The Economic Impact of Wheelchairs for the Disabled in Ethiopia

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Justin Grider

Master's Candidate
Department of Economics
University of San Francisco
2130 Fulton St.
San Francisco, CA 94117

e-mail: *jgrider15@gmail.com*

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Abstract: How do wheelchairs impact income and the possible channels of employment status and time allocation for the physically disabled? In order to improve opportunities for people with disability, it is imperative to know the effect that a wheelchair has on the lives of the disabled. Estimates from 261 participants across Addis Ababa, Ethiopia were taken to estimate a wheelchair's impact across numerous time, economic and distance variables. I demonstrate how nearest neighbor covariate matching methods can be used to estimate how wheelchair beneficiaries would have fared had they not been given a wheelchair. Results show that current wheelchair users earn $6.23 more per week, have a 15 percent higher probability of employment and work 1.75 hours more per day than their non-wheelchair using counterparts.

1. Introduction

The World Health Organization reports that there are currently 1 billion people in the world living with disabilities and an estimated 65 million people in need of a wheelchair. In Ethiopia alone, there are an estimated 15 million children, adults and elderly persons with disabilities (International Labour Organization, 2013). For those people who are physically disabled, only 5-15 percent who need assistive devices in the developing world have access to them. Disability and poverty are characteristically linked in prevalence around the world. The World Health Organization defines disability as an umbrella term for impairments, activity limitations and participation restrictions (WHO, 2013). Individuals with physical disabilities have lives filled with more obstacles and hurdles to overcome. People with disabilities consistently have lower income, higher poverty rates and unemployment than people without disabilities (Mitra et al., 2013). The main question regarding wheelchair allocation is *to what extent do wheelchairs increase income for the physically disabled?*

The research in this paper evaluates the impact of wheelchair allocation for the physically disabled in Addis Ababa, Ethiopia. Wheelchair donations seek to improve economic, societal, and personal outcomes for recipients. I therefore examine wheelchair impacts on weekly income levels, and other possible channels in which income might be impacted. A wheelchair theoretically has the potential for making a person more desirable in the labor market, increasing the probability of obtaining a job and increasing the amount of time spent working. These channels along with distance traveled are all evaluated. Up to this point, there has been no rigorous econometric analysis of wheelchair impact in the developing world. With such a large percentage of the world's population disabled, it is important to find out the impact that wheelchairs have on the lives of the physically disabled.

For this study, I partnered with three small scale non-profit organizations located in Addis Ababa; Cheshire Services, Prosthetics Orthotics Centre (POC) and Addis Guzo each provide wheelchairs to the disabled community throughout Ethiopia. Each organization must either wait for a shipment of wheelchairs or slowly rebuild wheelchairs to hand out to those in need. The organizations provided a list of all past wheelchair recipients as well as those on the waitlist to receive a wheelchair in the future. This paper uses one-time cross sectional data collected from past wheelchair recipients as well as those on a waitlist, to compare wheelchair beneficiaries to a control group of those targeted for needing a wheelchair but who have not yet received one. Using matching methods, the results show wheelchair users are over 15 percent more likely to say they were employed, work 1.75 hours more per day and earn $6.22 more per week than matched non-wheelchair users. The results are robust to different specifications and point to positive impacts across numerous measured economic and societal variables.

The potential for a wheelchair to change a person's life warrants extensive research. A wheelchair has the opportunity to be a cost-effective catalyst for the physically disabled beneficiaries. The remainder of the paper will proceed as follows: Section 2 is a literature review of past research conducted on the topic of disability interventions. Section 3 introduces the data and methodology. Section 4 introduces the model used to obtain the results. Section 5 interprets the results, robustness checks and cost-benefit analysis and the last section presents the conclusions and recommendations moving forward.

2. Literature

Failure to address the needs of the disabled hinders potential development. Countries may facilitate future growth if they can implement policies aimed at fostering participation by the physically disabled. Metts (2004) concludes that Ethiopia alone is losing anywhere between $598 and $779 million from its GDP of only $6.1 billion (2004), by not effectively addressing disability in the country. By studying a wheelchair's impact on time allocation for the disabled, a clearer picture is painted to how aiding the physically disabled translates into economic and social participation. Awan (2012) looks at the potential productivity gains from socio-economic health policies targeted for the blind population in Pakistan. Awan (2012) uses the average wage rate, appropriate discount factors to show that if the entire blind population in Pakistan is rehabilitated, the total economic benefit/ productivity gain of $4.9 billion is realizable over a period of ten years. Viewing wheelchair provision through a development lens pushes the debate toward sound economic externalities, both positive and negative to better understand how to bolster development for the disabled. Prior to this study, there has been minimal past research that tries to establish a valid counterfactual. The lack of a counterfactual for analysis is potentially harming the disabled community. In the research that has been done, there is no clear consensus on a wheelchair's impact and no study has sought to make causal links between wheelchairs and economic outcomes. The following framework presents current literature on the positive and negative implications of distributing wheelchairs.

