FINAL RESEARCH REPORT

Project 391 - Evaluating Pittsburgh's Universal Basic Mobility Pilot Program

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Project Summary

Our CMU team has begun a pilot study in cooperation with the City of Pittsburgh's Department of Mobility and Infrastructure, SPIN (a national provider of e-scooter transportation services), and Move PGH, a nonprofit. This study provides a group of low-income citizens in Pittsburgh access to a menu of subsidized transportation options, including standard mass transit (through monthly transit passes), Pittsburgh's POGOH bike-sharing service, SPIN (which offers access to smartphone-activated electric scooters across the city), and the Zipcar car rental service.[1] Low-income Pittsburgh residents were recruited into a randomized controlled trial in which the treatment group gets 12 months of generously subsidized access to the full menu of transportation options described above. Members of a demographically equivalent control group receive gift cards or electronic payments in return for downloading our GPS apps, transmitting data, and responding to surveys over the same period.

Use of a smartphone apps by members of both treatment and control groups allows for 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. We 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-term 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. In principle, participants in the treatment group could have access to total transit resources worth hundreds of dollars per month for up to one year. This could lead to large 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 begin 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.

The results of this research could provide important guidance to public policy efforts to improve the geographic and socioeconomic mobility of low-income urban residents. Delays in the start of the project, described later in this document, mean that much of the necessary data collection and analysis still lie many months in the future.

[1] In late June 2023, a budget disagreement between Pennsylvania's Governor and the State Senate prompted leaders of that legislative body to move to recess without finalizing their approval of the state budget or passing a number of pieces of routine legislation whose timely passage had heretofore seemed assured. Among these was a law extended SPIN's license to operate in Pittsburgh. The legislative impasse meant that SPIN's license expired in early July, forcing a (hopefully temporary) suspension of SPIN services in the region.

2. Introduction

The labor force participation rate in the United States among the poorly educated is very low. For adults aged 25 and over, it is less than 60% among those with a high school degree, and less than 50% among those without a high school education. One contributing factor to low participation in the labor market is relatively high transportation costs. At least since the classic work of Oi (1976), economists have understood that labor force participation can be sensitive to quasi-fixed costs, such as transportation costs, and there is a small but important empirical literature reinforcing this idea. However, this is a literature with many open questions.

As we discuss in our literature review below, researchers seeking to estimate a causal impact of transportation costs on labor supply face a daunting challenge. The ideal empirical design would be a quasi-experiment in which transportation costs decline for some (treatment) individuals, while remaining fixed for other (control) individuals, *and* while holding all other factors fixed. As a counter-example, consider an investment in public transportation system. It is likely that the investment will reduce transportation costs more in some neighborhoods than in other neighborhoods, but because of *equilibrium effects*, many of which are anticipated, it is exceedingly difficult to tease out the causal impact of the change in transportation costs on labor supply. For instance, property values of homes near new convenient transportation hubs will likely increase, perhaps even before the completion of the new transportation project, as individuals with a high propensity to work relocate to those locations.

As is emphasized in the "spatial mismatch" literature, transportation costs are likely to be particularly burdensome for lower-paid, poorly-educated workers, because these individuals often cannot afford housing near job opportunities. For these individuals in particular, then, it seems likely that an exogenous decline in transportation costs might increase labor force participation.

Against this backdrop, we describe here an ongoing field experiment, in which participants are engaged for a moderate duration (12 months), during which we reduce the transportation cost for a treatment group, and compare labor force outcomes to a control group. In our proposed experiment, the reduction in transportation cost will be implemented via an innovative treatment that has high potential policy relevance—the provision of free access to conventional mass transit coupled with free access to a portfolio of what we might characterize as "micro-mobility" providers, including e-scooters, e-bikes, and car-sharing. We are excited by this particular intervention because of the possibility that future directions in public urban transportation may include technology-enabled individualized transportation services as an integral part of a broader transportation system.

Thus, we view our experiment as accomplishing two goals:

(1) Our research will contribute to a small but growing literature on randomized controlled experiments designed to study the impact of transportation costs on the labor supply of a generally lower-paid population (see Brough et al. (2023), Baviskar et al. (2022, 2023). Most studies in this small literature provide enhanced access to only one form of transportation. Our study provides enhanced access to conventional mass transit and a portfolio of "micromobility" services that may increase "first-mile / last-mile" access to mass transit routes and/or expand mobility beyond what mass transit alone can provide.

