications technologies, for example, enable

access to information and communications with others absent mobility; physical proximity also enables access to destinations even when mobility is low ( Levine, Grengs, and Merlin 2019).

For better than a century, US transportation planning has been largely guided by the concept of mobility. Transportation planners and engineers have tended to focus on improving the speed of travel and reducing traffic congestion on the road networks. However, this focus on mobility inevitably leads to the view that the land uses that generate and attract trips are not the *raison d'etre* of transportation networks, but are instead *inhibitors* to mobility in traffic congested places. Under this framework, land uses are abstracted as origins and destinations of trips that, when driving is the norm, put traffic onto road networks, while changes to land uses -- such as an increase in development density -- will increase traffic and reduce travel speeds, which become the problem for transportation planning. Thus, transportation planners typically use TIAs to study the impact of land use changes on level of service (LOS), a measure of traffic flow, and propose mitigation measures to ensure LOS is not compromised too much. While local jurisdictions are not required to have TIAs guide project approvals, in the absence of more comprehensive analyses of development impacts, TIAs (and the environmental impact reviews that are closely linked to TIAs) often play a central role in the development approval process. As such, the purpose of the transportation system, and by extension land use systems, becomes free-flowing traffic, while the role of transportation in enabling social and economic activities by connecting land uses is subsumed.

A fundamental problem with the mobility framework is its conceptual incompleteness. Since transportation demand is largely derived from the demand to reach destinations, assessing the speed of travel is, at best, a partial assessment of people's transportation outcomes. A more complete assessment should be based on people's "capacity to reach destinations," or accessibility,

which is a function of both travel speed and destination proximity (Levine, Grengs, and Merlin 2019). Many scholars have similarly argued for a shift to an accessibility framework and defined the concept variably as capacity to reach destinations, or the ease of or potential for interaction, both of which capture the core idea that accessibility is a function of both travel speed and proximity of destinations (Duranton and Guerra 2016; El-Geneidy and Levinson 2006; Handy 2005; 2020; Hansen 1959; Levine, Grengs, and Merlin 2019). The key implication of this framework is that access depends on travel time rather than travel speed, thus can be improved not only by allowing freer and faster travel, but also by reducing the distance to opportunities. Information and communication technologies can also improve accessibility, but is often underemphasized because it is beyond the scope of most urban and transportation planning (H. Miller 2005; Grengs et al. 2010; Levine, Grengs, and Merlin 2019). For conceptual completeness, we define accessibility here as *the ability of people, households, firms, or institutions to avail themselves of goods, services, activities, and opportunities*.

While a growing chorus of urban and transportation planning scholars have been advocating for the shift from mobility to accessibility for decades given its conceptual completeness and theoretical elegance, accessibility has not yet been widely taken up in practice (Duranton and Guerra 2016; El-Geneidy and Levinson 2006; Geurs and Van Wee 2004; Hansen 1959; S. Handy 2005; 2020; Handy and Niemeier 1997; Levine, Grengs, and Merlin 2019; Levinson and King 2019; Wachs and Kumagai 1973). Metropolitan Planning Organizations have increasingly incorporated in their regional plans the idea of accessibility, but in ways that are often ambiguously defined and poorly operationalized (Handy 2005; Proffitt et al. 2019). At the local level, TIA practices still focus primarily on mobility, which is operationalized as LOS, though California's recent shift from LOS to vehicle miles travelled (VMT) as the metric of traffic impacts for

environmental review is a notable exception (Combs, McDonald, and Leimenstoll 2020; Volker, Kaylor, and Lee 2019).

The halting adoption of accessibility in planning practice can be attributed to a variety of factors, but local concerns over mobility and traffic congestion may well be the single biggest obstacle. While many rightfully note the complexity of operationalizing accessibility as a major challenge for practitioners to embrace the concept, others have argued that widespread use of cumulative place-based measures of accessibility, albeit imperfect measures, could fulfill many core policy tasks of urban and transportation planning (Bertolini, le Clercq, and Kapoen 2005; Boisjoly and El-Geneidy 2017; Curl, Nelson, and Anable 2011; Duranton and Guerra 2016; Grengs et al. 2010; Handy 2020; van Wee 2016). A bigger challenge is the inherent conflict between regional and local interests under the accessibility framework: a higher-density mixed-use development in an established residential neighborhood might improve regional accessibility by bringing residents closer to employment and other destinations than low-density housing on the suburban fringe, but current residents in that established neighborhood will likely experience increased local traffic associated with the new development and have little interest in the regional accessibility improvements. Thus, constituents' concerns with nearby traffic levels often translate into local land use regulations and decisions that limit development densities, push new housing to the suburban fringe, dampen regional accessibility, and reduce housing affordability (Levine, Grengs, and Merlin 2019).

The root of such concerns over localized mobility lies in the widespread perception that congestion is the central transportation problem, despite studies that suggest that the benefits of mobility and the costs of congestion may be overestimated (Handy 2020; Mondschein and Taylor 2017; Thomas et al. 2018; Osman et al. 2019). The extraordinary popularity of private vehicles and drivers'

desires to travel quickly to destinations with plenty of free parking has animated decades of mobility-focused transportation planning. This mobility focus has led to auto-oriented urban forms with segregated land uses in which accessibility depends primarily on auto-mobility. Thus, in a circular fashion, public perception and mobility-focused transportation planning have reinforced one another.

The institution of mobility-based local land use and transportation planning, exemplified by the LOS-based TIA in development reviews and abetted by local constituents' determination to limit local traffic congestion, is deeply entrenched (Duranton and Guerra 2016; Handy 2020; Levine, Grengs, and Merlin 2019). Moreover, the central focus on mitigating local traffic delays is frequently intertwined with local NIMBYist institutions with no- and slow-growth agendas (Manville and Osman 2017; Whittemore and BenDor 2019a). As a result, traffic impact analyses, and their focus on assessing proposed developments in terms of the vehicle trips they generate and attract may be contributing to the housing affordability crisis in many parts of the US (Figure 1).