The most recent study looked at health and lifestyle changes through the framework of the World Health Organization's International Classification of Functioning, Disability and Health (ICF). Partnering with Free Wheelchair Mission, Susan Shore (2012) identified over 600 wheelchair participants throughout India, Chile and Vietnam to study. The participants of the study were given a survey when given a wheelchair and then surveyed again 12 months later. The participants were informed that the purpose of the survey was to evaluate how the wheelchair affected their health and well-being. The lifestyle questions, taken from the ICF, used an ordinal scale to evaluate the level of difficulty when performing certain activities. Recipients reported less personal illness, less hospitalization, increased mobility and diminished pain. All of the results are summary in nature and no effort was made to identify a comparison group. Nonetheless the surveys highlight the improvement in mood and quality of life during the 12-month period of wheelchair use; with the number of people who felt that life was pretty good or great increasing from 12.6 to 63.6 percent. Coefficients for variables measuring dependence decreased as did the percentage of participants that never left the home from 46.6 to 22.4 percent.

Johan Borg et al. (2012) sought to answer if there is a positive relationship between use of assistive technologies and enjoyment of basic human rights in low-income countries. The study focused on assistive technology in the form of hearing aids and wheelchair provisions for the respective disabled participants. They use cross-sectional data in Bangladesh and a logistic regression to study standard of living, health, education and work. The results provide empirical support for assistive technology related to standard of living, health, education and work, but few statistically significant differences between users and non-users of wheelchairs were found. Wheelchairs seemed to increase mobility, but there was little difference in physical and mental health as well as a negative association between wheelchair use and working status. Wheelchair users were likely to report less mobility difficulty compared to non-users, and, after adjusting for physical accessibility to the working place, were more likely to enjoy the right to work. Borg et al. (2012) mention that the results should be interpreted cautiously, because the analysis was overfitted. This study is one of the few that attempts to compare results within the disabled community.

Any program evaluation, whether it be for economic development or for improving the lives of the disabled comes with a range of costs, benefits, risks and possible spillover effects. Quantifying the benefits as well as the risks of providing a wheelchair to someone highlights failures and successes. Shore (2008) surveys 188 wheelchair recipients in India and Peru who had had a wheelchair for a 33-month period. Beneficiaries were asked for feedback on reliability, wheelchair maintenance, health, maneuverability and comfort in wheelchairs. Surveying after 33 months of wheelchair use provides a longer time frame to evaluate how a person has accustomed to a wheelchair, but the sample size was small and only summary statistics are available. The survey conducted was more open-ended in nature providing chances of interpretation by the recipient. The other descriptive statistics such as employment and education in the research had no statistical significance. Factors besides a wheelchair may determine "major life areas" like employment rates and income, but trying to tease out the exact effect from a wheelchair is the desired goal.

Some studies also focus on why a wheelchair may or may not be used even when a wheelchair has been provided. For instance, Goutam Mukherjee (2005) analyzes the fate of donated wheelchairs in West Bengal. Wheelchair recipients were divided into two groups, regular users and occasional users. The two groups were monitored physically and then asked two basic questions regarding the fate of the donated wheelchair received. If the wheelchair was rejected, a follow-up questions were asked as to why. The seemingly benevolent act of supplying a wheelchair yielded some surprising findings. Out of 162 past wheelchair recipients from various NGOs, the data showed that 71.6 percent of the wheelchairs (116 out of 162 wheelchairs) were not used or sold. The main reasons for abandonment was pain or fatigue with use and the lack of habitat adaptability of wheelchairs. Even occasional wheelchair users had problems. Six recipients unable to manually propel a wheelchair continuously for 5 minutes at a sustained speed due to excessive cardiorespiratory stress and local muscular fatigue. The results moved Mukherjee (2005) to conclude that the wheelchair failed to bring the desired use to its recipient.

There is a possibility of both positive and negative effects in transferring a wheelchair to the physically disabled. No clear consensus has been reached in the literature. Shore (2008) reports 31 percent of wheelchair recipients could use the wheelchair independently for mobility as opposed to 7.4 percent in Mukherjee (2005), and only 6.9 percent reported using the chair for less than 1 hour per day versus 57.4 percent in the other study. The literature continually points to little or no significant change in major life activities such as employment and education for wheelchair recipients. Shore (2008, 2012), Pagan (2013) and Borg (2012) all see minimal evidence for wheelchair provision influencing labor markets, productivity, employment and education. Shore (2008) concludes that these activities may be dependent on factors other than an available wheelchair. This current study provides counter-evidence that wheelchairs do substantially influence employment outcomes.

Physical disability not only hinders health outcomes but also mobility and time allocation. Tolerico (2007) uses survey data and a custom data logger to investigate the mobility characteristics of fifty-two manual wheelchair users in the residential setting over the long term, showing that the average daily distance covered was approximately 3,400 meters. These results are purely descriptive and use a small sample size with no control group. Only Pagan (2013) investigates how people with disabilities allocate their time to daily activities as compared to their non-disabled counterparts. Using micro-data with over 20,000 observations from the Spanish Time Use Survey (STUS), Pagan uses a simple OLS model to show non-disabled males devoted 87.95 more minutes to market work, while non-disabled females devoted 57.81 more minutes than their counterparts. This research also investigates time use, but daily activities are compared between disabled groups.

