Using New Transportation Options to Drive Low-Income Citizens to Greater Success

Lee Branstetter (CMU, NBER) and Beibei Li (CMU)
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Introduction: Decades of research by economists and other social scientists have pointed to spatial mismatch as a barrier to employment in American cities. These issues are likely to pose special challenges for vulnerable populations such as less-educated, low-income mothers with children, given their child care responsibilities (Gobillon et al., 2007; Black et al., 2014). After mass layoffs (such as the ones induced by the COVID crisis), recent research suggests that spatial mismatch can substantially lengthen spells of unemployment, especially for females, African-Americans, and older workers (Andersson et al., 2018). The suburbanization of poverty has also changed the dynamics of spatial mismatch in American cities. Policies seeking to connect lower income and lower skilled workers living in the urban core to jobs may no longer work as these lower income populations move to the suburbs (Frey 2016). As the poor become more geographically dispersed along the urban periphery, the traditional hub and spoke model of most city mass transit systems becomes less useful. Disadvantaged residents need to move from one suburban area to another to pursue employment opportunities, but mass transit systems provide fewer links along the periphery. Some parts of the community are served by a single bus line that runs infrequently, making it challenging to secure employment, particularly third shift jobs or jobs in other suburban neighborhoods.

We see these trends and their consequences clearly in the area around Pittsburgh. The Allegheny County Department of Human Services *Suburban Poverty* report found that in many suburban census tracts, over 30 percent of residents do not own a vehicle. These residents face real transportation constraints, because 36 percent of suburban census tracts have limited access to public transportation and another 23 percent have only moderate access (Collins, Dalton, and Good, 2014). A study completed by the Shared Use Mobility Center argues that the suburbanization of poverty has led to longer commutes, poorer job access and increased reliance on personal vehicle ownership (APTA, 2016).