## Mobility-focused transportation planning and the housing problem

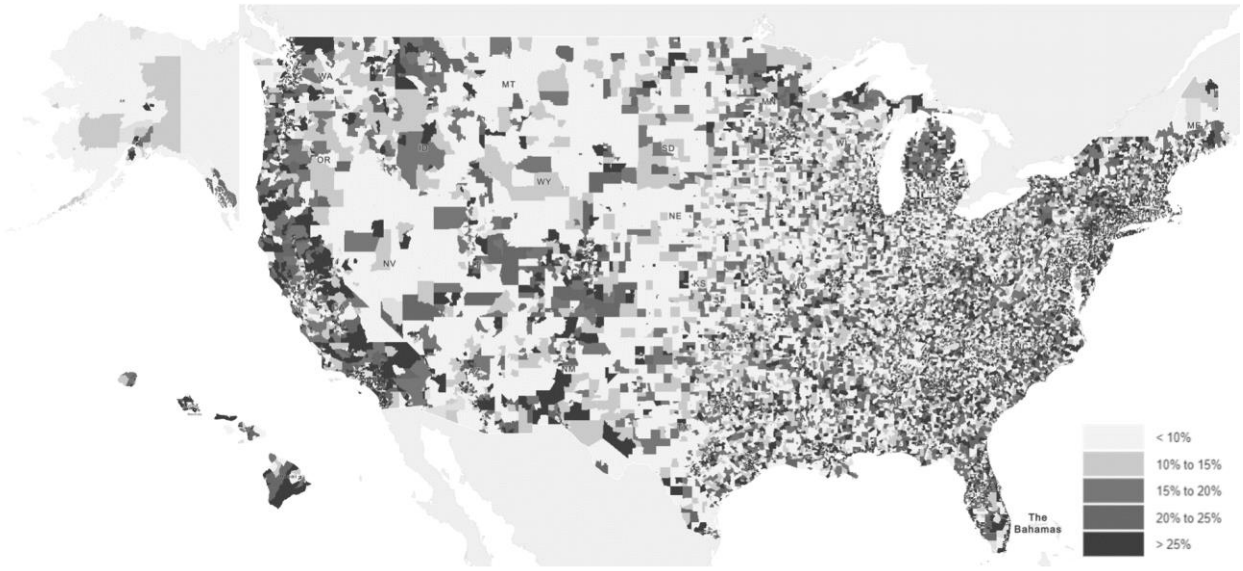


*Figure 1. Renters paying at least half of their income on rent (source: ACS 2018 5-year estimates, Social Explorer)*

Housing in many US metropolitan areas, particularly those close to the Pacific coast in California, Hawai'i, Oregon, and Washington, as well as the Atlantic coast of Florida and the northeastern states, has grown increasingly expensive and unaffordable. A particularly worrisome equity concern of the housing affordability crisis is its disproportionate impact on renters who are more likely than homeowners to be lower-income and racial and ethnic minorities (Dumont 2019; Quigley and Raphael 2004).

While the factors affecting housing affordability are many, shortages in the supply of housing relative to demand obviously play a central role. The factors affecting housing supply are complex and interrelated as well, though land use regulations are among the most important (Manville, Monkkonen, and Lens 2020). While construction costs determine housing prices in many parts of the US, in areas where housing prices are significantly higher than construction costs, zoning and other land use regulations are mainly responsible for the gap (Glaeser and Gyourko 2003). Land use regulations can reduce the availability of low cost housing and the affordability of all housing

if they make building new housing of any type more difficult, since low cost housing depends greatly on the "filtering" process in the housing market, by which newer housing units move through a quality hierarchy as they depreciate over time and become more affordable (Quigley and Raphael 2004). While high housing prices could also reflect improvements in housing quality and greater competition for urbanized land, land use regulations have been shown to contribute more to high housing prices generally, with stronger impact on low cost housing in particular (Quigley and Raphael 2004). Related to land use regulations, which mostly operate at the level of local municipalities, is the presence of community-level NIMBYist opposition to new housing developments in local politics (Pendall 1999; Whittemore and BenDor 2019a).

Transportation plays a central role in both local land use regulations and community-level NIMBYist opposition to new housing development. On one hand, LOS-based TIAs are typically required by local governments for any land use changes and development proposals to project their anticipated impact on traffic levels in the vicinity; local governments can then require traffic mitigation measures paid for by the developer to maintain acceptable levels of road traffic [1] (Fulton 2018). But the traffic projections in TIAs have been heavily criticized because they rely on inaccurate and theoretically flawed trip generation estimates and tend to inflate costs of development and hinder developments that are denser and/or mixed use (Ewing et al. 2011; Shoup 2003). In addition, TIAs have often been used by local residents as a cudgel to oppose land use changes and new development in their neighborhoods (Pendall 1999; Whittemore and BenDor 2019a; 2019b). The empirical evidence for these mechanisms is reviewed in the next three subsections: (i) the myth of trip generation, (ii) the effect of TIAs on housing production, and (iii) the role of traffic concerns in local development politics. Figure 2 illustrates the mechanisms and indicates the key works included in the following sections to support each mechanism.