Disability and poverty is an endogenous relationship, but there has been little effort to empirically evaluate disability programs in the developing world. The literature looking at disability and poverty is endless. Looking at sixty-nine countries through a standardized WHS measure of disability and employment rates, Suguru Mizunoya (2012) shows a disability gap in employment rates in developing countries. Mitra, et al. (2012) conducted a multidimensional study of disability and poverty in the developing world. She finds that persons with disability, on average, experience multiple deprivations at higher rates and in higher breadth, depth and severity than persons without disabilities. Mitra, et al. (2012) goes on to conclude that persons with disabilities should be explicitly incorporated in policymaking and research strategies. Gannon (2005) in Ireland, Contreras et al., (2006) in Chile and Uruguay, and Trani et al., (2012) in Afghanistan and Zambia all look at the interdependent relationship between disability and poverty. Disability is pervasive throughout countries, but my research shows that small interventions like providing a wheelchair may lead to increased positive economic and social outcomes for recipients.

This paper brings a unique and rigorous econometric analysis to quantify income, mobility and time effects between a treatment group of wheelchair beneficiaries and a control group of people who need but have not yet received a wheelchair.

3. Data and Methodology

3.1 *The Data*

During the summer of 2013 another graduate student and I traveled to Ethiopia to conduct an impact evaluation of wheelchair donations. We partnered with three non-governmental organizations in Ethiopia that work with disabled individuals throughout Addis Ababa. Cheshire, POC and Addis Guzo are organizations that seek to provide rehabilitative services and orthopedic devices to clients throughout Ethiopia. The data collected comes from a cross sectional survey of 261 individuals identified by wheelchair recipient lists and waitlists from Cheshire, POC and Addis Guzo. Physical disabilities in the sample range from polio, infections, work accidents, war victims, muscular dystrophy and leprosy, but everyone in the sample had been seen by a physician and had been deemed physically in need of a wheelchair.

This study was not designed to look at wheelchair durability or breakdowns as done in Mexico by Toro et al. (2012) or in rural West Bengal Mukherjee et al. (2005). Rather, the study seeks to find the current impact that a wheelchair is having in the relatively developed capital city of Addis Ababa and the surrounding sub-cities. Wheelchair and non-wheelchair users were interviewed using a survey created to measure household, economic, mobility, education and time allocation factors. Wheelchairs in the developing world do not last long with the terrain and break down with use. Of the 141 non-wheelchair users in the sample, 31 self-reported the reason they did not have a wheelchair was that the old wheelchair broke, with 66 reporting to being on a waitlist to receive a wheelchair. 120 individuals in the sample are currently using a wheelchair. 58 individuals in the sample used to have a wheelchair in the past but currently do not. In the analysis I break down outcomes between these groups to better see if wheelchair or disability adaptation takes place. The final sample size of 261 is the result of locating every person on the wheelchair recipient lists provided by each organization.

3.2 *The Allocation of Wheelchairs*

This study uses a control group of non-wheelchair users, statistically similar to wheelchair users over observable covariates, except for not having a wheelchair. For the analysis to be un-biased, it must account for individuals self-selecting to receive a wheelchair. This study does not have a baseline data or multiple cross sections and cannot control for unobserved heterogeneity, but multiple approaches are used to elucidate the possible presence of endogeneity.

I surveyed social workers, physicians and employees at Cheshire, POC and Addis Guzo to evaluate how wheelchair allocation took place. The organizations provide free wheelchairs to whomever needs them and do not withhold wheelchairs based on religion, sub-city or any other factors. Addis Ababa has 11 sub-cities within the city limits. Within each sub-city, a social worker from the Bureau of Labour and Social Affairs (BOLSA) works to locate individuals with physical disabilities. Social workers try and connect the physically disabled with organizations like Cheshire, that have trained physicians that evaluate each potential beneficiary and provide free wheelchairs to those who need one. Cheshire, Addis Guzo and POC only have two criteria for determining wheelchair donation eligibility; the first is to have a physician's note deeming the individual physically in need of a wheelchair and second, the organizations needs to have wheelchairs available to be fitted to the person. Everyone with or without a wheelchair in the study has been seen by a physician and deemed physically disabled to the point of needing a wheelchair.

Based on field observations, the order in which individuals receive a wheelchair from each of the organizations appears virtually random and wheelchairs are handed out in the order of the list. The survey includes an ambition question to try and control for determined individuals influencing treatment take-up. There is also an indicator variable if an observation in the sample used to have a wheelchair in the past, but no longer has one. These variables plausibly help control for possible self-selection to provide a more precise parameter estimate.