Figure 1. Poverty and Opportunity Zones in Allegheny County

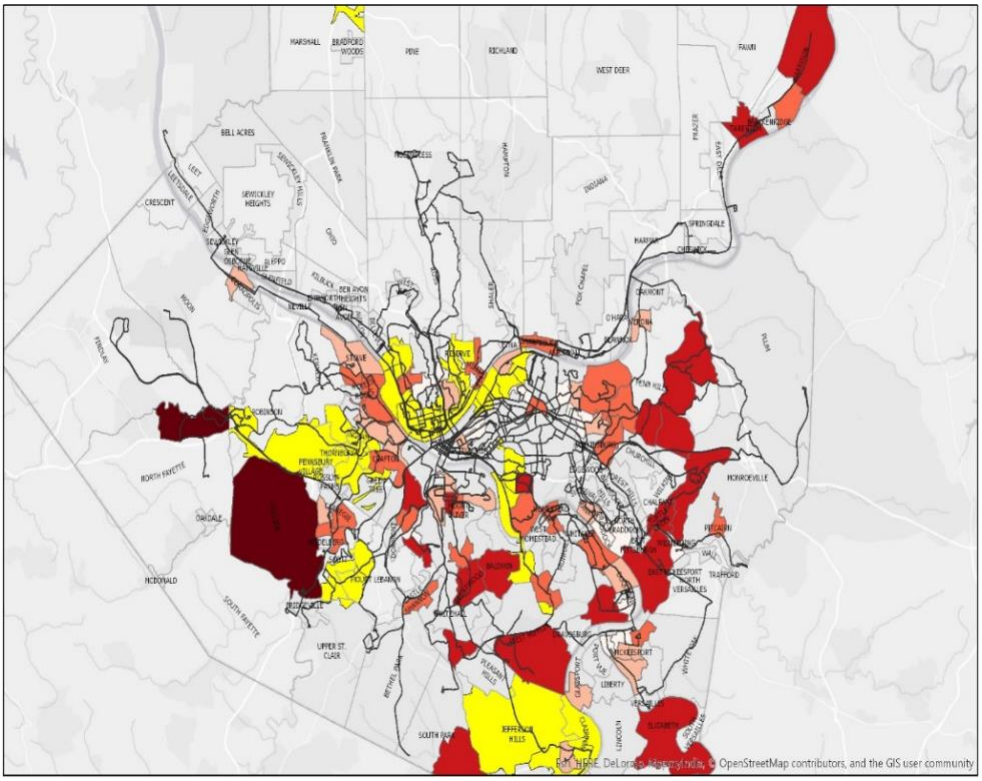


Figure 1 shows the spatial mismatch phenomenon in Allegheny County, Pennsylvania. The map uses publicly available data from the American Community Survey 5-year estimates from 2015 to create a pre-COVID index of neighborhood poverty based on income and education. Poorer neighborhoods are colored red, and the darker red zones indicate districts that are both poor and populous. The map also uses the Census Bureau's Longitudinal Employment-Household Dynamics

data from 2010-2014 to identify districts where low-skill jobs are being created in large numbers, which are colored yellow. It is immediately apparent that many of the poor neighborhoods are quite distant from many of the opportunity zones, and that many poor neighborhoods and opportunity zones lie well outside the urban core. When the route structure of the regional mass transit system is overlaid on top of this map, it becomes immediately apparent that the system provides limited linkages between many disadvantaged neighborhoods and the locations where residents might find appropriate jobs. In some cases the same commute that would take just minutes in a private car takes an hour or more on mass transit.

Now, however, a range of new, smartphone-enabled transportation options are diffusing rapidly through American cities, offering more flexible and convenient methods of transport that do not require incurring the fixed costs of private vehicle ownership. Recent research suggests that use of these new options is currently clustered in the wealthier districts of American cities (Thebault-Spieker, Treveen, and Hecht, 2017), reflecting the reality that the market price points at which these services are currently offered place them out of reach for many of the urban poor. However, targeted public policy interventions could alter this state of affairs. Could subsidized provision of these new transportation options to the poor enable better access to employment, training, and social services? This project seeks to put this question to a series of convincing empirical tests by conducting a series of large-scale randomized experiments in the Pittsburgh region.

At the same time, the experiments described in this proposal will also address a fundamental limitation in much of the literature that has informed our understanding of spatial mismatch – the paucity of credible *experimental* evidence showing that lower transport costs leads to higher labor force participation and greater socioeconomic mobility. Leveraging the emergence of new transportation options in the Pittsburgh region, our study will undertake exactly the kind of randomized control trials that have been largely missing in the prior literature, and it will exploit the rapid diffusion of smartphones among even the urban poor to track the impact of lower transportation costs on geographic mobility and self-reported employment and wages. Additional data collected by Allegheny County DHS will provide an important supplement to self-reported data. These data will also help us infer the impact of lower transportation costs on other social outcomes of interest, including utilization of social services.

Finally, we believe that our proposed combination of standard econometric methods, "app" development, and intensive use of smartphones may inspire other economists to expand their tool kits in similar ways. The wide diffusion of smartphones (even among the urban poor) and the relative ease with which user-friendly "apps" can be created and disseminated have worked together to provide researchers with new, often low-cost platforms through which experimental interventions can be directed and implemented. The same technologies also create important new opportunities for data collection and measurement, often to a degree of granularity and temporal frequency that would have been unimaginable to earlier generations of empirical researchers. While we plan to leverage these technologies to make an important contribution to the literature on spatial mismatch, we think they could be creatively applied to a broader range of research and policy domains. As the skill sets – especially with regard to mobile app development -- with which our Carnegie Mellon students are particular well-endowed become more commonplace, it will be increasingly easy for economists and other social scientists to move in this direction.

Research Questions/Data/Methods: This section of the proposal identifies three distinct research questions we will pursue, along with the key data sources and methods we will use to answer them.