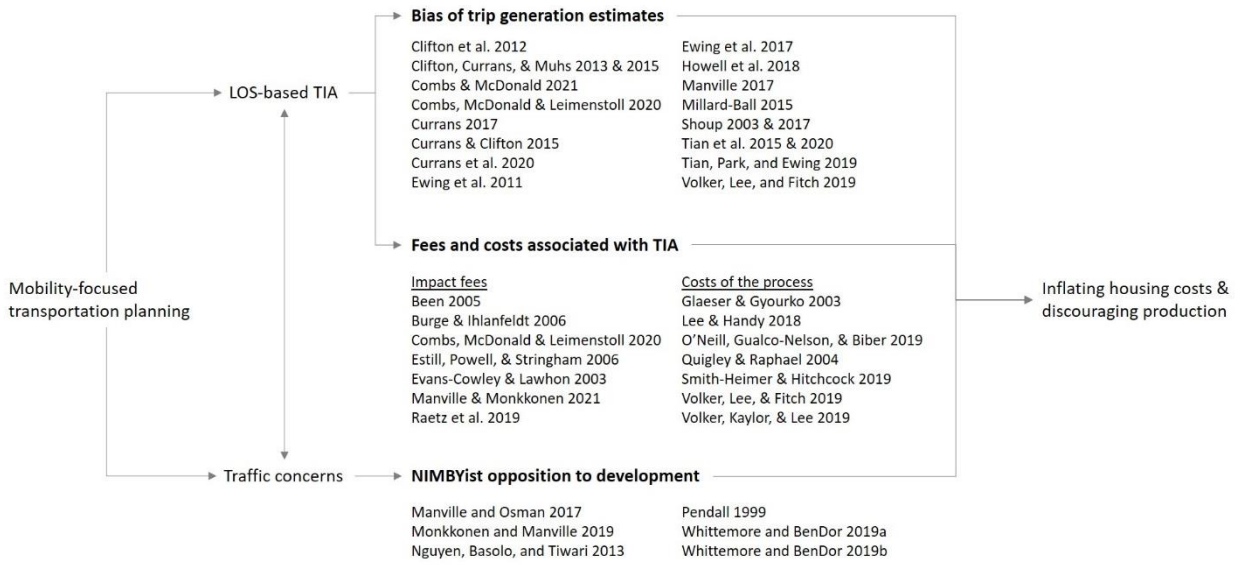


*Figure 2. How LOS-based TIA may affect housing affordability*

## *The myth of trip generation*

As noted earlier, local transportation planners use TIAs to assess the impact of proposed new developments and other land use changes on transportation systems. The core component of a TIA is the analysis of how a proposed project may affect the circulation of vehicular traffic on nearby road segments and at nearby intersections, as measured by level of service (LOS), based on ease of vehicular flow, on a scale of "A" (free flow) through "F" (forced flow). Besides an LOS analysis, different local jurisdictions may or may not require additional analyses of the project's impact on other aspects of the transportation system. If the LOS analysis and other analyses identify significant traffic impacts caused by the proposed project, the developer will typically be required to propose mitigations measures such as road and other transportation system improvements to maintain an acceptable LOS as part of the TIA. In addition to, or in lieu of, developer-financed traffic mitigations, the developer may also be asked to pay traffic impact fees or other fees to the local government to fund transportation improvements.

Trip generation analysis is the core component of LOS analyses used to identify and estimate the traffic impacts of proposed developments. The conventional method of trip generation analysis estimates the total number of (arriving and departing) motor vehicle trips generated by a proposed development, which are often based on trip generation rates published by the Institute for Transportation Engineers (ITE). ITE bases its trip generation rates on two factors: the land use in question, and some measure of development scale. Trip generation is estimated from field survey data collected most often from land uses in suburban areas with abundant free parking and little or no transit service, nearby pedestrian amenities, or travel demand management programs. Development scale is most often measured in terms of square footage, but sometimes in terms of other scale measures, like the number of employees, for 172 distinct land uses. The estimated trips generated are then used to simulate vehicular circulation on the nearby road systems, often in simple extrapolations of existing road network data but sometimes in more sophisticated travel demand models. These extrapolations or model output are then used to project whether nearby road links and intersections' LOS will degrade below accepted levels due to the new project -- resulting in significant traffic impacts (ITE, 2017;2019).

In addition to its exclusive focus on vehicular mobility, this conventional method of trip generation analysis has been criticized by many scholars for both its inaccuracy and conceptual shortcomings. Shoup (2003 & 2017) was among the first to point out the flaws in trip generation rates as well as similar parking generation rates reported by the ITE. Shoup argued that these reported rates are often based on very small sample sizes and yet presented in the ITE manuals with misleading precision by, among other things, omitting model statistics (but not the trip generation data) that were nonsensical. Further, Shoup contended that, even if the ITE were to use larger samples to boost statistical significance, there would remain a fundamental logical flaw because parking and

trip generation rates tend to be measured at peak volumes in suburban contexts with ample free parking and little or no accommodation for non-car travel. Thus, the conventional trip generation analysis tends to produce estimates biased in favor of driving, which leads to enhanced parking and street capacity to accommodate that driving, which then encourages driving in a self-fulfilling prophecy. Parking and trip generation rates are essentially two variable regressions that assume that human activity and associated trip-making are a function solely of land use type and some measure of building scale. This is both an atheoretical representation of travel behavior and antithetical to the evolution toward activity-based modeling in transportation travel demand analysis.

Many studies have empirically confirmed the biases in ITE's trip generation rates. Ewing et al. (2011) studied traffic generation of mixed-use developments across six US metro areas and found that on average 30 percent of trips generated by mixed-use developments put no strain on the external street network and that calculations using ITE rates significantly overestimate the trip counts at most sites studied. Such bias against mixed-use developments has been repeatedly found in studies involving more areas and using more advanced methodologies (Ewing et al. 2017; Tian et al. 2015; 2020). Clifton et al. (2015) studied trip generation rates for land uses including high-turn-over restaurants, convenience markets without gas stations, and drinking places in Portland, Oregon and found that the land uses built to higher densities and which had better accommodation for alternative travel modes like transit, cycling, and walking generate significantly fewer trips than the published ITE trip rates. Tian, Park and Ewing (2019) studied vehicle trips generated by different housing types in different urban forms across 30 US metropolitan areas and found that calculations based on ITE rates overestimate trip counts for all housing types and that trip rates tend to decrease as neighborhood compactness increases. Studies have also collected trip

generation data for other land uses such as multi-unit affordable housing and confirmed similar biases (Currans et al. 2020; Howell et al. 2018). Thus, the overwhelming weight of the empirical evidence suggests that ITE trip generation rates tend to overestimate vehicle trips in more urban contexts with higher densities, mixes of land uses, and infrastructure for alternative travel modes such as public transit, biking, and walking.

