POLICY BRIEF

Telecommuting

Susan Handy

University of California, Davis

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Based on the original policy brief written by Susan Handy, Gil Tal, and Marlon Boarnet.

Equity review by Jesus Barajas, University of California, Davis

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

Telecommuting, also known as remote working, is the practice of working from home by employees who have a regular workplace. Working at an alternative location that is located closer to home than the regular workplace is also considered telecommuting.

Behavioral Effect Size

The total impacts of telecommuting depend on the number of workers telecommuting, the number of days each telecommutes, and the impact per telecommuting day. Telecommuting reduces commute vehicle miles traveled (VMT) but may increase non-commute VMT. Telecommuting may reduce person miles of travel by 9.1 percent for the telecommuter on telecommuting days but increases in travel by household members may partially offset this decrease.

Strategy Extent

Telecommuting is possible for employees whose work does not require their physical presence. Following the COVID-19 pandemic, many employers are allowing employees to continue telecommuting but requiring their presence in the office for a specified number of days per week or month. As of 2022, 10.9 percent of U.S. workers had the option to telecommute.

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Strategy Synergy

Telecommuting has synergistic effects with land use, bicycle, and pedestrian strategies. The increase in non-commute VMT may be less in communities where residents are able to safely walk or bicycle to local destinations. Having remote workers in a neighborhood can increase the viability of local businesses.

Equity Effects

If telecommuting reduces VMT, it will reduce environmental impacts that disproportionately harm disadvantaged communities. Because many low-wage jobs do not offer the opportunity for telecommuting, the benefits of telecommuting are not available to all.

Strategy Description

Telecommuting, also known as remote working, is the practice of working from home by employees who have a regular workplace. Working at an alternative location that is located closer to home than the regular workplace is also considered telecommuting.

Telecommuting was first put forward in the 1960s as a strategy for reducing vehicle travel and congestion, and thus saving energy and improving air quality. Telecommuting represented less than 5 percent of full workdays before the COVID-19 pandemic but is now expected to remain as high as 20 percent (Barrero et al., 2021).

Strategy Effects

Behavioral Effect Size

The total impacts of telecommuting depend on the number of workers telecommuting, the number of days each telecommutes, and the impact per telecommuting day.

Three studies measure the reduction in vehicle-miles traveled (VMT) for a telecommuter on a telecommuting day and one measures the reduction in person-miles traveled (PMT) (Table 1). The studies vary in their use of commute VMT, personal VMT or PMT, or household VMT as the total from which the percentage reduction is calculated. The older studies examined impacts for both telecommuters who work at home and those who work at an alternative location, often known as a "telecenter."

The reductions in *commute* VMT appear to be substantial. In theory, the reduction in commute VMT for home-based telecommuters on a telecommuting day should be 100 percent, but Henderson and Mokhtarian (1996) found a reduction of 90.3 percent, owing to some trips to work on days that workers spent mostly working at home. Reductions in commute VMT for center-based telecommuters are lower, ranging from 62.0 to 77.2 percent, because of travel to the center.

Studies show that while telecommuting reduces commute VMT, it is associated with an increase in *non-commute* VMT. This increase, known as the "rebound effect," offsets the reduction in commute VMT to some degree. It is thus important to look at the effect of telecommuting on *total* VMT, including both commute VMT and non-commute VMT. In early studies, the reductions for personal daily VMT ranged from 66.5 to 76.5 percent on telecommuting days for home-based telecommuting and from 53.7 to 64.8 percent for center-based telecommuting (Table 1). According to a recent study, telecommuters reduced their total daily PMT on telecommuting days by 9.1 percent; the reduction in VMT will be somewhat less depending on the share of travel by modes other than driving.

Studies provide some evidence that telecommuting affects VMT not only for the telecommuter but also for other household members owing to a rearrangement of household duties and use of household vehicles. It may thus be important to look at the effect of telecommuting on total household

VMT. One study found that telecommuting leads to a smaller percent reduction in *household* VMT, meaning that the decrease in commute VMT for the telecommuter is partially offset by an increase in VMT by other household members, though the net effect is a still a reduction (Kitamura et al., 1991).