1. *Does access to new transportation options significantly expand the **geographic mobility** of low-income citizens?*

As already noted, widespread diffusion of smartphones has enabled a proliferation of new transportation options that offer some of the flexibility of personal vehicles without the fixed costs of vehicle ownership. The current pricing models of the newer transportation options often limit their accessibility to the urban poor. However, smartphone diffusion even among poor families is now quite extensive, raising the possibility that modest subsidies for the new transportation options could allow low-income citizens greater access to them, substantially enhancing their geographic mobility. The GPS capabilities embedded in those smartphones allow for the detailed tracking and measurement of individual mobility patterns (Macha et al., 2021). Our research team has already acquired extensive experience creating and deploying iOS and Android-compatible smartphone apps that gather detailed GPS location data several times per hour, in a way that achieves a good balance between mobility measurement and battery drain on users' phones. Through experience, we have identified robust approaches to mobility measurement that can contend with the noise in GPS data. Working together with CMU's Institutional Review Board, we have developed data anonymization protocols that allow us to analyze these rich data while also protecting the privacy of our participants. Finally, by implementing the best practices of a randomized controlled trial (RCT), we can experimentally manipulate participants' access to particular transportation options and make causal inferences about the impact of this on mobility outcomes. We note some preliminary estimates of the impact of randomly assigned access to Uber rides on various measures of individual mobility in the "Preliminary Research Efforts" section below.

2. *Does access to new transportation options increase the **socioeconomic mobility** of low-income citizens?* The same smartphone apps that collect high-frequency GPS data can also send and receive short surveys that capture aspects of the mobility experience which cannot be measured by GPS data alone. We are already using these tools to measure *self-reported* employment and income. However, we can also utilize the ongoing partnership between Allegheny County Department of Human Services (ACDHS) and CMU to measure the impact of experimentally induced increases in geographic mobility on the short-and long-term *socioeconomic mobility* of our study participants. ACDHS is a national leader in efforts to link the various administrative data sets generated by the major social assistance programs, local schools, police departments, and courts into a single integrated data warehouse, in which a unique identifier code links individual county residents' data records across data sets. The data warehouse provides comprehensive coverage on the recent income, employment, and social services utilization of the majority of low-income residents of Allegheny County. Birth and school records link adult members of the treatment group to the academic performance of their children in "reporting" school districts. While CMU researchers will not have direct access to sensitive individual-level records, cleared data analysts inside ACDHS can perform statistical analyses on those records and share the results with CMU researchers. This collaboration gives our team an unusual degree of insight into the short- and long-run effects of additional geographic mobility on a broad range of socioeconomic outcomes. In addition to providing us with access to extensive data, ACDHS is a trusted supporter of low-income county residents through its client-facing agencies and through the human service contractors that work under its supervision. Given the role it plays in our community, ACDHS can help publicize our programs and recruit low-income residents to participate in our studies.

3. *How do low-income citizens value different "new" transportation options and option combinations?* Drawing upon a long, rich economic literature modeling consumers' transportation choices (e.g., McFadden, 1974), we will seek to learn how low-income citizens value different "emerging" transportation options. The potential that urban planners and transportation policymakers associate with these newer options is tempered by a lack of extensive data on how much and under what circumstances low income citizens will choose to utilize them, even when access is substantially subsidized. Some of these options have well known shortcomings, especially in challenging weather conditions. Starting this fall, a new phase in our proposed research, undertaken in partnership with the City of Pittsburgh, will provide participants with a menu of options from which they can choose. As Pittsburgh's seasons change, and as a diverse group of low-income citizens is recruited into this study, we may be able to infer important elements of consumers' preferences for these various options. Detailed individual data on transportation choices made from a menu of multiple subsidized emerging transportation options will enable us to address this important set of issues.

