Technical Background Document on Impacts of Telecommuting Based on a Review of the Empirical Literature

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Study Selection

A review of the literature to assess the benefits of telecommuting was limited to experimental designs, which are the most rigorous approach to establishing the causal effect of a policy on vehicle miles of travel (VMT). Three studies examined changes in VMT from before to after workers began telecommuting, measured VMT for control groups of non-telecommuters, and used travel diary surveys to collect data on all travel, not just the commute (see Table 1). Studies that did not use before-and-after measurements, control groups, or travel diary surveys (e.g. Nelson, et al. 2007) were excluded, as well as studies from outside the U.S.

Effect Size, Methodology and Applicability Issues

These studies follow an experimental design, with the exception that participants were not randomly assigned to the telecommuting group or the control group. Instead, 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.

The estimated effect sizes were calculated based on 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. The effect size is thus calculated in three 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, and as percent change in household VMT, including changes for both the telecommuter and other household members. The values of the effect size decline in this order, because of the trend in both the numerator and the denominator in the calculation.

- 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.

- Percent change in daily personal VMT for the telecommuter only: This calculation includes both commute and non-commute VMT. Telecommuting directly decreases commute VMT but may also impact non-commute VMT. However, studies are mixed as to whether non-commute VMT decreases or increases on average for telecommuters (Mokhtarian 1998). Because the change in non-commute VMT, whether positive or negative, is relatively small compared to the change in commute VMT, the percent change in daily personal VMT is nearly equivalent to the change in commute VMT divided by commute plus non-commute VMT, and will thus be lower than percent change in commute VMT for the telecommuter.

- Percent change in household VMT: This calculation includes all VMT for the telecommuter, as well as for other household members. Telecommuting directly decreases VMT for the telecommuter, and may indirectly impact VMT for other households members. One study found that travel by other household members also decreased when one member telecommuted (Kitamura, et al. 1995). Because the change in VMT by other household members, whether positive or negative, is relatively small compared to the change in commute VMT, the percent change in household VMT is nearly equivalent to the change in commute VMT divided by commute plus non-commute VMT for all household members, and will thus be lower than percent change in commute VMT for the telecommuter or the percent change in daily personal VMT for the telecommuter only.

Henderson and Mokhtarian (1996) and Balepur, et al. (1996) both included data on both 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.

Note that although the three studies also include measures of changes in VMT for a control group, these values do not factor into the calculation of the effect size. Instead, they are used to test the statistical significance of the change in VMT for the telecommuters. In all three cases, the change in VMT for telecommuters was statistically significantly different from the change in VMT for non-telecommuters.

The estimated effects from these studies may represent the upper end of the range of possible effects. First, the telecommuters in these studies may differ from other workers in important ways. They are “early adopters” of telecommuting, with potentially stronger motivations to work at home than their colleagues. These motivations may be tied to other characteristics that influence their reductions in VMT. For example, in all three of these studies, telecommuters live farther from work than non-telecommuters. This makes their percent reductions in daily VMT greater than would be the reductions for

their colleagues who live closer to work, if they were to telecommute. For example, in Henderson and Mokhtarian (1996) average commute distances were 51 miles for home-based telecommuters, 40 miles for center-based telecommuters, and 21 miles for non-telecommuters. Data from the 2001 National Household Travel Survey (NHTS) showed that telecommuters had one-way commutes of 34.8 miles, compared to 24.2 miles for non-telecommuters (FHWA 2008).

Secondly, 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. Similarly, the time saved not commuting on telecommuting days can be used for travel for other purposes. Balepur, et al. (1996) found that non-commute VMT increased 3 miles, equivalent to 50 percent, on telecommuting days. Some telecommuting may replace transit trips or carpooling, rather than driving alone, in which case the reduction in VMT for that telecommuter may be zero or almost zero. 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. Although the long-term effects of telecommuting, which takes into account shifts in residential location, have not been directly studied, an analysis of overall volumes of telecommunications use and travel in the U.S. shows that total travel has increased rather than decreased in response to increased telecommunications use (and vice versa) (Choo and Mokhtarian 2007).

Note that these studies were all conducted within metropolitan areas. It is likely that the effect size for rural areas is different, depending on commute distances and on non-work 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.

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), workers who do some work at home (but also commute to the work site) 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 not on a daily basis). In general, total percent reduction in household VMT can be estimated using the following equation:

Total percent reduction in household VMT =
- percent reduction in household VMT per telecommuting day
- x share of workers telecommuting
- x share of days telecommuters telecommute

Table 1: Effect Calculations and Notes on Studies

Study	Telecommuting measures	Travel behavior measures	Effect calculation	Notes
Kitamura et al, (1991)	Telecommuting days – home-based	Daily personal VMT Daily household VMT	Percent reductions calculated from VMT numbers reported in Table 6 of cited paper as shown below, , according to this formula: (VMT before – VMT after)/ VMT before Daily personal VMT: (56.1 - 13.1) / 56.1 = 0.766 Daily household VMT: VMT before = 56.1 for telecommuter + 33.1 for others in household = 89.2 VMT VMT after = 13.2 for telecommuter + 33.1 for others in household = 46.3 VMT Percent change = (89.2 – 46.3) / 89.2 = 0.481	73 telecommuters from state agencies. Before-and-after study, including control group and data collection for households. Travel diary survey used to measure VMT.

Study	Telecommuting measures	Travel behavior measures	Effect calculation	Notes
Henderson and Mokhtarian (1996)	Telecommuting days – home-based Telecommuting days – center-based	Commute VMT Daily personal VMT	Percent reductions calculated from VMT numbers reported in Table 3 of cited paper as shown below, according to this formula: (VMT before – VMT after) / VMT before. Home-based commute VMT: (40.29 - 3.90) / 40.29 = 0.903 Home-based daily personal VMT: (51.03 - 17.12) / 51.03 = 0.665 Center-based commuter VMT: (51.36 - 19.54) / 51.36 = 0.620 Center-based daily personal VMT: (63.25 - 29.31) / 63.25 = 0.537	72 telecommuters from public and private organizations. Before-and-after study, including control group. Travel diary survey used to measure VMT.
Balepur et al, (1996)	Telecommuting day – center-based	Commute VMT Daily personal VMT	Percent reductions calculated from VMT numbers reported in Table 3 of cited paper as shown below, according to this formula: (VMT before – VMT after)/ VMT before. Home-based commute VMT: (53.1 - 12.1) / 53.1 = 0.772 Home-based daily personal VMT: (58.9 - 20.8) / 58.9 = 0.647	24 telecommuters using telecommuting centers. Before-and-after study, including control group. Travel diary survey used to measure VMT.

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Acknowledgments

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