Such overestimation of trip generation tends to discourage compact, dense, mixed-use, and infill development, as well as travel by means other than driving, and thus needs to be improved and adjusted for the specific contexts of different developments. Ewing et al. (2011) outline a process by which overestimates of trip generation (and hence traffic impacts) in urban contexts may exacerbate community opposition to new development, which manifest in scaled-back, lower-density projects or no project at all. Consequently, unmet market demand for development tends to be channeled out to locations that are less dense, more suburban, and more auto-oriented, and the developments built in such locations tend to generate more vehicle traffic (Ewing et al. 2011). In addition, overestimates of urban development trip generation will also result in overestimates of the environmental costs of proposed projects as well as traffic impact fees that are higher and mitigation measures that are more costly than warranted by the added traffic. For example, a study of street widening in Los Angeles, a common form traffic mitigation, found that requirements of street widening are often based on over-predicted traffic flows attributed to proposed developments, which may negatively affect housing affordability because it introduces burdensome development costs, and more importantly, land dedicated to street widening means less land for housing (Manville 2017). As a result, the LOS-based TIA tends to disproportionately affect urban developments because it increases the cost of development in dense urban areas where there tends to be more traffic and the cost of mitigation measures is higher (Volker, Lee, and Fitch

2019). Thus, many researchers have been studying ways to improve trip generation analyses by estimating trip generation rates from characteristics of urban form at the neighborhood level and socio-demographics at the household level, based on theories of travel demand and travel behavior (Clifton et al. 2012; Clifton, Currans, and Muhs 2013; 2015; Currans 2017; Currans et al. 2020; Currans and Clifton 2015; Ewing et al. 2017; Howell et al. 2018; Tian et al. 2020; Tian, Park, and Ewing 2019).

Partly in response to these criticisms, the ITE recommends users of its manuals to consider site contexts when applying trip generation rates and to adjust the rates to fit particular contexts, though they are largely silent on the form that such consideration should take. A recent study of alternative approaches to the conventional TIA adopted by 36 local jurisdictions in North Carolina, Virginia, and Maryland finds that about half of the jurisdictions use some form of adjustment to better fit their trip generation models to local contexts (Combs, McDonald, and Leimenstoll 2020). The study also finds that many more jurisdictions also waive TIA requirements, require inclusion of non-car modes in the analysis, and/or strengthen the role of planning in TIA administration. While such changes and adjustments reflect increasing recognition of the biases of ITE trip and parking generation rates, they leave the larger TIA framework largely intact. Admittedly, some of these improvements can promote multi-modal mobility, which is a notable step away from focusing solely on auto-mobility, but multi-modal mobility is still a mobility framework, and not an accessibility one. Nevertheless, even these improvements to the TIA process can face significant obstacles. Small jurisdictions often lack technical guidance and expertise to instigate the changes, even when motivated to do so, while larger jurisdictions that have adopted some modifications to the TIA process often cite public opposition to them due to local concerns over traffic congestion (Combs and McDonald 2021).

However, LOS-based TIAs have more fundamental flaws that are not addressed by ITE trip generation rates. Trip generation should be interpreted as an average rather than marginal rate, though the latter tends to be smaller because it accounts for substituted trips (Millard-Ball 2015). This means that traffic impacts estimated from ITE trip rates are likely overestimates because the actual traffic impacts of a new development will be marginal additions to an already established land use-transportation system. In addition, the difference between the marginal and average trip generation rate should vary depending on the spatial scale of analysis: the difference might be small for a development-adjacent intersection LOS analysis, but larger for an analysis of sub-regional traffic levels, and larger still for an analysis of regional environmental impacts (Millard-Ball 2015). In other words, the larger the spatial scale of analysis, the more problematic the use of average trip generation rates becomes.

More importantly, even if the systematic overestimation of trip and parking generation rates is reduced, the problematic focus on LOS remains because trip generation analyses and LOS-based TIAs are centered on local area traffic flow and mobility. Without changing the focus from local vehicular mobility to local and regional accessibility, even the most accurate trip generation analysis is a self-referential mobility framework, where adding road capacity and parking to accommodate predicted vehicle trips all but ensures that those vehicle trips will indeed occur. In other words, if these more fundamental conceptual flaws are not addressed, adjusting trip generation rates in the conventional LOS-based TIA may reduce bias by adding complexity to a conceptually flawed system.

From an accessibility perspective, Millard-Ball's argument regarding marginal effects on regional transportation systems and the environment may be even more salient, because the spatial scale of a new development's accessibility effects will be far greater than adjacent intersections. In any

case, if the suburban bias in ITE trip generation rates leads to overestimated traffic impacts in urban areas and, in turn, higher impact fees and development costs; these will tend to put downward pressure on project scale and upward pressure on the cost of housing developments in already built up areas. The next subsection reviews relevant empirical evidence on this.

*The effects of TIAs on housing production*

As discussed above, TIAs tend to overestimate traffic impacts of new developments not only because of the bias in ITE's trip generation rates towards car-oriented suburban contexts, but also because it focuses on average rather than marginal effects. These systematic biases in traffic impacts are likely to negatively affect urban housing markets, and more. For example, TIAs may affect both property and labor markets: first, traffic impact fees that are significantly higher than the actual marginal traffic impact of developments motivate developers to build less; this can reduce supply and drive up prices and rents for both residential and commercial properties; these higher prices, in turn, increase business costs, which can reduce employment and/or encourage relocation to lower-cost, outlying settings (Estill, Powell, and Stringham 2006). While this relationship between TIAs and urban housing supply and costs is plausible, there has been little direct examination of the issue. There is, however, considerable circumstantial evidence that TIAs contribute to higher housing costs by both raising development costs and making urban development, particularly higher-density urban housing development, more difficult to build, which we consider below.

A large body of research has found that development impact fees more broadly tend to increase housing prices, which is indirect evidence for the effect of TIAs and traffic impact fees on the housing market. Two comprehensive reviews of this literature, by Evans-Cowley and Lawhon

(2003) and by Been (2005), synthesize the theories and empirical evidence for the effect of impact fees on housing prices and production. Economic theories suggest that the effect of impact fees on housing prices depends substantially on land market conditions. By raising the cost of development, impact fees should tend to depress land prices in places with ample supply of developable land, so that prices paid by homebuyers and renters are not affected much; but in land markets where the supply of developable land is limited, impact fees should be passed on to home buyers in the form of higher housing prices (Evans-Cowley and Lawhon 2003).

Empirical evidence shows that impact fees tend to increase the prices of both new and existing homes in communities lacking sufficient substitutes (Evans-Cowley and Lawhon 2003; Been 2005). Been (2005) paid particular attention to the varying elasticities of housing prices in different housing market segments with respect to impact fees, and found some evidence that elasticities tend to be greater for higher quality and higher income housing, and smaller for lower quality and lower income housing. Thus, Been argued that a more complete characterization of the relationship between impact fees and housing affordability requires more research on the effect of impact fees on housing consumed by lower-income residents.