My study is observational rather than experimental, because using a randomized control trial would be difficult given that treatment of a wheelchair is a proven medical device and would unlikely pass a human subjects review board. I am comparing those who have received a wheelchair and are currently using it to those who are either on the waitlist to receive a wheelchair or are not currently using a wheelchair because the wheelchair was broken, stolen or sold. The non-random eligibility requires close attention and scrutiny to control for prospective ex ante differences between wheelchair beneficiaries and non-wheelchair users. The difference could be correlated with differences in income, time-allocation and distance traveled status. The key assumption is that assignment to treatment is orthogonal to potential outcomes.

3.3 *Pictorial Time Survey*

The survey is fifty-five questions plus a time survey (Figure 7). A pictorial-journal approach through surveys better isolates exact time use throughout a given day. The survey methods are a mixture of both the Melina Method and the Participatory Rural Appraisal (PRA) method, used by Masuda et al. (2012) to measure time use in rural Ethiopia from the impact of water provision. The enumerators asked everyone in the sample about their previous days' activities in 30 minute segments. The time survey includes 19 pictures and descriptions of the depicted activities in a box on the top of the sheet with a letter corresponding to each picture. Time is split up into 30 minute segments for a 24 hour period. With only 1440 minutes in a day, each participant has the same amount of time to allocate to various activities performed throughout the day.

Each participant indicates the correct letter that corresponds to the picture performed at a given time (i.e. the letter A is matched with going to school). The time survey interviews took place between Tuesdays-Saturdays asking participants about the previous day to isolate activities to within the week. A direct time comparison can be made between both wheelchair and non-wheelchair users, aggregating exactly how each person spent his or her day and week. Participants that allocate more time to numerous activities may be doing so because of increased mobility. Any changes and influences in time allocation through a wheelchair may translate into economic productivity whether it be through work, shopping or other channels of development.

3.4 *Methodology*

The research attempts to develop a good as random, well-identified control group that can be compared to wheelchair users. The analysis uses a variety of covariate and propensity score matching estimators. Matching strategies either match units directly on observed covariates or use a composite score (Steiner 2010). Propensity score matching (PSM) uses the probability of a unit belonging to the treatment group based on covariates and matches an observation with a similar propensity score observation in the control group. Covariate matching creates the closest Euclidean distance over an interval between a treatment and control observation. Both rely on a conditional independence assumption as well as matching on covariates that do not change with treatment status. PSM may be unreliable because of the non-linearity of the probit and logit functions used to estimate the propensity scores as PSM is believed by Imbens (2004) and others to generate unreliable standard errors. As a result the analysis uses nearest neighbor covariate matching given the small sample size as well as extensive robustness checks. Covariate matching does not help control for selection bias, but does have standard errors that can be estimated more reliably. All individuals surveyed are similar in that they all expressed the desire of receiving a wheelchair. From discussions with Cheshire, Addis Guzo and POC, the reason that the people in the survey do not have a wheelchair is either a supply issue or because a past wheelchair has broken down. Given the methods outlined by each organization that provide wheelchairs, idiosyncratic factors related to wheelchair selection are orthogonal to impact variables and matching can be used.

Measuring the average treatment effect on the treated without bias requires a conditional independence assumption: $Y_i^T, Y_i^C \perp T_i | X_i$ with Y_i^T representing the outcomes for wheelchair recipients, Y_i^C being the outcome for non-wheelchair users, T_i indicating the treatment and X_i being a vector of observable controls not affected by the treatment of receiving a wheelchair (Khandker et al. 2010). The conditional independence assumptions means that the only factors influencing wheelchair take-up are contained in the vector X. This assumption might not hold thoroughly, but there is at least good reason to believe that they should approximately hold due to the nature of the supply constraint and the high level of matching in the pretreatment covariates. The problem is one of supply and eligibility of needing a wheelchair based on a physician's assessment and not self-selection. Based on the model, matching for the treatment and control groups use covariates on age, gender, education level, amount of time disabled, number of siblings, religion and type of disability.

Covariate nearest neighbor matching is an appropriate econometric technique to quantify the impact of a wheelchair. The outcome variables explored are: time spent working, probability of employment, weekly income received, days left the house and farthest distance traveled in the past week. The goal is to construct a proper counterfactual to wheelchair participants. Particularly I am interested in the average treatment effect on the treated (ATT):

$$(1) \quad ATT = E(Y_1 | T = 1) - E(Y_0 | T = 1)$$

Equation 1 above for the ATT is what a wheelchair would have done to the outcome variables if a person who is currently using a wheelchair had not received one. The ATE is the average effect, at the population level, of moving an entire population from untreated to treated. The ATT is the average effect of treatment on those subjects who receive treatment. But the second term in the equation above is not observable. We cannot observe the same individual receiving and not receiving treatment. What is observed is:

$$(2)\quad \text{ATE} = E(Y_1|T = 1) - E(Y_0|T = 0)$$

By both adding and subtracting the counterfactual, the difference between $Y_1|T = 1$ and $Y_0|T = 0$ is defined as the ATT plus the selection bias as shown below.

$$(3)\quad E(Y_1|T = 1) - E(Y_0|T = 1) + E(Y_0|T = 1) - E(Y_0|T = 0)$$

Selection bias moves to zero with random assignment because treatment is independent of potential outcomes. Without randomization, matching is applicable and used here with the assumption that only observed characteristics affect program participation, or receiving a wheelchair. The ignorability assumption between treatment and control group limits the selection bias present and allows for comparison in outcomes over a set of observables between the two groups. The comparison group that did not receive a wheelchair is similar to the treatment group that did receive a wheelchair over a set of observables that do not change because of treatment.