Table 1. Studies of Telecommuting and VMT

Study	Study Location	Study Years	Telecommuting Variable	VMT Variable	VMT Reduction per Unit of Telecommuting Variable
Zheng et al., 2024	US	2020-2022	Onsite workers	State-level VMT	-0.99%
Obeid et al., 2024	US	2020-2021	Telecommuting day – home-based	Personal daily PMT	-9.1%
Balepur et al., 1996	California	1995	Telecommuting day – center-based	Commute VMT	-77.2%
				Personal daily VMT	-64.8%
Handerson & Mokhtarian, 1996	Puget Sound, WA	1990-1991	Telecommuting day – home-based	Commute VMT	-90.3%
				Personal daily VMT	-66.5%
			Telecommuting day – center-based	Commute VMT	-62.0%
				Personal daily VMT	-53.7%
Kitamura et al., 1991	California	1988-1989	Telecommuting day – home-based	Personal daily VMT	-76.6%
				Household daily VMT	-48.1%

Telecommuting offers many potential co-benefits for workers, employers, and the community. For workers, telecommuting helps to reduce personal transportation costs, save time, reduce stress, and increase flexibility. These benefits to the worker create benefits for the employer in the form of increased employee morale and productivity. Telecommuting represents a relatively low-cost benefit that employers can offer to their workers. Employers may be able to save money by reducing workspace and energy costs if a sufficient share of workers telecommute. For the community, telecommuting has the benefit of reducing traffic and vehicle-related air pollution and enabling greater participation in the workforce, particularly for workers with mobility limitations.

The overall effect of telecommuting across the population could be substantial. A study of telecommuting patterns at the state level between April 2020 and October 2022 found that a 1 percent decrease in onsite workers was associated with a 0.99 percent decrease in state-level VMT (Zheng et al., 2024).

Extent

Scale of Application: In theory, telecommuting is possible for all employees whose work does not require their physical presence. Rates of telecommuting are highest for management, professional, and related occupations and for sales and office occupations, which make up 57 percent of jobs in the U.S. (U.S. Bureau of Labor, 2023). As of 2022, 10.6 percent of civilian workers in the U.S. had the ability to telecommute (U.S. Bureau of Labor Statistics, 2022). Following the COVID-19 pandemic many employers are allowing employees to continue telecommuting but requiring their presence in the office for a specified number of days per week or month.

Efficiency or Cost: Telecommuting can be a low-cost strategy for reducing VMT. The average worker spent 15 hours of time and $561 on home equipment to facilitate working from home during the COVID-19 pandemic (Barrero et al., 2021). But many workers are now well equipped to work from home without additional expense, and many companies are well prepared to support them.

Time / Speed of Change: Telecommuting can be implemented quickly, as demonstrated during the pandemic, particularly now that many workers and many companies are well prepared for remote work.

Geographic variation: The geographic distributions of jobs that do not require a physical presence and of the residences of the employees that fill them will determine where telecommuting has the greatest impact. Cities and regions rich in information-oriented jobs, such as San Francisco and Silicon Valley, may see higher rates of telecommuting and thus a greater reduction in commute VMT. However, in areas with higher shares of commuting by transit, the effect of telecommuting on VMT will be more muted (Zheng et al., 2024).

Equity

To the degree that telecommuting reduces VMT, it will reduce environmental impacts, such as the emission of air pollutants that disproportionately harm disadvantaged communities.

Workers who are able to telecommute have the opportunity to save the time and money associated with commuting. However, many low-wage jobs require a physical presence and thus do not offer the opportunity for telecommuting. Disparities in access to reliable broadband services may also lead to inequities in the ability to telecommute. The benefits of telecommuting are not evenly distributed across the population (Okashita et al., 2023).

Synergy

Telecommuting has synergistic effects with land use, bicycle, and pedestrian strategies. The rebound effect associated with telecommuting is likely to be less in communities where residents are able to safely walk or bicycle to local destinations. Conversely, having remote workers in a neighborhood can increase the viability of local businesses, since remote workers are likely to patronize these businesses in place of ones near their workplace.

It is important to note that telecommuting may have a negative effect on transit ridership. The declines in transit ridership during and following the COVID-19 pandemic can be attributed at least in part to the increase in and persistence of remote work. A shift from transit commuting to telecommuting results in a decline in transit ridership rather than a decline in VMT.

Confidence

Evidence Quality

The four studies in Table 1 provide solid evidence of the effect of telecommuting because they examine changes in VMT for individual telecommuters and collect data on all travel, not just the commute. Their results

suggest that telecommuting leads to a net reduction in VMT, though the size of the reduction is uncertain and context-dependent.

The results of the three 1990s studies should be used with caution owing to small sample sizes, the likelihood that the study participants are not representative of the larger pool of potential telecommuters, and the timing of the studies, occurring in the 1990s prior to widespread use of the Internet and smart phones.