(2) Our experiment can also be thought of as an innovative "pilot program" designed to examine how new technologies in transportation can be leveraged to improve the labor market outcomes in low-income residents. In particular, if our work suggests that the flexibility afforded by the basket of transportation services we subsidize improves labor force participation, this result could be provide

an impetus for future research on the role of transportation innovation in improving labor market outcomes. More broadly we hope that the resulting research can be a valuable input for the design of integrated public transportation systems that link to micro-mobility services in the decades to come.

3. Spatial Mismatch in the U.S. Labor Market

The spatial mismatch hypothesis centers on the idea that many workers may have poor labor market outcomes because they reside far from the job opportunities appropriate to their skill level, and the monetary or time cost of transporting these workers from their residences to job sites is high. Formal study of this problem began in the 1960s, and was spurred in part by the investigations surrounding the 1965 Watts riots in Los Angeles (McCone Commission, 1965). The investigating commission concluded that the low employment rates of Watts residents contributed to the riot, and these low employment rates were, in turn, driven by the geographic isolation of residents from skill-appropriate jobs elsewhere in the Los Angeles metro area. Lower rates of personal vehicle ownership among Watts residents not only cut off access to jobs but also access to many social services provided outside the neighborhood. The commission strongly recommended improvements in public transportation in order to boost employment outcomes and access to more services. However, city transportation budgets have limits, and the long-term shift of many low-skill jobs to the urban periphery, where population density is low and job sites are relatively far apart, has made it difficult to resolve this issue through traditional public transportation technologies. Decades after the release of the McCone Commission Report, researchers continue to find evidence consistent with a significant degree of spatial mismatch in American cities.

There is now little doubt that spatial mismatch is a serious social problem. One particularly persuasive study on spatial mismatch, by Andersson et al. (2018), uses employer-employee administrative data, combined with a person-specific job accessibility measure, to show that after a mass lay-off, lower-skilled workers were disproportionately likely to face long unemployment spells due to poor job accessibility. The study found that African Americans, females and older workers are more sensitive to travel time than other subpopulations.[2] This research is important because it provides solid evidence for the important role of transportation time costs as a key factor shaping labor market success, particularly among lower-skilled workers.

A modest literature focuses more directly on transportation costs/time as a factor affecting labor market outcomes. Black, Kolesnikova and Taylor (2014) found that participation in the labor force of married women is negatively correlated with the city's average commuting time, and provide some evidence of a causal link. Also, studies of local transportation systems provide useful evidence on the topic, e.g., Moeller and Zierer's (2018) evaluation of highway expansion in Germany, and Thierry and Trevien's study of the expansion of France's Regional Express Rail (RER).

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[2] Andersson et al. also provide links to a large related literature on the topic, including review articles by Kain (1992, 2004), Ihlanfeldt and Sjoquist (1998), and Gobillon et al. (2007). It is well understood that racial discrimination in housing and labor markets can be an important factor in urban spatial mismatch (e.g., Gabriel and Rosenthal, 1996). Interestingly, Chetty and Hendren (2018) find that commuting time within a metro area is correlated with the odds that the next generation of residents escape poverty; the longer the average commute in a given county, the worse the chances of low-income families there moving up the ladder.

Of course, none of these studies mentioned in the previous paragraphs are a substitute for an experiment that exogenously varies transportation costs. The Black et al. (2014) paper, for example, shows a strong relationship between commuting time and labor force participation, but, as they acknowledge, part of that relationship could be driven by the sorting of households with high rates of labor force participation into cities where commuting times are shorter. Similarly, the research on the role of public transportation expansion demonstrates that reduced transportation costs shape labor markets, but as we mention in the introduction, these innovations have *equilibrium* effects—making it difficult to tease out causal effects on individual work behaviors.[3]

Finally, it is important to note that limited access to public transportation can hinder access to job opportunities (Lichtenwalter, Koeske, and Sales 2006) and can make job search difficult as well. Studies have shown that higher time and distance from jobs leads to lower search efforts. Not surprisingly, having access to a car makes job searching less costly and those with cars tend to have higher search intensity (Patacchini and Zenou 2005). Dependence on personal vehicles for job searching stands as a major barrier for lower income households who cannot afford to own a car.

4. Spatial Mismatch in Allegheny County, Pennsylvania

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 our own region of Southwestern Pennsylvania. 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).