Contrary to the relatively conclusive case for the positive effect of impact fees on housing prices, empirical evidence on the effect of impact fees on housing production is mixed. While some have found negative associations between impact fees and new housing construction, others found no effect and have concluded that other regulatory restrictions may have greater influence (Been 2005). Presumably more housing construction should ease increases in housing prices, but Burge and Ihlanfeldt (2006) paint a more complex picture. On one hand, they found that impact fees are associated with more construction of homes in suburban areas, but have no effect in urban or rural areas; on the other hand, they also found that impact fees are associated with higher prices for

homes of all sizes, with greater effect on larger homes. Thus, despite mixed evidence on the effect of impact fees on housing production, the weight of the empirical evidence shows that impact fees tend to increase housing prices.

Given this evidence, it would be logical to conclude that traffic impact fees may contribute to higher housing prices, and that TIAs, by tending to overestimate traffic impacts in urban areas, have negative effects on housing affordability. However, the empirical question of how big of a role TIAs and associated traffic impact fees play in raising housing prices remains an open one. Given the evidence reviewed here, we hypothesize that the effect varies depending on how local jurisdictions conduct TIAs and implement traffic impact fee schemes in the larger context of development review and impact fee assessment. Local jurisdictions may or may not adopt alternative approaches to the conventional LOS-based TIA, which can reduce, to varied degrees, the bias against higher density housing in urban areas (Combs, McDonald, and Leimenstoll 2020). They may also have varying impact fee schemes, of which traffic impact fees comprise a major or a minor component.

Consider this example of a 249-unit apartment building in Santa Monica, California that broke ground in 2018. The transportation related mitigations included paying $240,000 to the city's bus system, $1.6 million to its transportation fund, limiting the number of peak hour vehicle trips generated by the building and paying the city a fee for every trip exceeding the limit, as well as providing more parking spaces than zoning would normally require. Other mitigations included payments to the city's water infrastructure fund, early childhood development programs, parks and recreation fund, and historic preservation programs, obtaining an LEED platinum certification, prioritizing local residents in all hiring decisions during construction, including in the building a community space for all city residents, and acquiring and entitling an entirely separate parcel of

land to be donated to develop affordable housing (Manville and Monkkonen 2021). One might argue that in this extreme example the transportation related impact fees and mitigations are just one of the many components of the development approval process, and in this case not the most costly one. However, the substantial transportation-related mitigations are based on projected traffic impacts that may be over-estimated given the project's location in downtown Santa Monica. Moreover, the fact that the developer was required to both pay for additional vehicle trips generated and provide more parking spaces than normally required by zoning is an apt illustration of the cyclical logic of the mobility-based transportation planning and mitigation.

In practice, local jurisdictions have widely varying traffic impact fee schemes. A recent study of residential impact fees in ten California cities shows that transportation accounts for between 10 to 100 percent of total impact fees collected for residential projects in different cities (Raetz et al. 2019). It also found that the cost of impact fees per square foot is higher for multi-family projects (while per unit cost is higher for single-family projects). This suggests that higher per-square-foot impact fees may have a larger effect on lower-income and majority non-white neighborhoods where higher-density, multi-family housing projects are more common. While suggestive, there is insufficient empirical evidence to conclude whether impact fees in general and traffic impact fees in particular affect lower-income and non-white residents more or less than elsewhere. Recall that earlier studies suggest that the price effect of impact fees tends to be smaller for housing consumed by lower-income and minority populations, yet there may be a longer-term effect on housing affordability if impact fees have restrictive effects on multi-family housing supply (Been 2005; Burge and Ihlanfeldt 2006). Thus, whether traffic impact fees disproportionately affect lower-income and non-white neighborhoods remains an important empirical question.

In addition to the effects of traffic impact fees, the process of TIA itself adds to development costs as part of local government regulations on land uses. While studies have found evidence that land use regulations in general and zoning in particular tend to discourage housing production and raise housing prices, there has not been much study of the role of TIAs in this (Glaeser and Gyourko 2003; Quigley and Raphael 2004). However, some research has examined the impact of environmental review processes on housing production and prices. Given the prominent role of TIA in many environmental reviews, the findings from these studies offer insights on the potential effects of TIA on the housing market.

In California, a deepening housing affordability crisis has prompted calls for revisions to the environmental review process required by the CEQA on the grounds that the reviews have restricted housing production due to the costs and uncertainties associated with environmental review (Volker, Lee, and Fitch 2019). LOS-based TIA plays an outsized role in CEQA reviews because chronic traffic congestion in many California metropolitan areas means that most new urban housing will reduce nearby LOS, triggering the most onerous form of CEQA review (Volker, Lee, and Fitch 2019). However, empirical evidence on the impact of CEQA on housing production in California is both limited and mixed. We could find no studies that quantify the full cost of CEQA compliance and its effect on land development, but some have explored how CEQA review can cause delays and lags in the entitlement process. A 2008 survey of public sector staff responsible for environmental reviews in 46 California cities and counties shows that, while virtually all large projects required environmental impact reports (EIRs), 42 percent of housing projects with more than five units were streamlined or exempted from CEQA reviews and just six percent of those required EIRs (Smith-Heimer and Hitchcock 2019). The top factors limiting housing production as indicated by the public sector survey respondents are high construction

costs, neighborhood opposition (which can center on traffic impacts), lack of developable sites, while CEQA is less frequently cited (Smith-Heimer and Hitchcock 2019). A 2019 study of the entitlement processes in five San Francisco Bay Area cities found no association between entitlement timelines and types of environmental review employed (O'Neill, Gualco-Nelson, and Biber 2019). However, the authors suggested that uncertainties in local regulatory systems – particularly the discretionary approval process – are responsible for delays and lags in entitlement timelines. This evidence, albeit limited, suggests that the costs of environmental review in California, on average, may be relatively small for developers, but there exists considerable variation in the process that adds unpredictability to local regulatory systems and thus could discourage housing production. Thus, it may be that TIA, as a central element of CEQA reviews in California, suppresses housing supply and contributes to higher housing prices -- though there is to date no direct empirical evidence on this question.

