

### THE AUTHORS REPLY

We thank Blakely et al. (1) for their observations. We welcome their stance that researchers conducting instrumental variable (IV)–fixed-effects (FE) analysis should be wary of potential violations of the exclusion restriction—in our study (2), the assumption that eligibility for the free bus pass only impacts cognitive function through the effect on public transportation use. The exclusion restriction is essentially untestable and must be supported by strong arguments. We argue that Blakely et al.’s concerns do not offer convincing evidence to conclude that the difference in magnitude between our FE estimates and our IV-FE estimates is due to an exclusion restriction violation.

The observation that the IV-FE estimates are larger than the FE estimates is not in itself evidence of an assumption violation. The difference may, for example, be explained by the fact that FE models assess the average association between changes in transportation use and cognitive function, while the IV-FE model aims to capture the local average treatment effect among persons who were induced to change their use of public transportation as a result of becoming eligible for the free bus pass. The IV-FE may also address omitted variable bias and random measurement error in self-reported public transportation use, which may bias the FE estimates toward the null. We also note that confidence intervals for the IV-FE and FE estimates overlap and are thus not significantly different from each other.

Blakely et al. raise 2 concerns about the exclusion restriction (1). The first is that prior public transportation users may have increased their frequency of transportation use after becoming eligible for the free bus pass. As requested by Blakely et al. (1), we estimated the change in cognitive function as a result of becoming eligible for the bus pass among prior transportation users and nonusers and found no significant effect for prior transportation users (0.017 standard deviations, 95% confidence interval: –0.009, 0.042) but a significant effect for non–prior users (0.042 standard deviations, 95% confidence interval: 0.001, 0.084). Additionally, using IV-FE models and testing different cutoffs for transportation use frequency, we found that increased transportation use was not associated with changes in overall cognitive function among prior users (results available upon request). A potential explanation is that starting to use public transportation provides larger benefits for cognition than small increases in public transportation use among prior users.

The second potential violation Blakely et al. propose (1) is that prior transportation users may apply their savings on bus fares from the free pass to other activities that benefit cognitive health. Estimates from the Institute for Fiscal Studies (3) suggest that, on average, a transportation user who becomes eligible for the free pass may save approximately

£155 (\$203) on bus fares per year—less than £3 (\$4) per week. While it is not impossible, these very small potential savings are unlikely to be driving the larger IV-FE estimate.

In conclusion, while we concur with Blakely et al. on the importance of being cautious about assumption violations in IV-FE analysis, we do not believe their concerns represent likely sources of exclusion restriction violations in our study. Furthermore, we welcome Blakely et al.’s point (1) that their concerns do not compromise the main conclusion of our paper: that increased public transportation use may benefit cognitive function and that transportation policies may serve as tools for promoting cognitive health in older age.

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Conflict of interest: none declared.

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