Preliminary Research Efforts/ Research Findings

Step 1 -- The "Uber Project": Existing funding from the National Science Foundation, the Hillman Foundation, and CMU's Traffic21 research center has allowed us to begin our research by examining the impact of subsidized access to one smartphone-enabled transportation option: ride-hailing. This project, undertaken in partnership with Uber and ACDHS, provided us with the resources to develop smartphone apps (compatible with both iOS and Android operating systems) that gather GPS data and provide a platform through which we can send and receive short surveys to participants that enable us to measure aspects of our participants' experience not captured by administrative data sets. This research project is ongoing, with a rolling recruitment of participants that will extend into 2022. We are not yet in a position to estimate the impact of our treatment on employment or income, but we have been able to identify a causal impact of our treatment on the geographic mobility of our participants that is statistically significant and economically meaningful. The measured impact varies depending on the exact specification, but appears to lie in the range of 10-15%. Survey evidence suggests that participants are using the resources provided to members of our treatment group to expedite their job searches and their commutes to work, but are also using these resources to expand access for themselves and their families to other social resources, including health care, parks and recreation, and goods and services purchased outside their neighborhoods. By the end of this study, we expect to have recruited 650 low-income mothers as participants, equally divided across the treatment and control arms. More details about this study are available upon request.

Step 2 -- Guaranteed Mobility for Pittsburgh's Manchester Community: This fall, our CMU team will begin a pilot study in cooperation with the City of Pittsburgh's Department of Mobility and Infrastructure, the Manchester Community Corporation, SPIN (a national provider of e-scooter transportation services), the R. K. Mellon Foundation, and other local nonprofits. Rather than provide low-income residents with subsidized access to a single smartphone-enabled transportation option, such as Uber, this pilot will provide access to a *menu* of transportation options, including standard mass transit (through monthly transit passes), Pittsburgh's Healthy Ride bike-sharing service, SPIN (which offers access to smartphone-activated electric scooters across the city), Scoobi (which offers access to smartphone-activated electric mopeds across the city), the Zipcar car rental service, and Waze Carpool, a "peer to peer" ridesharing service. Residents of Pittsburgh's Manchester neighborhood (a low-income neighborhood on the city's North Side) will be recruited into a randomized controlled trial in which the treatment group will get 12 months of generously subsidized access to the full menu of transportation options described above. Members of the demographically equivalent control group will receive gift cards in return for downloading our GPS app, and responding to surveys over the same period. Use of our smartphone app by members of both groups will allow for precise measurement of the magnitude and nature of any

impact of the treatment on geographic mobility. This information will be supplemented with detailed user-specific information on utilization of the transportation options described above. As in Step 1, ongoing cooperation with ACDHS will allow comprehensive measurement of the impact of treatment on socioeconomic mobility. The active study period for this project is likely to extend into the fall of 2022.

This new step in our research program provides a broader and far more generous menu of transportation options to participants than our first study. In principle, participants in the treatment group could have access to total transit resources worth more than $800 per month for up to one year. More generous, broader support could lead to larger measured increases in geographic and socioeconomic mobility. By offering a diverse group of low-income citizens a broad menu of options, the project can also began to elicit low-income consumer preferences for these options, contingent on consumer characteristics (gender, age, etc.), environmental factors (weather, temperature, time of day, etc.), and other variables, by observing participants choices. Despite these attractive features, current funding limitations restrict our sample size to a relatively small number of treatment and control participants. In addition, the menu of transportation options in this Guaranteed Mobility study is far from complete, and the geographic focus of the study, limited as it is by the jurisdiction of the City of Pittsburgh, necessarily omits consideration of low-income citizens in Pittsburgh suburbs and adjacent communities. This is a significant omission, because – like cities across the nation – Pittsburgh has seen growing populations of low-income citizens choosing to reside *outside* the urban core, where conventional mass transit service is far less dense than in core neighborhoods. Many of the parts of Allegheny County that have seen the most growth in less skill-intensive jobs are also located outside the urban core, creating a growing need for longer-distance commuting solutions that are not currently part of the menu of the Guaranteed Mobility study.