California's recent move to change the basis of TIAs in CEQA from LOS to VMT has sparked some research on the consequences of such a shift, which offers some new insights on the effect of LOS-based TIAs on housing production. Lee and Handy (2018) compared the predicted VMT impacts of three land use projects in Davis, California to LOS-based traffic impacts [2]. They concluded that the switch to VMT could lead to lower development costs due to streamlining and fewer required mitigation measures for transit-oriented, infill, and mixed use developments, all of which are thought to reduce per resident vehicle travel overall, but would have large nearby LOS impacts because the projects reviewed tended to be located in more traffic congested areas. Volker, Lee, and Fitch (2019) took a historical counterfactual approach to examine what could have happened to development projects if the VMT-based metric were in place instead of LOS. They estimated the VMT impacts of 153 development projects in City of Los Angeles that produced

EIRs (meaning that they were determined to have a significant LOS impact) between 2001 and 2016, and found that 99 out of 153 projects could have been streamlined under the VMT-based framework (that is, no EIR would have been required) and that projects containing residential units would more likely have been streamlined than non-residential projects. They further estimated that, under the VMT-based framework, as many as 40,000 residential units could have benefited from streamlining over the period of study, or 2,500 units per year on average, which would equate to 28 percent of the city's average annual housing production in that period.

Thus, under the VMT-based framework, not only will projects estimated to generate less vehicle travel be less costly to build, but mitigation measures required under the VMT-based framework will emphasize travel by means other than driving and in-town locations near other destinations, both of which favor compact, mixed use developments (Lee and Handy 2018). This should encourage more housing production in already built-up areas where both traffic and housing costs tend to be highest. Despite their many plausible virtues, these VMT analyses do not measure accessibility; they, like LOS analyses, center on mobility, but instead of seeking to improve vehicular mobility, the goal instead is to reduce it.

However, a recent survey of planners from 77 California cities and counties shows that, while 66 percent of those surveyed thought that the switch from LOS to VMT in environmental reviews was appropriate, about a quarter of them reported that their jurisdictions would continue using LOS or a combination of LOS and VMT analyses to assess impacts and development fees outside of the CEQA process, with 67 percent saying the issue had yet to be decided (Volker, Kaylor, and Lee 2019). This suggests that TIAs, and a focus on development-adjacent traffic delays, will remain a central element of local land use decision-making in many, if not most, California cities for the foreseeable future. Further, for the rest of the country, LOS-based TIAs may continue

playing an important role in development impact reviews, especially in places where traffic congestion is high.

To illustrate the problem with focusing primarily or exclusively on development-adjacent traffic, consider the example of a 1,200-unit mixed-use project near a light rail station in Los Angeles. The project's EIR found that the traffic generated by it will create "significant and unavoidable impacts" because it will degrade LOS at eight nearby intersections and worsen air pollution, and concluded that not building the project would avoid such negative impacts (Manville and Monkkonen 2021). The problem with such a conclusion is that it is based on a counterfactual scenario that only considers the area adjacent to the development, even though the projected additional traffic associated with the development is likely smaller at larger scales of analysis, and smaller as well than building the same number of units on the suburban fringe. On the other hand, the cost of not building more housing, particularly in a region with high and rising housing prices, has regional impacts that are not considered in the analysis.

To sum, LOS-based TIAs may contribute to higher housing prices by (i) overestimating the marginal traffic impacts and associated impact fees in urban areas, (ii) adding to regulatory compliance costs for new developments, and (iii) discouraging housing production in urban areas and at higher densities where demand is typically highest on the grounds that local traffic delays will worsen (even if overall vehicle travel is reduced). California's recent move to switch from LOS to VMT as the measure of traffic impacts and environmental impacts under the CEQA framework is likely a significant step toward reorienting transportation planning away from a primary focus on LOS, though the focus of the new VMT metric is more on reducing vehicle travel than on increasing people's access. Regardless, the VMT framework should allow for more

housing production in urban areas, which may help alleviate California's housing affordability crisis.

However, LOS-based TIAs, given their focus on localized traffic flows, continue to play an important role in local development approval processes in many places. Even in California, the shift from LOS to VMT under CEQA does not necessarily stop local jurisdictions from requiring LOS-based TIAs in their project approval processes, and may introduce another regulatory hurdle as some cities may require the LOS-based TIA on top of a VMT-based impact study required by CEQA. This is perhaps not surprising because the homeowners who tend to oppose infill housing benefit from both rising housing prices and mitigating nearby traffic delays. It is to the role of traffic concerns in NIMBYist movements to oppose new developments that we now turn.

*The role of traffic concerns in local development politics*

The vast majority (82.3%)[1] of daily trips made by US residents are in private vehicles, and the vast majority of automobile trips end in a free parking space (Shoup 2017). Given the centrality of private vehicles to rural, suburban, and even urban life in the US, it should come as no surprise that residents so often oppose developments that they think will inhibit their ability to drive and park freely. Thus, traffic congestion, and the dense development that increases it, can be existential threats to mobility in the minds of many incumbent residents. In addition, opposing new development on traffic grounds can also be a convenient pretext to cover for more pernicious motivations, such as a desire to limit housing supply in order to increase the value of their homes, or to keep poor or non-white residents out of their neighborhoods. Whatever the motivation, opposition to new housing development, and in particular higher-density multi-family

[1] Data source: 2017 National Household Travel Survey.

development, on ostensibly benign traffic service grounds, is a frequent tool of NIMBYs and a likely contributor to higher housing prices.

One of the earliest studies of traffic concerns in local opposition to developments was Pendall's analysis of protests from local residents against 113 late 1980s development projects in the San Francisco Bay Area (Pendall 1999). Pendall found that 54 percent of all protests were about off-site infrastructure effects, of which 82 percent were about traffic conditions. By contrast, other concerns, including site design, surrounding uses, and growth and density, were raised less frequently than traffic effects. More recent studies corroborate Pendall's findings. Whittemore and BenDor (2019b) surveyed residents in medium to medium-high density zip codes about their attitudes towards a hypothetically proposed high-density infill housing project in their neighborhood, and found that most respondents raised traffic as a significant concern, along with the bulk/size of the project, its effects on public works, property values and public services, and who the prospective residents are. In another study, they analyzed public hearing comments regarding proposed rezoning for housing developments between 1986 and 2015 in the largely suburban Henrico County in Virginia, and found that traffic volumes and road conditions are the most commonly cited concerns; other frequently mentioned concerns include effects on drainage/flooding and property values (Whittemore and BenDor 2019a). They also found that large lot size developments and multi-family housing projects were most likely to raise concerns and oppositions among residents.