[3] For example, Thierry and Trevien (2017) note that their results "suggest that the arrival of the RER may have increased competition for land, since high-skilled households were more likely to locate in the vicinity of a RER station."

Figure 1. Poverty and Opportunity Zones in Allegheny County

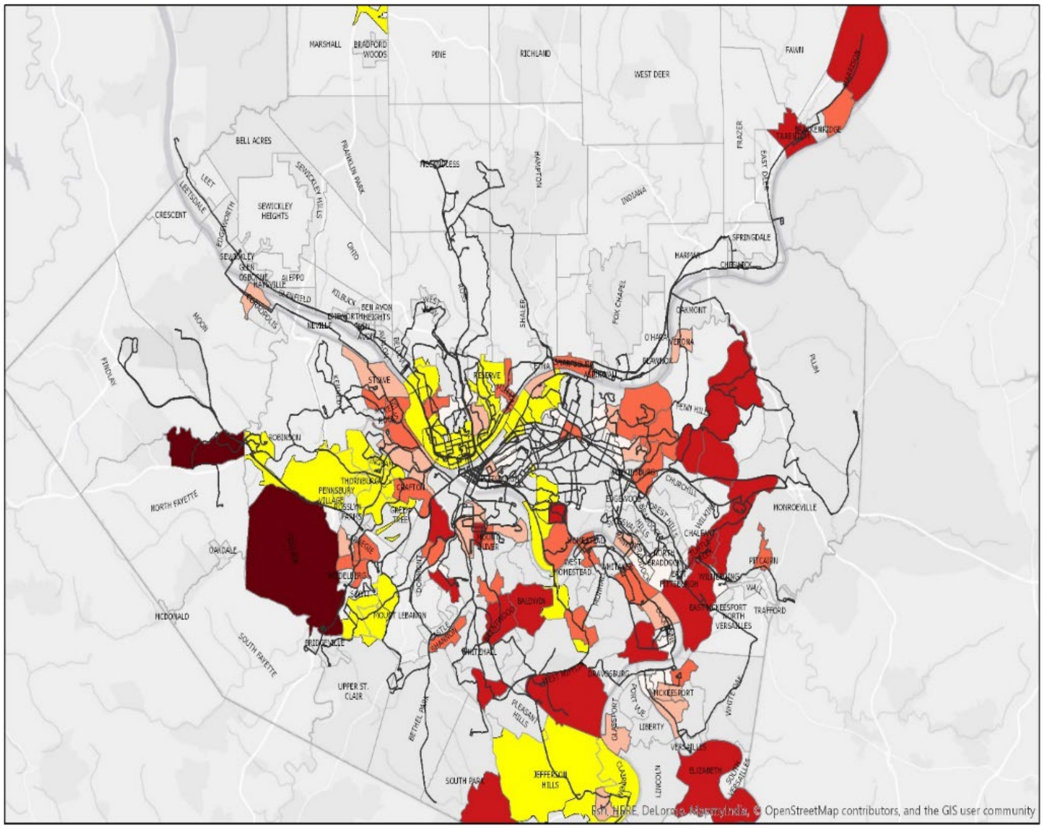

Figure 1 shows the spatial mismatch phenomenon in Allegheny County. The map uses publicly available data from the American Community Survey 5-year estimates from 2015 to create an index of neighborhood poverty based on income and education. Poorer neighborhoods are colored red, and the darker red zones 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.

5. A Field Experiment on the Impact of Reducing Transportation Costs

A major goal of this project is to test the impact of reduced transportation costs on labor force participation, income, and other socioeconomic outcomes for low-income Pittsburgh city residents who do not have regular access to a car.

5.1. Recruitment of Subjects -- Challenges and Successes

This project began in response to a request from the City of Pittsburgh's Department of Mobility and Infrastructure (DOMI) and an affiliated nonprofit, MOVE PGH, to CMU for help in evaluating an RCT. Initial plans put forward by DOMI and MOVE PGH to recruit city residents into the study relied on a community-based organization, Manchester Citizen's Corporation (MCC). MCC leaders took on the task of recruiting the full set of 100 participants, believing that their community-based nonprofit and advocacy group could easily persuade large numbers of residents in the neighborhood in which it had been based for decades to "sign up" for our study in short order. Unfortunately, these efforts were not successful. After many weeks of effort, MCC only succeeded in recruiting two prospective participants out of the 100 our pilot required. The reasons for this lack of success are still not well understood. However, this experience suggests to us that the current wave of enthusiasm for research partnerships between university-based scientists and community-based advocacy groups may be based, in part, on an overly optimistic view of the degree to which community-based advocacy groups can function effectively as intermediaries and partners in quantitative research studies with university-based quantitative social scientists. These partnerships often require the advocacy groups to interact with their client populations in ways that may be quite different from their historical patterns of interaction, and rapid success may not be assured.