The Next Step -- Expanding Transportation Options and Sample Size: We are currently seeking substantial funding for an expansion of the project described above with respect to sample size, geographic scope, and transportation options. In order to better capture the impact of subsidized access on geographic and socioeconomic mobility, we seek to recruit at least 400-600 participants to participate in our next set of RCTs. We also seek to expand the geographic scope of our study from the City of Pittsburgh to all of Allegheny County, enabling us to offer new transportation options to residents that are especially poorly served by conventional mass transit. Given this larger geographic scope, we also wish to include additional transportation options that could provide subsidized support for the kinds of longer distance commutes that are increasingly common for low-income workers in our region, even in unfavorable weather conditions. These additional transportation options would include regional micro transit agencies that cooperate with and extend the reach of mass transit, such as RideACTA, more conventional carpools and vanpools that are generously subsidized by the state, such as those supported by the Commute Info program, and new entrants into the ride-hailing industry that offer services on a subscription model and are more focused on the needs and travel patterns of lower-income individuals and families, such as RubyRide. With the support of an NSF Civic Innovation planning grant, we have worked out provisional cooperative relationships with ten separate regional transportation service providers. Unfortunately, we have not yet secured sufficient funding to engage this full network at the desired scale. We look forward to working with other participants in this NBER project to identify nontraditional sources of funding that might provide us with the necessary financial support.

Research Team: PI Lee Branstetter is an expert on the economics of innovation and technology diffusion. His work has been published in leading journals including the *American Economic Review*, the *Quarterly Journal of Economics*, the *RAND Journal of Economics*, the *Review of Economics and Statistics*, and the *Economic Journal*. Professor Branstetter is a research associate of the NBER, and he served as a senior economist on the staff of President Barack Obama's Council of Economic Advisers in 2011-2012. As the Director for the Future of Work Initiative at CMU's Block Center for Technology and Society, an interdisciplinary research center based in Carnegie Mellon's Heinz College, Professor Branstetter also brings to the project strong ties with social service agencies and nonprofits in the Pittsburgh region that regularly interact with the population this project is designed to help. Branstetter is the PI for NSF grant "Driving Low-Income Mothers to Greater Success: The Impact of Ride-hailing on Employment and Income" (SBE- #1851862), $285,080 and for NSF grant "City of Bridges: Using New Transportation Options to Drive Low-Income Mothers to Greater Success in Pittsburgh" (SCC-CIVIC-PG 2043634), $50,000.

Co-PI Beibei Li has extensive experience at leveraging both observational data analytics and experimental analysis in analyzing large-scale individual user behavior and mobility data across online, offline and mobile channels for decision support and user interface design. Her background in computer science and doctoral training in information systems will enable her to provide effective leadership of the technical aspects of this project, including the development of information collection systems and improvement of smartphone aps. As a professor in one of North America's leading professional degree programs in analytics and information systems management, Professor Li has access to a broad away of talented and experienced doctoral and masters students, with strong programming and data analysis skills, ensuring that we can recruit outstanding graduate research assistants for this project. Professor Li's research skills are evidenced by her publication record and by her receipt of the Anna McCandless Career Development Professorship. Li was co-PI on the two NSF grants named above.

Conflict of Interest Statement: Neither PI has any significant financial investment, corporate board seat, consulting arrangement, or any other relationship that might impact the conduct of the research described this proposal. However, we acknowledge that Uber Technologies, a leading ride-hailing company, has supported one of our ongoing randomized controlled trials, described earlier in this proposal, through the provision of a substantial number of free rides to our study participants. The commercial value of this in-kind support is approximately $320,000. This in-kind support has not affected our conduct of the research, nor will it impact the conclusions we derive from our analysis. Nevertheless, we acknowledge this support from Uber Technologies in the interests of full disclosure. We also noted our participation in a new mobility project led by the City of Pittsburgh's Department of Mobility and Infrastructure. SPIN, a national provider of smartphone-enabled e-scooter mobility services, has pledged to contribute $50,000 toward the total cost of this project. In addition, transportation providers Healthy Ride, SPIN, and Scoobi have offered to discount their service provision over the life of the study. The market value of these discounts is expected to be $3,000, $56,000, and $3000 respectively. Neither PI will receive compensation directly from SPIN, nor will they receive the subsidized services. These provider contributions will not affect the conduct of our research or the conclusions we derive from our analysis. Nevertheless, we acknowledge this in the interests of full disclosure.

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