While the above-cited studies find traffic to be the most common concern raised by resident opposition to new housing development, other studies find traffic to be a major concern, but not necessarily the biggest one. Monkkonen and Manville (2019) conducted an online survey with 1,300 adults from Los Angeles County to examine the persuasive power of different arguments

against new market rate housing developments. They found that worsening traffic and parking conditions is a significant factor contributing to opposition to new projects, the effect of which is greater than concerns over increased strains on local services. However, the effect of traffic concerns is smaller than concerns expressed over changing neighborhood character and the worry that developers might earn high profits. Nguyen, Basolo and Tiwari (2013) reviewed NIMBYist narratives against affordable housing projects in newspaper articles in California from 1996 to 2006, specifically examining how frequently various characteristics of housing, neighborhood, and tenants appeared in the articles. They found that, among neighborhood characteristics, increased traffic is the third most-cited concern, after crime and falling property values. Thus, while these studies all confirm the importance of traffic concerns in local residents' oppositions to new development, especially at higher densities, they also imply that the relative importance of traffic concerns may vary depending on specific contexts such as the amount and type of information residents are exposed to as well as the type of proposed development.

As noted above, however, the frequency with which traffic concerns are raised in opposition to new developments may not always indicate the degree to which local residents actually care about traffic. Traffic concerns may act as a proxy for more socially-unacceptable concerns or, conversely, broader concerns like preserving neighborhood character or protecting property values may stand in for worries about traffic. With respect to the former, Nguyen, Basolo and Tiwari (2013) found that opponents of affordable housing would insist that their main concerns were negative externalities such as increased traffic and crime, whereas their unstated concerns are more about the "unwanted class or race of people" associated in their minds with affordable housing. Interviews of local officials also reveal that opponents of affordable housing have become more sophisticated in constructing their narratives by shifting away from referring to demographic

changes that might be occasioned by new development to incorporating more planning-related concerns, such as traffic (Nguyen, Basolo, and Tiwari 2013). But whether the motivations to oppose new development are really about traffic, or more transparently self-serving (increase property values), or outright racist (new residents increasing crime) reasons, traffic impacts and the needs to mitigate them often become the means to scale back or deny new development, particularly multi-unit housing development, entirely. The power of these narratives comes from the wide-spread and deeply embedded notion of mobility, particularly auto-mobility, in American urban life. In other words, it is LOS-based TIAs, and other practices guided by mobility-focused transportation planning, that have legitimized and perhaps even strengthened the use of traffic concerns as a reason to oppose new development.

Although there is limited empirical evidence on the systemic effect of opposition to housing production on traffic grounds, some research suggests that TIAs tend to raise the cost of new housing and/or prevent local governments from approving higher density development. Whittemore and BenDor (2019a) found that the most common proffers made by planning commissions in response to opposition to rezoning to allow more housing development are to limit project density and increase the size of individual units, both of which tend to decrease the number and increase size, quality, and price of units built. Manville and Osman (2017) studied five growth revolts in Southern California between 1998 and 2008, of which three had a central focus on traffic. They found that the revolts are largely triggered by local officials' use of discretionary approval to allow for more and denser development than zoning and general plans permitted, and that successful revolts are able to strip elected officials of their discretionary power and force them to follow zoning and general plans. It is thus reasonable to conclude that traffic concerns have played a significant role in local NIMBYist opposition to new developments, which in turn have

contributed to chronic housing shortages in high-cost US cities. Hence, it is likely that LOS-based TIAs, by legitimizing such traffic concerns, have also contributed to the housing crisis.

Our review of evidence presents a strong, albeit mostly circumstantial, case that LOS-based TIAs, central to a mobility-focused transportation planning framework, has a negative effect on both housing supply and affordability in urban areas because (i) conventional trip and parking generation analyses tend to overestimate traffic impacts, (ii) the higher traffic impact fees that often result contribute to higher housing prices, (iii) the process of TIA and related environmental reviews tend to raise development costs, (iv) the LOS-based logic of TIA leads to "mitigations" that typically decrease development densities and increase nearby road, intersection, parking vehicle capacities, all of which support increased driving over other means of travel, and (v) concerns with traffic impacts and the need to mitigate them, whether sincere or tactical, effectively elevate traffic congestion above housing affordability in the hierarchy of planning goals. Collectively, these five factors combine to perpetuate a local transportation and land use regulatory system centered on auto-mobility and mitigating traffic congestion, and not on access to goods, services, jobs, and affordable housing -- a system where vehicle travel has become the end rather than the means. As a growing number of scholars argue, a misplaced emphasis on mobility is at the root of the problem, and only with a shift to an accessibility framework can the means and ends of the mobility framework be altered (Duranton and Guerra 2016; El-Geneidy and Levinson 2006; Geurs and Van Wee 2004; Handy 2005; 2020; Handy and Niemeier 1997; Hansen 1959; Levine, Grengs, and Merlin 2019; Levinson and Wu 2020; E. Miller 2018; Mondschein and Taylor 2017; Wachs and Kumagai 1973).

Towards an accessibility-focused framework

This review of relevant transportation, land use, and housing literatures has demonstrated that the current, widespread mobility-based TIA and mitigation framework places auto-mobility at the center of land use planning, and treats land uses that generate and attract trips as *inhibitors to mobility* in traffic congested places. Guided by this framework, the LOS-based TIAs focus on how a land use change affects the speed of travel on the road network in its immediate vicinity. An inherent flaw of this approach, however, is that the number of trips generated by a new development, and the vehicle miles traveled by those traveling to or from that new development, vary significantly depending on the larger built environment context and the spatial scale of analysis. For example, infill mixed use developments may introduce fewer trips or even reduce travel over the larger urban-regional transportation network because walking, biking, transit, and driving trips to/from nearby destinations are likely to substitute for longer driving trips to/from farther destinations -- but such developments are also more likely to have an outsized traffic impact on nearby intersections.