The nearly complete failure of the initial recruitment plan required the CMU team to take on primary responsibility for subject recruitment. Efforts to solicit the aid of other area nonprofits and social service providers that worked with low-income, transportation-constrained populations also failed to recruit more than a trivial number of city residents. A completely different approach to subject recruitment had to be developed, approved by the CMU IRB, and implemented. These subject recruiting challenges delayed the beginning of the project by several months.

Relying on its partnership with Allegheny County DHS, and earlier experience collaborating with DHS to recruit prospective participants into RCTs through selective email and text invitations, the CMU team eventually devised a successful recruiting strategy. Once this strategy was fully implemented, the target number of participants was quickly recruited.

A DHS analyst used the email and text contact information in the extensive data records maintained by DHS to inform potentially qualifying city residents of our study. These potentially eligible participants were referred to a website, where they received more information about the study and were given the opportunity to request a screening for eligibility. Trained research staff contacted these individuals and screened them for eligibility. Eligible participants were then directed to a website directed where they (electronically) signed a consent form and were randomized into the treatment or control groups. The consent form obtained permission for collection of all the data described below.

Once participants completed the consent process, they were asked to fill out an online enrollment survey that collected additional information. Participants were also required to download onto their smartphones a team-designed GPS "tracker app" and they were required to set up the Google Maps app to track their mobility in such a way that the data could be transmitted to our research team. Every 2 months, for the following 12 months, we will send all participants another short online survey via email and text message links. At the end of the study, we will ask members of both groups to take an end-of-study survey, also delivered via email and text message.

One of the qualifying conditions is that participants own and regularly use a smartphone. Our experience confirms what survey research already indicates – smartphone usage has penetrated deeply into low-income urban communities, and the residents we have sought to recruit use this technology on a regular basis.

Our goal was to recruit 100 low-income city residents into the study—50 into the treatment group and 50 into the control group. At the time of this writing, recruitment had been completed and nearly one month of active study has occurred. Unfortunately, the delays in the start of the study mean that little data analysis has been possible, and the results will not be known for nearly one year.

5.2. The Treatment Group

"Treatment" is a roughly 12-month intervention, which can be described as follows:

Members of the treatment group, referred to as group A, will be eligible to receive access to certain kinds of free transportation each month for up to a full year during the study. These free rides will come in the following form.

Service Type:	**Group A eligibility amount:**
Spin (electric scooter)	Five 30-minute rides daily
Pittsburgh Regional Transit (city bus)	Unlimited transit pass
POGOH (battery-powered E-Assist bicycles)	Unlimited 30-minute rides
Zipcar (short-term car rental)	Membership and $60 monthly credit

The actual amount of rides members of this groups will receive will depend on their usage and whether they create and activate their accounts with the relevant transportation providers.

For members of Group A, some transportation benefits will depend on transmitting GPS data, using our study app, and filling out online surveys every other month.

5.3 The Control Group

Members of the control group, referred to as group B, will not get free transportation, but they could receive compensation of up to $180 if they follow the following procedures.

Members of group B receive a $10 payment for every survey they fill out while they are in the study. We expect to send out 7 surveys during the 12-month study period. A final survey will be sent one year after the end of our 12-month study period.

Members of group B will receive an additional $100 payment at the end of 12 months if they are still in the study at that time and have maintained transmission of GPS data during the 12-month period and if they filled out more than 50% of the surveys (that is, at least 4 of the 7 surveys during the 12-month period).

6. The Anticipated Impact of Treatment: Theoretical Considerations

The basic intuition behind our treatment is simple: an intervention that reduces commuting time is likely to have a positive impact on labor supply. We can show this idea quite simply with the following standard (static) model of labor supply. Suppose utility is a function of consumption (C) measured in dollars, and "leisure" (L), which is simply defined to be time spent *not* working or commuting to work. Now consider an individual who has L_F total hours, which she can allocate between leisure and work (plus commuting to work if she chooses to work), and has I_N dollars of non-labor income. The individual maximizes $U(C,L)$ subject to the following non-convex budget set: if she does *not* work, $C = I_N$ and $L = L_F$; if she does work, $C = w(L_F - T - L) + I_N$, where w is the hourly wage and T is time (in hours) of commuting to work. This standard model provides us with the following unambiguous prediction: A reduction in the commuting time T cannot reduce LFP for any worker, and induces positive LFP for marginal workers (who previously choose not to work).

