POLICY BRIEF

Employment Density

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Project Description

This project reviews and summarizes empirical evidence for a selection of transportation and land use policies, infrastructure investments, demand management programs, and pricing policies for reducing vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions. The project explicitly considers social equity (fairness that accounts for differences in opportunity) and justice (equity of social systems) for the strategies and their outcomes. Each brief identifies the best available evidence in the peer-reviewed academic literature and has detailed discussions of study selection and methodological issues.

VMT and GHG emissions reduction is shown by effect size, defined as the amount of change in VMT (or other measures of travel behavior) per unit of the strategy, e.g., a unit increase in density. Effect sizes can be used to predict the outcome of a proposed policy or strategy. They can be in absolute terms (e.g., VMT reduced), but are more commonly in relative terms (e.g., percent VMT reduced). Relative effect sizes are often reported as the percent change in the outcome divided by the percent change in the strategy, also called an elasticity.

Summary

Strategy Description

Employment density is usually measured as the number of jobs per unit of land area (e.g., jobs per acre, jobs per square mile, or employees per square foot). Policies to increase employment densities may include changes to zoning ordinances to allow more non-residential uses, increases to building floor space on each parcel, and reductions in parking requirements. Employment density is often correlated with a number of characteristics of the built environment that are associated with differences in per capita VMT, including mixed land uses, transit access, the quality of the pedestrian environment, and proximity to residential areas.

Behavioral Effect Size

The selected studies show that the impact of employment density on VMT per capita is relatively weak and varies depending on the specific area of study: a doubling of employment density (100 percent increase) is associated with at most a 3 percent reduction in VMT in suburban and rural areas, and in some cases can be associated with an increase in VMT per capita.

Strategy Extent

The impact of increases in employment density is likely to depend on the existing density and job-housing balance of an area, with the greatest potential for VMT reduction in job-poor, low-density areas. Employment densities can be increased through changes to land-use

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policies, though financial incentives and infrastructure investments may be needed to attract development and jobs. Increasing employment densities is a long-term strategy.

Synergy

Increases in employment density yield the most benefits if adopted as a part of a coordinated set of strategies rather than in isolation. Land use policies that encourage higher employment densities in conjunction with concentrations of shopping and service destinations and high-quality transit service together make alternatives to driving more attractive. The combined effects of these changes might result in much larger changes in VMT.

Equity Effects

Increased employment density, particularly in job-poor areas, has the potential to increase access to jobs depending on the types of jobs provided. At the same time, efforts to increase employment density, especially in residential areas, could result in displacement of current residents and could fuel gentrification. Local measures to increase affordable housing and reduce displacement can help to counter these effects.

Strategy Description

While much attention has been given to increased residential densities as a strategy for reducing per capita vehicle miles traveled (VMT) and greenhouse gas (GHG) emissions from transportation, increased employment densities may have similar effects.

Employment density is usually measured as the number of jobs per unit of land area (e.g., jobs per acre, jobs per square mile, or employees per square foot). Employment density can be measured at different scales, for example, at the building or parcel level, the level of the census tract, traffic-analysis zone (TAZ), neighborhood, or city/county.

Policies to increase employment densities include changes to zoning ordinances to allow more non-residential uses, increases to building floor space on each parcel, and reductions in parking requirements that allow for more employee-occupied space. In most cases, these policies are coordinated with a combination of infrastructure investments and/or financial incentives that, for example, promote increased accessibility by public transportation and development around transit stations.

Employment density is often correlated with a number of characteristics of the built environment that are associated with differences in VMT, including mixed land uses, transit access, the quality of the pedestrian environment, and proximity to residential areas. Unless otherwise noted, the evidence here focuses on the effect of employment density alone on VMT. This strategy is related to the jobs-housing balance strategy, described in a separate brief.

Strategy Effects

Behavioral Effect Size

The selected studies show that the impact of employment density on VMT is relatively weak and varies depending on the specific area of study: a doubling of employment density (100 percent increase) is associated with at most a 3 percent reduction in VMT per capita in suburban and rural areas, and in some cases can be associated with an increase in VMT. A meta-analysis by Ewing and Cervero (2010) concluded that the effect of employment density on VMT is close to zero. Stevens' (2017) more recent meta-regression analysis found that a doubling of density was associated with a 1 percent to 7 percent reduction in VMT per capita but concludes that this strategy has "very little potential" to reduce driving.