Matching is not regression but rather uses the difference in means of the matches in the sample. The matches are on the nearest Euclidean distance so that in the sample:

$\{(\mathrm{Y_i}, \mathrm{X_i}, \mathrm{T_i})\}$, let $l(m)$ be the index that satisfies $T_l \neq T_i$ and

$$\sum_{j|T_l \neq T_i} 1\{\|\boldsymbol{X_j} - \boldsymbol{X_i}\| \leq \|\boldsymbol{X_l} - \boldsymbol{X_i}\|\} = m$$

Nearest neighbor matching finds the closest Euclidean distance of a non-treated observation to a treated observation. Matching is done over the nearest 4 neighbors ($m = 4$) and done with replacement to reduce the lower expected variance of the treatment effect. The matching estimator is matching over a multi-dimensional set of variables specified above.

Because matching involves a number of assumptions, other econometric techniques are also used as checks. Rosenbaum bounds are used to help measure selection bias by calculating how large the endogeneity bias can be in order to make the results invalid. Selection bias is a serious issue in the study and cannot be overlooked. With a large amount of censoring in the outcome variables, alternative matching specification, PSM, OLS, Tobit and Heckman models are used as robustness checks. A Seemingly Unrelated Regression is also used as a check for time allocation. These additional econometric techniques do not solve the issue of self-selection bias or endogeneity, but do provide a valid check and an opportunity to see how robust the results are to different specifications.

4. Model and Hypothesis

I use both OLS and matching as a model because of the unique sample size and setting. OLS is a necessary reference when using Seemingly Unrelated Regressions such as a time allocation survey, as well as for evaluating the amount of censored data present. But matching is used because of the difference in treated and untreated groups in a nonrandomized setting. I was able to survey and capture first hand data to match people based on observable covariates. To estimate the effects of a wheelchair on the lives of the physically disabled, time allocated to working, weekly income, probability of employment, number of days left the house and farthest distance traveled the past week will act as the main dependent variables. The regression is estimated as:

$$\mathbf{Y_i = \beta_0 + \beta_1 W_i + \beta_2 P_i + \beta_3 A_i + \varepsilon_i}$$

$\mathbf{Y_i}$ are the dependent variables, either the number of hours worked per day, the farthest distance traveled the past 7 days (measured in kilometers), number of days left the house, probability of being employed, or the amount of weekly income received (measured in USD) for an individual i. $\mathbf{W_i}$ is a treatment dummy variable for currently using a wheelchair at the time of the interview. $\mathbf{P_i}$ is a dummy variable if an individual used to use a wheelchair in the past but could still be using one. $\mathbf{A_i}$ is a vector of control variables used and finally ε_i is the error term. Given the assumption that losing a wheelchair is random and orthogonal to potential outcome variables, comparing outcomes between past wheelchair users and current wheelchair users provides the ATT. Comparing weekly income between a current wheelchair user and ever having used a wheelchair in the past better controls for selection. The coefficient β_2 for past wheelchair users ($\mathbf{P_i}$) will also include current wheelchair users in it. That makes the β_1 coefficient on $\mathbf{W_i}$ for current wheelchair users the ATT, because β_2 soaks up all the selection into treatment.

With this model the following hypotheses are made:

$\mathbf{H_0 : W_i = 0}$ and is not significantly different from zero, thus receiving a wheelchair does not have any effects on the time spent working, probability of employment, income received, number of days left the house or farthest distance traveled compared to non-wheelchair users from the different regressions.

H_A: $W_i \neq 0$ and is significantly different from zero, thus receiving a wheelchair significantly effects the time spent working, probability of employment, income received, number of days left the house and farthest distance traveled for wheelchair users.

Figure 1 shows the characteristics of the treatment and control groups. Preexisting covariates: age, the number of children, the number of siblings, disability type and marital status are measured for both treatment and control groups, given by simple means tests. Figure 1 shows that the preexisting covariates are statistically similar between the treatment and control groups. A simple means test between the treatment and control groups show that ambition, the number of days a person left the house, time spent working, the probability of having a job, farthest distance traveled, weekly income and the number of years of schooling are all significantly more for wheelchair users, compared to non-wheelchair users (Figure 1). All the variables that could be affected by the wheelchair are quite different between the treatment and control groups.

5. Results and Data Analysis

Table 1 presents the summary statistics. From the sample, 121 observations are part of the treatment group as wheelchair users and 140 are part of the control group. The simple mean comparison shows the two groups to be on average 36 years old, have just over one child, four siblings, and have similar marital status. All outcome variables are significantly different between the two groups. The treatment group travels 12.56 kilometers farther, spends over two hours more working, has a 20 percent higher probability of having a job, has almost 2 more years of schooling and $6.693 more per week than the control group (Table 1).