Figure 2. The Potential Impact of Access To Ridesharing on Labor Force Participation

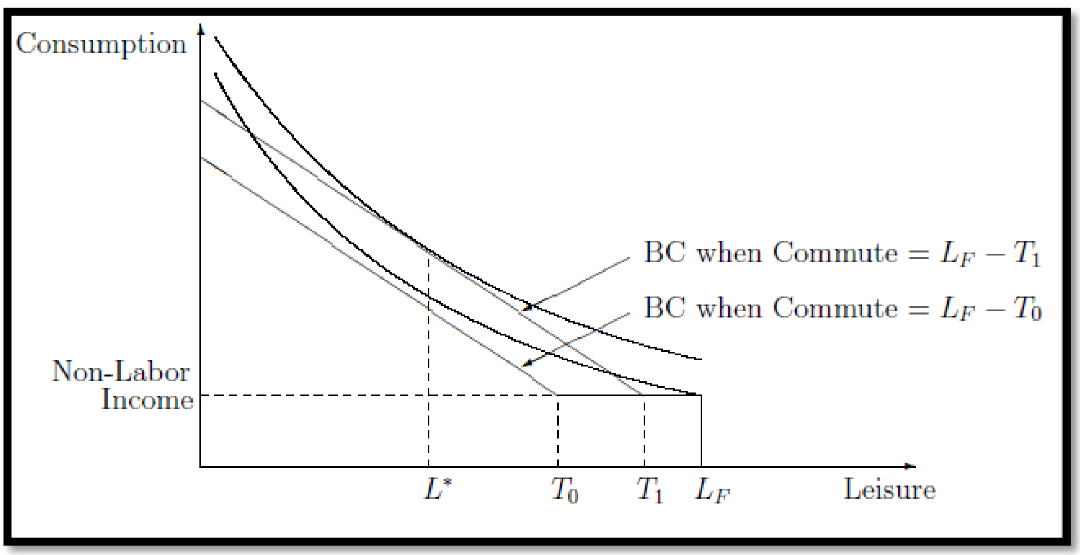

Figure 2 illustrates these ideas. If commute time is $T = L_F - T_0$ the individual will choose fulltime leisure L_F (and because she has no labor income, $C = I_N$). If commute time decreases to $T= L_F - T_1$ she chooses to work, thereby reducing her chosen leisure level to L^* (and of course has substantially higher consumption).

Black, Kolesnikova, and Taylor (2014) show that the logic of the static model extends to *dynamic* models of labor supply, and to models of *household* labor supply. In addition, they connect this logic and contemporary scholarship on these issues to the earlier literature on location and labor supply, which includes important early contributions by Oi (1976) and Cogan (1981). As we have noted, Black et al (2014) also show that as an empirical matter the LFP of married women with children is quite sensitive to commute times. They estimate that commute-time variation across cities was responsible for labor force participation differences as high as 10 percentage points for these women (from low commute-time cities to high-commute-time cities).

Our experiment thus is designed to implement a test of the basic theory of labor supply with quasi-fixed costs (commuting costs in this case) using experimental methods. To our knowledge this will be the first study of its kind that incorporates both expanded access to conventional mass transit and new modes of micro-mobility.

In addition, as we have noted, our work can be thought of as a "program evaluation" of potential new IT-enabled modes of public transportation. In the future, new technologies might allow municipalities to include (to at least some degree) the kind of flexibility that we are providing subjects in our experiment. In particular, our work will constitute a potentially important assessment of the value of such transportation for increasing the labor force participation in a particularly vulnerable population.