California's recent shift from LOS to VMT for TIA under the CEQA framework is an improvement over the LOS-based approach. The VMT metric can significantly reduce the bias towards infill, higher density, and mixed use developments, as such projects would likely have small VMT impacts since they tend to be located in dense urban areas where there are abundant destinations and are well served by transit networks, thereby generating fewer and shorter vehicle trips while encouraging travel by other means.

Notwithstanding the notable improvements occasioned by the new VMT metric, neither it nor the LOS-based metric directly address the core function of transportation: access. The LOS-based metric only partially addresses accessibility by focusing on auto mobility but ignores both proximity and access via other modes, such as walking, biking, and public transit. The VMT metric

considers the amount of vehicle travel generated, and thus is still a mobility measure, though it is now used to discourage auto travel rather than speed it along. While this new metric is a significant step away from LOS-based TIAs, it only indirectly addresses accessibility. By contrast, an accessibility-focused framework better integrates the transportation and land use systems because it accounts for both mobility and proximity (Duranton and Guerra 2016; El-Geneidy and Levinson 2006; Geurs and Van Wee 2004; Handy 2005; 2020; Handy and Niemeier 1997; Hansen 1959; Levine, Grengs, and Merlin 2019; Levinson and Wu 2020; E. Miller 2018; Mondschein and Taylor 2017; Wachs and Kumagai 1973). Under this framework, the focus of land use shifts from arriving and departing motor vehicles to its effect on how people reach needed destinations. Thus, instead of assessing the transportation impacts of a proposed development based solely or largely on the number of auto trips it may generate and attract, as LOS-based TIAs do, an accessibility-based development impact analysis would focus instead on how a new grocery store or apartment building would affect overall access to destinations in a given community. Such a shift would more fully address the bias against urban and infill housing inherent in LOS-based TIA [3]. There are promising new innovations in the development and use of access measurement tools, which are beginning to be adopted by some planning jurisdictions, though more to date have focused on regional accessibility measurement and only a few on project evaluation (Siddiq and Taylor forthcoming).

Unfortunately, even a shift to an accessibility-focused land use development evaluation framework may be unlikely to overcome local NIMBYist opposition to new developments. While accessibility analyses may undermine the power of traffic in anti-development narratives, NIMBYs can weigh in on and obstruct many other parts of the development approval process in order to keep locally unwanted land uses out of their neighborhoods (Einstein, Glick, and Palmer 2019; Monkkonen

and Manville 2020). Moreover, in circumstances where incumbent residents substitute traffic and other legitimate planning concerns for unstated and less socially-acceptable motivations, dismantling the narrative of traffic congestion does not address the root causes of such deeply embedded attitudes and biases.

## Conclusion and recommendations for future research

In this review, we have woven together largely distinct transportation and land use planning literatures to demonstrate that TIAs in transportation planning likely affect housing supply and affordability, particularly in built-up and traffic congested metropolitan areas. We have reviewed the mechanisms through which LOS-based TIA can discourage housing production and raise housing prices, and have supported our hypotheses with empirical evidence drawn from the transportation, housing, and land development literatures. We have presented the case, albeit a largely circumstantial one, that LOS-based TIA contributes to the housing affordability crisis afflicting American cities. We have situated this problem within the academic debate over mobility versus accessibility in transportation planning, and suggest that a much-needed shift towards an accessibility-based framework in analyzing the impacts of local land use changes on transportation and land use systems can avoid the many flaws of the still-prevalent LOS-based TIAs.

While strongly suggestive, the case presented here is not yet conclusive. Research is needed to directly test the effect of LOS-based TIAs on housing supply and costs. Toward that end, we propose three specific lines of research, as well as a case for research translation into practice. First, given ample evidence on the effect of impact fees on housing production and prices, future research should empirically test the specific effect of traffic impact fees -- especially those based on ITE trip rates -- on housing markets, with a particular focus on low-income and non-white

communities. This will quantify the relative importance of the effect of traffic impact fees assessed based on LOS-based TIAs vis-a-vis other impact fees on housing affordability. Second, since many studies have established the negative effect of many zoning and development regulations on housing production, future research should investigate the extent to which traffic impact studies act as a regulatory hurdle and discourage development. Third, recognizing that traffic concerns may stand in for other reasons incumbent residents may oppose development, and in particular multi-unit housing development, in their neighborhoods, additional research is needed on cases where local government officials successfully addressed traffic concerns over multi-unit housing without either reducing the number of proposed units or increasing their size and cost. And fourth, while research on access analysis tools has matured considerably over the past quarter century, commercially available and supported ready-for-practice tools, designed for project access impact analyses, are only now beginning to appear. The emergence of such tools is needed to finally move development impact analyses from local traffic impacts, to connecting households and firms with desired destinations, and lowering housing costs in the process.

**NOTES**

[1] For example, in California, any development project and land use change is subject to environmental reviews under CEQA and is required to prepare an environmental impact report if the project is determined to have a significant environmental impact, which includes traffic impacts as a key component. Thus, LOS-based TIAs are often prepared by traffic engineers to estimate the numbers of vehicle trips generated by and attracted to proposed projects and the distribution and circulation of those trips in the local transportation network, in order to determine the effect of the impact of a proposed project on local traffic congestion as measured by LOS on nearby roadways and intersections. These TIAs usually also include mitigation measures for developers to implement in order to maintain an acceptable LOS, while local governments also often require additional impact fee payments into local transportation programs based on the estimated traffic impacts.

[2] Two main approaches of VMT estimation were considered: one method multiplies trip generation rates -- adjusted to account for trips internal to and those that pass by the project -- by trip lengths; the other uses travel demand models to predict VMT from project characteristics, as well as urban form and socio-demographic variables.

[3] While a denser and more compact urban form may raise concerns regarding public health risks as some have correlated high density with the spread of Novel Coronavirus in the current pandemic, we would argue that density should be distinguished with the condition of crowding, the latter of which has been shown to affect virus transmission. Building at higher density does not necessarily lead to crowding, and in fact is likely to reduce it if housing supply increases reduce

housing prices. In fact, housing shortages and high housing prices likely contribute to more people living in crowded housing situations, even in less dense urban areas.

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