5.1 *Matching Results for Current Wheelchair Users*

The results from matching show both the average treatment effect of a wheelchair (ATE) and the average treatment effect of a wheelchair on those who were provided a wheelchair (ATT). Nearest neighbor covariate matching estimates the ATT and ATE on the dependent variables by comparing outcomes between treated and control observations across observable covariates. The difference between the ATT and the ATE is that the estimates are either for the treated observations (ATT) or for the sample as a whole (ATE). For example when estimating the ATE of weekly income, all observations are matched to their nearest *m* neighbors of the opposite treatment group; when estimating the ATT, only the treated are matched. Below are the results from the entire sample, matching a current wheelchair user to a non-wheelchair user in the sample. Section 5.2 and

5.3 break the sample size down further to compare past wheelchair users, those who have never used a wheelchair before but are in need of one and current wheelchair users.

Looking at the average treatment effect for the treated using covariate matching to the nearest neighbor 1 to 4 matching approach, Table 2 (measured in number of 60 minute periods) shows that current wheelchair users spend over 1.75 more hours working per day, significant at the 1 percent level, compared to non-wheelchair users. The same covariate matching method shows that wheelchair beneficiaries earn $6.22 more per week and are 15.08 percent more likely to have a job compared to the control group, significant at the 1 percent and 5 percent level respectively (Table 3). Wheelchair beneficiaries travel 11.18 kilometers farther in a week than the control group, but it is not statistically significant (Table 4). The possibility of other transportation options may play a role in taking significance from the wheelchair in terms of distance traveled. Taxis, buses and private vehicles can all be taken by both wheelchair and non-wheelchair users.

The results reject the null hypothesis for time allocated to work, probability of employment and weekly income, showing at the very least the importance of further research on disability intervention impacts. It appears that wheelchairs are making a nontrivial impact on beneficiaries. There is possible endogeneity in the results; probability of employment, time spent working, farthest distance traveled and income all influence each other. But receiving a wheelchair does increase the correlation of each one of the outcome variables. Future analysis through a randomized rollout could better tease out the channel of impact that a wheelchair is having on each of the outcome variables separately.

Table 2: Covariate Matching Current Wheelchair Users to Non-Wheelchair Users

	(1)	(2)
VARIABLES	timeworking	timebegging
ATT	1.745***	-1.392***
	(0.586)	(0.399)
ATE	1.862***	-1.282***
	(0.557)	(0.389)
Observations	260	260

*Matching covariates: age, gender, education, time disabled, siblings, religion, disability type
*Standard errors in parentheses
*Coefficients are given as hours per day
*** p<0.01, ** p<0.05, * p<0.1

Table 3: Covariate Matching Current Wheelchair Users to Non-Wheelchair Users

	(1)	(2)
VARIABLES	weeklyincome	employed
ATT	6.225***	0.151**
	(2.004)	(0.067)
ATE	5.739***	0.175***
	(1.779)	(0.063)
Observations	260	260

*Matching covariates: age, gender, education, time disabled, siblings, religion, disability type
*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Weekly Income is shown as $USD, Job is the probability of having a job

Table 4: Covariate Matching Current Wheelchair Users to Non-Wheelchair Users

	(1)	(2)
VARIABLES	fardistance	dayslefthouse
ATT	11.176	0.463
	(6.883)	(0.369)
ATE	14.474*	0.589*
	(7.606)	(0.345)
Observations	260	260

*Matching covariates: age, gender, education, time disabled, siblings, religion, disability type
*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Farthest Distance traveled in the past week, in kilometers

PSM results presented in Table 5 in the Appendix are similar in magnitude and significance with the results from covariate matching. PSM shows the difference in means between treatment and control groups to be quite large for the outcome variables measured. Wheelchair beneficiaries earn $7.44 more a week, are more than 20 percent more likely to be employed and work over 2.20 hours more each day compared to the control group, each significant at the 1 percent level. PSM results also show that the farthest distance traveled by wheelchair beneficiaries is 12.37 kilometers farther in a week than non-wheelchair users, significant at the 5 percent level now (Table 5). The difference between means for beneficiaries and non-beneficiaries is large and points to a necessity of strong assumptions in the selection process for treatment.

Wheelchair beneficiaries with higher weekly income is linked to the amount of time spent working each day. The empirical results add evidence to an old theory. The first formalized theory of time allocation came from Gary Becker (1965) who created a basic theoretical analysis of choice that includes the cost of time on the same ground as the cost of market goods. Becker (1965) stresses households as producers as well as consumers and the importance of forgone earnings and its determinants: the amount of time used per dollar of goods and the cost per unit of time. From my analysis, wheelchairs may empirically make leisure time more expensive. A shock of a wheelchair has the potential of increasing productivity and promoting a substitution effect of wheelchair beneficiaries into allocating more time to market work and increasing realized income.