7. Data Analysis Methods and Approaches

One eventual focus of this study will be to examine the impact of our intervention on labor market and other outcomes, including:

- labor force participation (LFP)
- wages and earnings
- utilization of social services
- geographic mobility

We anticipate using regression-based methods. The most basic such regression would be

$$y_i = \beta_0 + T_i\beta_1 + X_i\beta_2 + \varepsilon_i,$$

Where y_i is the outcome of interest (earnings, LFP, etc.), T_i is a dummy variable indicating treatment status (so β_1 estimates the treatment effect) and X_i is a vector of individual-level characteristics (such as location, race, age, etc.). These characteristics would be drawn from the intake survey and from data collected and maintained by DHS. Given randomization, we do not need control variables to form an unbiased estimate of the treatment effect, but inclusion of the variables can help with the precision of the estimate and would also be a useful check for randomization fidelity.

Importantly, our outcomes can include not only self-reports, but also outcomes determined from the GPS tracking data, *and* outcomes constructed from data provided by the DHS, which includes data on employment and wages taken from official records of the state Department of Labor and Industry. This last feature of our research design is useful for two reasons. First, having administrative data will add to the credibility of our results (and will also allow for some methodologically interesting analysis of measurement error). Second, it will allow us to do a follow-up analysis in which we can examine longer-run impacts. For instance, we may find that our transportation treatment not only increases labor force participation during the 12 months of the study but also has a longer-term impact. In addition, we may find that at least some individuals in our treatment group continue to earn higher incomes – and therefore have less demand for social services -- years after the cessation of the treatment.

Exploratory Analyses of Treatment on Other Outcomes. Our design will allow us to do some "exploratory" analysis of the impact on other outcomes from the self-reported data, the GPS location tracking data, and more importantly from the DHS data.

For example, DHS records individual-level use of training programs and other social services. Also, the data include child-level outcomes, such as school truancy and disciplinary actions. It seems possible that improved access to transportation flexibility may improve family lives in ways that extent beyond employment.

Also, recall that all participants will have an app on their smartphones that regularly notes their GPS coordinates. These data will be recorded using an algorithm that assigns a unique identifier to every participant but protects his or her identity. In addition, for participants with access to subsidized micro-mobility mass transit services, the data generated by our cell phone "location tracker" app will be supplemented by the pickup and drop-off data collected by the transportation provider. It is quite possible that access to these transportation services may enhance the mobility of participants in ways that are not always directly connected to job search or efforts to access social services. For instance, micro-mobility services might enhance the ability of lower-income participants in poor, geographically isolated communities to access community amenities (parks, libraries, etc.). It could also expand their ability to consume a wider range (and higher quality) of commercial goods and services, and engage in more frequent social interaction through community events, religious services, musical performances, etc. The granularity of our user mobility data may allow us to detect or infer some of these changes in consumption and social interaction. As part of our initial efforts to explore these data, we will quantify differences in mobility between the control group and the treated groups along a number of dimensions. We plan to measure the number of unique neighborhoods (or zip codes) an individual visits per day/week. We can build upon prior analyses of individual mobility by measuring the spatial entropy of an individual's movements over a period of time (e.g., a measure of the distribution of an individual's movement through geographic space across distinct neighborhoods and locations). Finally, we can, in principle, compare the patterns of movement of participants with transportation services who reside in certain neighborhoods to members of the control group who live in the same neighborhoods, but lack access ridesharing services.

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 can learn how low-income citizens value different "emerging" transportation options, such as e-scooters, e-bikes, and car sharing. 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. Our study 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.

8. Scientific Contributions of the Study

Decades of research by economists and other social scientists have pointed to spatial mismatch as a barrier to employment in American cities. Less skilled workers are often concentrated in areas that are geographically distant from the districts where the jobs appropriate to their skill level are being generated in large numbers. Because much of this job creation is happening on the urban periphery, where population density is low and the distances between establishments are high, it can be difficult for less-skilled residents to travel to these jobs if they are wholly reliant on public transportation. Unfortunately, these residents have been trapped for decades between the limitations of public mass transit systems and their own inability to afford cars. Existing transportation technology has offered few alternatives to these two imperfect modes of transit.

Now, however, new transportation modes are diffusing rapidly through American cities, offering a far more flexible and convenient method of transport that does not require private car ownership. As Thebault-Spieker, Treveen, and Hecht (2017) have shown, these services are currently clustered in wealthier districts of American cities, 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. Would subsidized provision of micro-mobility services to the poor enable better access to employment, training, and social services? Could it raise labor force participation, generating social benefits that outweigh the costs? This project seeks to put those questions to a convincing empirical test by conducting a randomized experiment in the Pittsburgh region. The study will shed light on how a new transportation technology enabled by innovations in mobile computing and machine learning may be provide a new solution to one of the most serious social problems American cities have been contending with for decades.