The mix of positive and negative effects is notable. Zhang et al. (2012) found that VMT was lower where employment density was higher in three U.S. metropolitan regions but that the relationship was the opposite in the fourth metropolitan region. Zhou and Kockelman (2008) found that VMT was higher in higher density areas within the Austin region but lower in lower density areas. The degree of competition for space between jobs and housing may explain these results: in a job-rich area, adding additional jobs may mean that workers are forced to live farther away from work on average, thereby increasing commute distances; in a job-poor area, adding additional jobs might put jobs and housing in closer proximity, thereby decreasing commute distances.

Table 1. Impact of Employment Density on VMT

Study	Study location	Study year	Employment density variable	% VMT change for 1% increase in employment density
Zhou and Kockelman (2008)	Autstin, TX - Urban areas	1998-1999	Jobs per square mile	+0.074
	Austin, TX - Suburban & rural areas			-0.030
Ewing and Cervero (2010)	International meta-analysis	1997-2009	Job density (jobs per unit area)	0.00
Zhang et al (2012)	Four US cities	2005-2009	Jobs per square mile	-0.011 to +0.013
Stevens (2017)	International meta-regression analysis	1997-2015	Job density (jobs per unit area)	-0.07 to -0.01

Even if the changes in VMT per capita directly associated with an increase in employment density are not large, it is possible that significant changes in travel demand will result through indirect effects. Some studies show, for example, that employment density has a significant impact on vehicle ownership (Chen and Costa, 2022; Tao and Naess, 2022). Because vehicle ownership affects VMT per capita, employment density may have an indirect effect on VMT even in the absence of a direct effect.

Overall, the literature suggests that characteristics typically found in areas with higher employment density such as a higher density street network, good transit access, a high-quality pedestrian environment, shorter distance to downtown, and greater access to jobs have a more important effect on travel behavior than employment density itself (Ewing and Cervero, 2010; Stevens, 2017).

Extent

The impact of an increase in employment density is likely to depend on the existing employment density and job-housing balance of an area. The evidence suggests that increasing employment density in job-poor areas, often found in suburban and rural areas, has the potential to reduce VMT. In job-rich areas, increased job density might lead to an increase in VMT, though proximity to high-quality transit is likely to enhance the potential for increased employment density to reduce VMT.

Employment densities can be increased through policies such as changes to zoning ordinances to allow more non-residential uses, more building floor space, and fewer parking spaces on each parcel. The costs of such policies to local governments are minimal. However, in some contexts, local governments may need to offer financial subsidies to developers and/or employers to encourage increases in employment density. Infrastructure investments may also be necessary to support higher employment densities. Both subsidies and infrastructure investments may require additional resources and funding.

Increasing employment densities is a long-term strategy. Local governments must first change policies, develop and implement incentive programs, and plan necessary infrastructure investments. The private sector must then respond with development projects and locational decisions. Local governments can increase employment densities more directly through strategic decisions about the location of public facilities.

The impacts of employment density on VMT may vary considerably across cities depending on unique local conditions. One study suggests that changes in employment density produce larger effects in Canadian and European cities than in the United States (van de Coevering & Schwanen, 2006).

Equity

Increased employment density, particularly in job-poor areas, has the potential to increase access to jobs. Who benefits from the increase in employment density depends on the kinds of jobs attracted to the area. Attracting jobs that match the skillsets of the local population, as is the goal of community benefits frameworks, is important for enhancing equity from the standpoint of both job opportunities and shorter commute distances for disadvantaged populations.

At the same time, efforts to increase employment density, especially in residential areas, could result in displacement of current residents and could fuel gentrification. These effects may be less likely if job density is increased through redevelopment of existing or underutilized industrial, office, and commercial sites. Policies to protect and encourage small businesses, including microbusinesses, could help to counter displacement, as could programs to retrain the local workforce for new kinds of jobs coming to the area.