Gonau (1986) expands on Becker's model and concludes that wage changes and the subsequent income-leisure tradeoff depends on the person's employment status. An increase in the wage rate should not affect the allocation of time of the unemployed. However, looking at the results from Table 3, the probability of having a job is over 15 percent points higher for current wheelchair users, significant at the 5 percent level using covariate matching. The results point to the mechanisms that can increase societal participation for wheelchair beneficiaries. Wheelchair users have a higher probability of having a job, spend more time working and through these channels receive more income than the control group of non-wheelchair users.

5.2 *Comparing Past Wheelchair Users and Current Wheelchair Users*

It is possible to break the sample down and test for differences in disability groups. Table 7, 8 and 9 are alternative covariate matching results for past wheelchair users that currently are not using a wheelchair (because it is broken, stolen, etc.). The results look at outcomes of current wheelchair users compared to those in the sample who received a wheelchair in the past. With this specification it is possible to test if ambition drives results as well as testing if having a wheelchair in the past is enough to have an impact on current levels of income, distance traveled, employment status and time working. It is possible that simply receiving a wheelchair at some point in the past is enough to influence current outcomes.

Table 7, 8 and 9 show the matching results comparing current wheelchair users to past wheelchair users. The results show that current wheelchair users make $4.31 more each week and have a 15 percent greater probability of employment compared to past wheelchair users, significant at the 10 percent level. Current wheelchair users also work over 1.76 hours more per day than past wheelchair users, significant at the 5 percent level. The coefficient on time spent working and probability of employment is approximately the same size as in Table 2 and Table 3 when the entire sample is used. The coefficient on weekly income in Table 7 is not as large as in Table 3, but is still significant. Current wheelchair users significantly work more each day, have a higher probability of employment and have a higher weekly income than past wheelchair users. The data shows that there is little adaptation in terms of employment for past wheelchair users. It appears that ever having a wheelchair in the past is not enough to affect current employment status.

Table 7: Covariate Matching Current Wheelchair Users to Past Wheelchair Users

	(1)	(2)
VARIABLES	weeklyincome	employed
ATT	4.305*	0.151*
	(2.559)	(0.088)
ATE	3.726	0.146*
	(2.351)	(0.084)
Observations	179	179

*Matching current wheelchair users to those who used to use a wheelchair in the past
*Matching covariates: age, gender, education, ambition, siblings, religion, disability, time disabled
*Time disabled added to matching covariates
*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Weekly Income is shown as $USD, Job is the probability of having a job

Table 8: Covariate Matching Current Wheelchair Users to Past Wheelchair Users

	(1)	(2)
VARIABLES	timeworking	timebegging
ATT	1.767**	-1.502***
	(0.748)	(0.488)
ATE	1.763**	-1.261***
	(0.722)	(0.467)
Observations	179	179

*Matching covariates: age, gender, education, siblings, religion, disability, time disabled
*Matching current wheelchair users to those who used to use a wheelchair in the past
*Standard errors in parentheses
*Coefficients are given as hours per day
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Covariate Matching Current Wheelchair Users to Past Wheelchair Users

	(1)	(2)
VARIABLES	fardistance	dayslefthouse
ATT	11.932	0.097
	(8.571)	(0.445)
ATE	14.275	0.265
	(9.497)	(0.429)
Observations	179	179

*Matching covariates: age, gender, education, siblings, religion, disability, time disabled
*Matching current wheelchair users to those who used to use a wheelchair in the past
*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Farthest Distance traveled in the past week, given in kilometers

5.4 *Comparing Past Wheelchair Users and Non-Wheelchair Users*

Finally, I compare outcomes for past wheelchair users and those who have never used in the wheelchair in the past but are in need of a wheelchair and will receive one in the future. All current wheelchair users are dropped from the sample. Table 10, 11 and 12 show that past wheelchair users on average have a higher weekly of $3.25 than those who have never used a wheelchair before, significant at the 10 percent level. There is no statistical difference for time spent working, probability of employment and distance traveled. The results for job, time working and distance traveled are not surprising; a person needs to be currently using a wheelchair to affect current levels of time, employment status and mobility. The major difference is in weekly income, indicating that past wheelchair users are plausibly pushed to increased income levels. A past wheelchair user may not have a higher probability of employment, but is able to get more income from what job they do have.

Table 10: Covariate Matching Past Wheelchair Users to Never-Wheelchair Users

	(1)	(2)
VARIABLES	weeklyincome	employed
ATT	3.248*	-0.004
	(1.936)	(0.102)
ATE	4.585***	0.061
	(1.669)	(0.088)
Observations	139	139

*Matching past wheelchair users not currently using wheelchair to non-wheelchair users
*Matching covariates: age, gender, education, siblings, religion, disability, time disabled
*Time disabled added to matching covariates
*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Weekly Income is shown as $USD, Job is the probability of having a job

Table 11: Covariate Matching Past Wheelchair Users to Never-Wheelchair Users

	(1)	(2)
VARIABLES	timeworking	timebegging
ATT	-.963	-.097
	(0.807)	(0.644)
ATE	0.234	-0.272
	(0.715)	(0.598)
Observations	139	139