At the same time, the experiment described in this proposal will also address a fundamental limitation in much of the literature that has informed our understanding of spatial mismatch – the severely limited amount of credible experimental evidence showing that lower transport costs lead to higher labor force participation. Leveraging the emergence of smart phone enabled micro-mobility as a new transportation option in the Pittsburgh region, our study will undertake exactly the kind of randomized control trial that has been largely missing in the literature, and it will exploit the diffusion of smartphones among even the urban poor to track the impact of lower transportation costs on employment and wages. Additional data collected by Allegheny County DHS will provide an important supplement to self-reported data and to the inferences that can be made from the extensive GPS data on participant mobility our study will collect. These data will also help us infer the impact of lower transportation costs on other social outcomes of interest, including utilization of social services. In all of these ways, our study will address important shortcomings in a long literature that has influenced policymakers and social planners for decades.

In addition, this study will provide among the first estimates of low-income urban rider preferences across a broad range of emerging transportation options. We will observe consumer choices and relate them to consumer characteristics and weather conditions, providing badly needed insight to urban planners and transportation resources concerning how much and under what conditions low-income populations will actually utilize these new options. Today, the ratio of speculation on this question to hard evidence is far too high. Our project will remedy this significant problem, generating parameters of a discrete choice model that can inform multiple streams of future research.

Finally, we believe that our 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 poor) and the relative ease with which user-friendly "apps" can be created and disseminated have worked together to provide researchers with a new, often low-cost platform 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 vast 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.

9. Broader Impacts of the Study

Three decades of research in labor economics document a dispiriting reality – less educated Americans have faced relatively weak demand for their services, stagnant wages, and an increasingly polarized job market (Autor, Katz, and Kearney, 2006). Conventionally measured unemployment is low, but this masks the reality that nearly all of the growth in employment in recent years has been concentrated in in high-skill, high-wage jobs or low-skill, low-wage jobs, with weak job growth in the crucial "middle skill" jobs that traditionally offered a pathway into the middle class (Autor and Dorn, 2013). While some of these jobs have been displaced by the rise of imports from low-wage developing countries (Autor, Dorn, and Hanson, 2013), a firm consensus within economics suggests that, over the past generation, the most important force driving this dislocation has been skill-biased technological change, with information technology playing an especially important role in this ongoing exacerbation of inequality.

These dramatic economic and political developments are national in scope, but we see them clearly in Carnegie Mellon's backyard. As residents of the city of Pittsburgh, it is clear to us that the much touted technology-driven renaissance of Pittsburgh has certainly not reached every community in the city, nor is there any reason to expect this outcome without intelligent public policy intervention. Ongoing skill-biased technological change may exacerbate the longstanding geographic inequities within Pittsburgh, and other American cities, that earlier sections of this proposal emphasized. Low-skilled workers in geographically isolated neighborhoods are unlikely to share fully – and perhaps not at all – in the revival of the region, unless intelligent and effective action is taken.

We believe this project will advance Pittsburgh's "innovating mobility for all" agenda by contributing to research on multi-modal connections, novel modes of transport, and improved transportation access to disadvantaged neighborhoods. The analyses described above may lead directly to significant policy implications and science-based policy recommendations. If our results demonstrate that the provision of the transportation supports described above have economically and statistically significant positive effects on the geographic and socioeconomic mobility of the participants relative to the control group, it could provide strong evidence in favor of a nationwide effort to improve the access of the urban poor to these transportation options. If the effects are large enough, public expenditure in support of additional transportation access could pay for itself through higher tax revenue (obtained from the higher incomes of those who benefit) and lower expenditures on social assistance programs. In addition, our estimation of consumer preferences for different options could guide policymakers in terms of selecting which transportation options are most valuable to low-income urban residents, enabling policymakers to obtain the maximum increase in geographic and socioeconomic mobility by targeting the most useful new transportation options.

References

American Public Transportation Association, (2016), “Shared Mobility and the Transformation of Public Transit,” Research Analysis Submitted by the Shared-Used Mobility Center.

Fredrik Andersson, John C. Haltiwanger, Mark J. Kutzbach, Henry O. Pollakowski, and Daniel H.Weinberg, (2018), “Job Displacement and Duration of Joblessness: The Role of Spatial Mismatch,” *Review of Economics and Statistics*, 100 (2), 203-218

David Autor and David Dorn, (2013), “The Growth of Low-Skill Service Jobs and the Polarization of the U.S. Labor Market,” *American Economic Review*, 103 (5), 1553-97.