Synergy

Increases in employment density yield the most benefits if adopted as a part of a coordinated set of strategies rather than in isolation. Land use policies that encourage higher employment densities in conjunction with concentrations of shopping and service destinations and high-quality transit service together make alternatives to driving more attractive. A package of such strategies can produce many benefits beyond reductions in VMT. Shifts in travel mode from driving to transit, walking, or bicycling are likely to have positive impacts on health through increases in physical activity and through improvements in local and regional air quality. The combined effects of these changes might result in much larger changes in VMT than suggested by the effect sizes shown in Table 1 (National Research Council, 2009).

Confidence

Evidence Quality

The studies in Table 1 use sound statistical methods to analyze disaggregated data for individual households while controlling for the impact of additional land use variables and sociodemographic characteristics. However, the associations found in these studies do not necessarily show a causal effect of employment density (or other land use variables) on VMT. Because they use cross-sectional data, collected in different places at one point in time, these studies show that differences in employment density are associated with differences in VMT, but they do not necessarily show that changes in employment density would produce changes in VMT.

Caveats

It is difficult to separate the impact of employment density from the effect of other variables. Often, employment density is included in a package of policies that aim to reduce VMT. Empirical results suggest that the impact of employment density on travel behavior is greater if this strategy is coupled with other strategies. For instance, according to Ewing and Cervero (2010), some of the effects of employment density reported in the literature are not due to employment density itself but rather to better walking conditions, shorter distances to transit service, and parking fees usually (but not always) associated with higher employment density. Several studies show that areas with higher employment density in proximity to railway stations have higher use of commuter rail (Frank and Pivo, 1994; Parsons Brinkerhoff, Quade and Douglas Inc., 1996; Badoe and Miller, 2000).

Studies show that the impact of employment density on travel behavior is characterized by thresholds. Frank and Pivo (1994) observed that the effects of an increase in employment density on mode shift from drive-alone to transit or walking vary significantly depending on the initial employment density. Increases in employment density had a significant effect on the split between travel modes in areas with initial densities of 20 to 75 employees per acre and in areas with more than 125 employees per acre; changes in employment density had little effect in areas where initial employment densities were between 75 and 125 employees per acre. These results suggest that the relationship between employment density and both VMT and mode share are not linear, but rather strongly influenced by thresholds and by the impact of other factors such as the types of transit services that are provided in each area. A recent study in Norway also provides evidence of thresholds: employment density had a small effect on VMT at densities below 2 jobs per acre but essentially no effect above this threshold (Tao and Naess, 2022).

Technical & Background Information

Study Selection

Many studies over the past two decades have investigated the relationship between land use and travel behavior. The extensive reviews in Parsons Brinkerhoff Quade and Douglas Inc. (1996), Badoe and Miller (2000), Ewing and Cervero (2001), Leck (2006), National Resource Council (2009), Ewing and Cervero (2010), and Stevens (2017) provide detailed overviews of these studies and their evolution over time. However, relatively few studies have specifically investigated the impact of employment density on vehicle miles traveled (VMT).

Studies were selected for this brief based on the following criteria: published within the last 20 years, used disaggregate data on individual travel behavior for one or more U.S. metropolitan areas, employed statistically robust methods that controlled for the impacts of other land use characteristics as well as sociodemographic characteristics, and reported an effect size or enough information in order to compute the elasticity values. Two studies met these criteria: Zhang et al (2012), and Zhou and Kockelman (2008). Two meta-analyses are also included in Table 1: Ewing and Cervero (2010), and Stevens (2017).

Methodological Considerations

Zhang et al. (2012) analyzed the impact of land use variables on travel behavior using individual travel survey data for four major U.S. metropolitan areas (Seattle, WA; Richmond-Petersburg and Norfolk-Virginia Beach, VA; Baltimore, MD; and Washington, D.C.). The data used in this study were collected between 2005 and 2009. The study used a Bayesian multilevel model to estimate the effects of employment density and other variables in each metropolitan area. We computed the values of the elasticity of VMT per capita with respect to employment density (defined as the percentage change in VMT for a one percent change in employment density) using the percentage changes reported in the published paper. The elasticity of VMT per capita with respect to employment density was found to be rather modest, with values as shown in Table 2. The positive value for the Richmond-Petersburg and Norfolk-Virginia Beach, VA metropolitan area suggests that higher employment density is associated with higher values of VMT.