The results from Obeid et al. (2024) reflect conditions during the COVID-19 pandemic, which may or may not persist. Although the study reports the impact of telecommuting on PMT, it is reasonable to assume that the effect on VMT is similar given that the vast majority of workers in the U.S. commute by private vehicle.

Recent cross-sectional studies that compare travel for telecommuters and non-telecommuters are not recommended for use in estimating effect sizes. New quasi-experimental studies are needed to assess the impact of telecommuting on VMT given today's high rates of remote working.

Caveats

The telecommuters in these studies may differ from other workers in important ways. They may have stronger motivations to work at home than their colleagues, and these motivations may be tied to other characteristics that influence their reductions in VMT. It is possible that the opportunity to telecommute induces workers to move farther away from work, thus off-setting some of the VMT reduction on telecommuting days with longer commutes on non-telecommuting days. One study found that the option to telecommute led 20 percent of workers to move (Asmussen et al., 2023). Some telecommuting may replace transit trips or carpooling, rather than driving alone, potentially jeopardizing the viability of these modes. While the net effect of telecommuting in the short run still appears to be a significant reduction in VMT, the long-term effects are more uncertain.

These studies do not provide evidence on the effect of telecommuting on VMT in rural areas. It is likely that the effect size for rural areas is different than for metropolitan areas, depending on commute distances and on non-work travel in those areas. These studies do not directly address situations in which telecommuting enables workers to move their residence from metropolitan areas to rural areas, bringing their non-work VMT with them to those areas.

The total effect of telecommuting in a region depends on the reduction in VMT per telecommuting day, as estimated in Table 1, as well as the number of days of telecommuting per worker and the number of workers telecommuting in the region. Accurately forecasting each of these numbers is difficult.

Technical & Background Information

Study Selection

The selection of studies to assess the benefits of telecommuting was limited to quasi-experimental studies that examine changes in travel for individual commuters. Such studies are the most rigorous approach to establishing the causal effect of telecommuting on VMT. Three studies from the 1990s examined changes in VMT from before to after workers began telecommuting, measured VMT for control groups of non-telecommuters, and analyzed data on all travel, not just the commute (see Table 1). Obeid et al. (2024) examined differences in personal miles of travel (PMT) on days workers telecommuted compared to days they commuted to their worksite. Studies that did not examine changes in travel for individual commuters were excluded, as were studies from outside the US.

Methodological Considerations

Most of the recent studies on the effects of telecommuting are cross-sectional, meaning that they compare the travel of telecommuters to the travel of non-telecommuters at one point in time. Recent studies show that telecommuters generate more total VMT on average than non-telecommuters (Reily and Tawfik, 2022; Zhu and Mason, 2014; Su et al., 2022). A key explanation for this difference is that telecommuters live farther from work on average and thus have longer commutes when they do commute. These studies do not resolve the question of whether having a long commute leads a worker to opt for telecommuting or whether opting for telecommuting leads a worker to move farther from work. In the first case, telecommuting cannot be considered a cause of the increase in VMT, meaning that the difference in VMT between telecommuters and non-telecommuters is not entirely attributable to telecommuting. For this reason, results from cross-sectional studies should not be used to estimate effect sizes for telecommuting.

The selected studies follow an experimental design, with the exception that participants were not randomly assigned to the telecommuting group or the control group. In the three 1990s studies, conducted for pilot telecommuting programs, participants themselves decided whether or not to telecommute. This self-selection explains the observed differences in average commute distance: telecommuters have significantly longer commutes on average than non-telecommuters. These differences might mean that the estimated effect sizes over-state the reduction in VMT that would occur if a greater share of workers (including those with shorter commutes) were to telecommute. Indeed, differences in commute distance between telecommuters and non-telecommuters were much smaller in Obeid et al. (2024), conducted when rates of remote work were much higher. The participants in this study may or may not have had a choice about telecommuting, regardless of their distance from work. A study from Germany provides further evidence that post-COVID telecommuters had shorter commutes (on the days they commuted) than pre-COVID telecommuters (Reiffer et al., 2023).

The estimated effect sizes were calculated based on differences in the reported values for VMT on telecommuting days and non-telecommuting days. Henderson and Mokhtarian (1996) and Balepur et al. (1996) report both commute and non-commute VMT, while Kitamura et al. (1991) report total daily VMT, including both commute and non-commute VMT, for both the worker and the household as a whole. Obeid et al. (2024) report total daily PMT. The effect size is thus calculated in four different ways, as noted in Table 1: as percent change in commute VMT for the telecommuter only, as percent change in daily personal VMT for the telecommuter only, as a percent change in daily personal PMT for the telecommuter only, and as percent change in household VMT, including changes for both the telecommuter and other household members.