David Autor, David Dorn, and Gordon Hanson, (2013), “The China Syndrome: Local Labor Market Effects of Import Competition in the United States,” *American Economic Review*, 130 (6), 2121-68.

David H. Autor, Lawrence F. Katz and Melissa S. Kearney, (2006), “The Polarization of the U.S. Labor Market,” *American Economic Review Papers and Proceedings*, 96(2), 189 – 194.

Sagar Baviskar, Naveen Basavaraj, Seth Chizeck, Beibei Li, Lee Branstetter, (2023), “The Impact of Ride-Hailing Access on the Geographic Mobility of a Disadvantaged Population: Evidence from an RCT Using Subject-Level Geospatial Data,” working paper.

Sagar Baviskar, Lee Branstetter, Seth Chizeck, Beibei Li, (2022), “The Short-Term Effects of Subsidized Car Access on Employment and Earnings,” working paper.

Dan A. Black, Natalia Kolesnikova, and Lowell J. Taylor, (2014), “Why Do So Few Women Work in New York (And So Many in Minneapolis)? Labor Supply of Married Women Across US Cities,” *Journal of Urban Economics*, 79 (C), 59-71.

Rebecca Brough, David Philllips, and Matthew Freedman, (2023), “Eliminating Fares to Expand Opportunities: Experimental Evidence on the Impacts of Free Public Transportation on Economic Disparities,” working paper.

Raj Chetty and Nathaniel Hendren, (2018), “The Effects of Neighborhoods on Intergenerational Mobility II: County Level Estimates,” *Quarterly Journal of Economics*, 133(3), 1163-1228.

John Cogan, (1981), “Fixed Costs and Labor Supply,” *Econometrica*, 49(4), 945-963.

Kathryn Collins, Erin Dalton, Megan Good, (2014), “Suburban Poverty: Assessing Community Need Outside the Central City,” Allegheny County Department of Human Services Report.

William H. Frey, (2016), “Melting Pot Cities and Suburbs: Racial and Ethnic Change in Metro America in the 2000s,” Metropolitan Policy Program at Brookings Institution Report.

Stuart Gabriel and Stuart Rosenthal, (1996), “Commutes, Neighborhood Effects, and Earnings: An Analysis of Racial Discrimination and Compensating Differentials,” *Journal of Urban Economics* 40, 61-83.

Laurent Gobillon, Harris Selod, and Yves Zenou, (2007), “The Mechanisms of Spatial Mismatch,” *Urban Studies*, 44 (12) 2401-2427.

Keith Ihlanfeldt and David Sjoquist, (1998) "The Spatial Mismatch Hypothesis: A Review of Recent Studies and Their Implications for Welfare Reform," *Housing Policy Debate*, 9 (4), 849-892.

John F. Kain, (1992), "The Spatial Mismatch Hypothesis: Three Decades Later," *Housing Policy Debate*, 3 (2), 371-392.

Sara Lichtenwalter, Gary Koeske, and Esther Sales, (2006), "Examining Transportation and Employment Outcomes: Evidence for Moving Beyond The Bus Pass," *Journal of Poverty*, 10 (1), 93-115.

Mayer, Thierry, and Corentin Trevien (2017), "The impact of urban public transportation evidence from the Paris region" *Journal of Urban Economics*, 102: 1-21.

McCone Commission Report, (1965), Violence in the City: An End or a Beginning? Report of the Governor's Commission on the Los Angeles Riots.

Moeller, J. and M. Zierer (2018). "Autobahns and jobs: A regional study using historical instrumental variables," *Journal of Urban Economics*,103: 18–33.

Walter Oi, "Residential Location and Labor Supply," *Journal of Political Economy*, 84 (4) S221-38.

Eleonora Patacchini and Yves Zenou, (2005), "Spatial Mismatch, Transport Mode and Search Decisions in England," *Journal of Urban Economics*, 58 (1), 62-90.

Jacob Thebault-Spieker, Loren Terveen, and Brent Hecht, (2017), "Towards a Geographic Understanding of the Sharing Economy: Systemic Biases in UberX and TaskRabbit," *ACM Transactions on Computing-Human Interaction* (ACM ToCHI) 24 (3), 21:1–40.