Table 2. Elasticities by City from Zhang, et al. (2012)

Location	Percent VMT Change for 1% Increase in Employment Density
Seattle	-0.0084
Virginia	+0.0125
Baltimore	-0.0114
Washington, D.C.	-0.0015

Similar values were found in the study from Zhou and Kockelman (2008) that analyzed VMT data from households in Austin, TX, through the estimation of linear regression models. The study used travel data collected in the Austin Area Household Travel Survey and land use data provided by the local metropolitan planning organization. The authors estimated separate models for central business district/urban areas and suburban/rural areas. We computed the elasticity of VMT per capita with respect to employment density using the value of the estimated coefficient for employment density from the linear regression models and the values of the mean employment density and VMT for the sample. Given that the coefficient represents the unit change in VMT for a 1 unit change in employment density, elasticity is calculated as follows:

Elasticity = percent change in VMT / percent change in employment density

= (coefficient/mean VMT) / (1/mean density)

Estimates for the elasticity of VMT per capita with respect to employment density are -0.030 in suburban and rural areas and +0.074 in the higher density urban areas, indicating that a further increase in employment density in the latter is associated with a small increase in VMT.

The mix of positive and negative effects coupled with the small magnitudes of the effects in both studies support the conclusion that the effect of employment density on VMT per capita is minimal, at least at the regional level. The reported increases in VMT may stem from competition between jobs and residences for space: as employment density increases, less space is available for residences, and commute distances may increase. The finding by Zhou and Kockelman (2008) of a decrease in VMT in lower density areas but an increase in VMT in higher density areas supports this explanation, as competition for space is greater in higher density areas.

Two recent studies from outside the U.S. provide further support for the conclusion that employment density has a limited effect on VMT. Tao and Naess (2022) used data from Stavenger, Norway to explore non-linearities in the relationships between characteristics of the built environment and travel behavior. They concluded that employment density has little effect on VMT and only at densities below the threshold of 2 jobs per acre, though the effect on car ownership at low densities is more substantial. Chen and Costa (2022) used a unique experimental design in Shanghai to study the relationship between the built environment and travel behavior, similarly finding that employment density had essentially no effect on VMT, though it did have a significant negative influence on vehicle ownership, suggesting that people own fewer cars in areas with high employment densities but do not drive less as a result (meaning that each car is driven more on average).

Meta-analyses use robust statistical approaches to compute effect sizes across a set of studies using the datasets from the original studies. Ewing and Cervero (2010) compute an elasticity for employment density by calculating a weighted average of the elasticities of six studies, using the sample size from each study for the weighting. Stevens (2017) uses a meta-regression analysis in which the elasticities from the available studies are the dependent variable and characteristics of the studies are independent variables in a regression model. Two estimates of the elasticity for employment density are reported: one estimate based on studies that control for self-selection (-0.07, based on two studies), and one estimate based on studies that do not control for self-selection (-0.01, based on eleven studies).

Meta-analysis is a powerful tool for summarizing the evidence, but the approach has notable limitations. It runs the risk of mixing methodologically flawed studies with methodologically sound studies, thereby contaminating the results of the latter, and it may suffer from the mixing of “apples and oranges” owing to variation among studies in modeling techniques, independent and dependent variables, and sampling units. Another issue is that studies that show a significant effect are more likely to be published than those that don’t, so that meta-analyses based on published studies may inflate the absolute size of the effects (Ewing and Cervero, 2010).

Many studies have used aggregate data—data for cities, counties, or metropolitan areas rather than for individuals or households—to investigate the relationships between a number of land use variables, including density and travel demand (e.g., Newman & Kenworthy, 1989, 1999, 2006; van de Coevering & Schwanen, 2006). Although these studies allow researchers to expand the investigation to a larger number of areas, and specifically to areas for which disaggregate data are not available, they do not necessarily reveal the actual relationships between land use characteristics and travel behavior. The relationships observed at the city level, for example, may not hold for individuals or households within those cities. For this reason, causal inferences are even more tenuous for aggregate studies than for disaggregate studies.

Nevertheless, such studies can yield important insights. Cervero and Murakami (2010), using data for urbanized areas in the U.S., found no statistically significant direct effects of employment density on VMT per capita but did find that employment density influenced VMT indirectly through population density and the geographic size of the urbanized area, resulting in a modest net reduction in VMT per capita.

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