- Percent change in commute VMT for the telecommuter only: In theory, the reduction in commute VMT for home-based telecommuters on a telecommuting day should be 100 percent, but Henderson and Mokhtarian (1996) found a reduction of 90.3 percent, owing to some trips to work on days that workers spent mostly working at home (calculations are shown in Handy et al., 2013).
- Percent change in daily personal VMT for the telecommuter only: This calculation includes both commute and non-commute VMT (Handy et al., 2013). Telecommuting directly decreases commute VMT but may also impact non-commute VMT. Early studies were mixed as to whether non-commute VMT decreases or increases on average for telecommuters (Mokhtarian 1998),

but current studies suggest that telecommuters make more non-work trips than non-telecommuters (Su et al., 2022; Reily and Tawfik, 2022; Zhu and Mason, 2014).

- Percent change in daily personal PMT for the telecommuter only: This calculation includes both commute and non-commute PMT. Obeid et al. (2024) found that telecommuters make an average of one additional trip on telecommuting days but that the average distance for this trip was less than the average distance for commute trips, meaning that the net effect of telecommuting on PMT was negative: workers traveled 35 kilometers on average on telecommuting days, compared to 38.5 kilometers on commuting days, a decrease of 9 percent. Given that most of the travel in the US is by car, it is reasonable to assume that the effect size for PMT is a good approximation of the effect size for VMT.
- Percent change in household VMT: This calculation includes all VMT for the telecommuter, as well as for other household members (Handy et al., 2013). Telecommuting directly decreases VMT for the telecommuter and may indirectly impact VMT for other household members. One study found that travel by other household members also decreased when one member telecommuted (Kitamura et al., 1995). Another study suggests that if telecommuting frees up a vehicle for use by other household members, their VMT is likely to increase (Kim et al., 2015).

Henderson and Mokhtarian (1996) and Balepur et al. (1996) both included data on home-based and telecenter-based telecommuters. The effect sizes for telecenter-based telecommuters are smaller than for home-based telecommuters, as this form of telecommuting still involves a work trip, though a shorter one than the trip to the usual work site. In contrast, if home-based telecommuters work entirely from home on telecommuting days (rather than driving to the office for some part of the day), their reduction in commute VMT on telecommuting days will be 100 percent.

The three 1990s studies were all conducted within metropolitan areas on the West Coast, while Obeid et al. (2024) used a nationwide sample stratified by region. It is likely that the effect size for rural areas is different than for metropolitan areas, depending on commute distances and on nonwork travel in those areas. In addition, if telecommuting enables workers to move from metropolitan areas to rural areas, much of their VMT will move with them to the rural area, even if their total VMT goes down. The effect of telecommuting on VMT appears to be smaller in larger metropolitan areas than in smaller ones, but telecommuters generate more VMT on average than non-telecommuters across metropolitan areas of all sizes (Zhu et al., 2018).

As noted, the total effect of telecommuting in a region depends on the reduction in VMT per telecommuting day, the number of days of telecommuting per worker, and the number of workers telecommuting in the region. Researchers have had little success in the past in accurately forecasting the share of the workforce that will adopt telecommuting. In addition, it is often difficult to distinguish between telecommuters who forgo the trip to their usual work site for the entire day (on some or all days), workers who commute to the work site but also do some work at home (i.e., before and/or after commuting) on a particular day, and home-based workers who do not have a usual work site other than home and thus forgo commuting in the long-run but do not eliminate a commute trip on a daily basis. In general, total percent reduction in household VMT can be estimated using the following equation:

$$\begin{aligned} &Total\ percent\ reduction\ in\ household\ VMT \\ &\quad = percent\ reduction\ in\ household\ VMT\ per\ telecommuting\ day \\ &\quad \times share\ of\ workers\ telecommuting \\ &\quad \times share\ of\ days\ telecommuters\ telecommute \end{aligned}$$

Zheng et al. (2024) provide evidence of a state-level association between onsite workers (a proxy for the inverse of telecommuters) and VMT. An instrumental variable analysis using longitudinal data from April 2020 to October 2022 shows that a 1 percent decrease in the number of on-site workers is associated with a 0.99 percent decrease in state-level VMT but also a 2.26 percent drop in transit ridership in metropolitan statistical areas. Although these relationships were relatively stable across the time period analyzed, the long-term effects of telecommuting on VMT and transit ridership are uncertain.

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