*Matching covariates: age, gender, education, siblings, religion, disability, time disabled
*Matching past wheelchair users not currently using wheelchair to non-wheelchair users
*Standard errors in parentheses
*Coefficients are given as hours per day
*** p<0.01, ** p<0.05, * p<0.1

Table 12: Covariate Matching Past Wheelchair Users to Never-Wheelchair Users

	(1)	(2)
VARIABLES	fardistance	dayslefthouse
ATT	-2.892	0.479
	(3.589)	(0.622)
ATE	-1.477	(0.637)
	(2.593)	(0.513)
Observations	139	139

*Matching covariates: age, gender, education, siblings, religion, disability, time disabled
*Matching past wheelchair users not currently using wheelchair to non-wheelchair users
*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Farthest Distance traveled in the past week, given in kilometers

Everyone in the sample has been evaluated by a doctor and deemed to physically require a wheelchair. Breaking down the sample to three distinct groups shows that there is correlation between wheelchair use and outcome variables. With the added assumptions that wheelchair loss is random and orthogonal to outcomes as well as past income from a wheelchair orthogonal to current income I can disaggregate the wheelchair impact of income between groups. I hypothesize that current wheelchair users have higher income than past wheelchair users, who subsequently have higher incomes than persons in need of a wheelchair but who have never used one in the past.

$$\mathbf{Y_{currentwc} > Y_{pastwc} > Y_{neverwc}}$$

The data statistically supports the theory for income of current, past and never-wheelchair users. Simply ever having owned a wheelchair in the past is correlated with higher current income, but currently owning a wheelchair is correlated with highest income. The results show marginal support of income adaptation to owning a wheelchair, but no statistical difference between past wheelchair users and never-wheelchair users for probability of employment, time spent working and distance traveled. A person who has been disabled for an extended period of time, or used to have a wheelchair but currently is not using one, may have adapted to produce higher income levels. By comparing these three groups, it is clear that past wheelchair users are making more income than those who have never owned a wheelchair before but are not making as much as current wheelchair users.

5.5 *Robustness Checks*

To measure the effect of self-selection and unobservable bias, Rosenbaum Bounds are estimated for the propensity score matching outcome variables as well as alternative matching specifications, Tobit, Seemingly Unrelated Regressions and OLS regressions used with a host of available control variables to test robustness.

The Rosenbaum Bounds are estimated after PSM of time spent working, weekly income and farthest distance traveled in the past seven days. After weekly income, the bounds suggest that even with endogeneity that make beneficiaries 1.5 times more likely to apply to receive a wheelchair, the PSM results are still valid (Table 13). Assuming a factor imbedded in the error term that (nearly) perfectly predicts the impact variable is present among the treated, the treated would have to be 1.5 times more likely to be selected to receive a wheelchair to render the impact insignificant. The Rosenbaum Bounds of time spent working and farthest distance traveled the past week are more concerning. For time spent working and farthest distance the Rosenbaum Bounds suggest that even with unobserved factors that make beneficiaries 1.2 and 1.1 times more likely to apply to receive a wheelchair, the PSM results are still valid (Table 14 and Table 15). PSM results only still valid up to a gamma of 1.2 or 1.1. The gamma is the log odds of differential assignment due to unobserved factors. It is not a test for endogeneity but is a test to see how bad the endogeneity problem can be before significance is lost. Therefore the PSM average treatment effect for the treated of an additional $6.92 more earned per week is valid until unobservable factors cause beneficiaries to have 1.5 times higher odds of applying for a wheelchair. The gamma of 1.2 for time spent working each day and farthest distance is troubling, showing that significance will go away with just 20 percent more likely to get into treatment. Ideally one would want a gamma of above 3, but given the small sample size, these results are not surprising. The results of the Rosenbaum Bounds test are not completely surprising, given a small sample size, adding endogeneity through a changing gamma makes a quicker loss of significance more likely.

Time spent working on a given day is an endogenous relationship with a lot of factors influencing how many hours a day a given person works. The farthest distance outcome may have a lot of selection issues and other factors such as proximity to a bus driving results more than the wheelchair. The results still point to a clear correlation between receiving a wheelchair and the positive influence on probability of having a job, daily time spent working, farthest distance traveled and weekly income received.

Matching shows significant results, but requires strong assumptions as well as using means instead of individual observed values to compare the treatment and control groups. For further robustness checks, various generalizations of a linear regression model were used that could control for a number of more variables and check results. Table 16 shows the results of the Seemingly Unrelated Regression (SUR). A Seemingly Unrelated Regression model uses multiple valid linear regression equations for time allocation, but allows the errors to be correlated across the equations. Regressing time allocation to working, socializing, begging and other activities are all related, and

SUR allows flexibility to the error terms between these regressions to be correlated. By grouping activities into five categories and controlling for a number of variables including a dummy variable for if a person used to have a wheelchair in the past but currently does not, shows that current wheelchair users spend 1.9 more hours per day working than non-wheelchair users, significant at the 1 percent level. Estimating the differences in impact variables between those who have a wheelchair now and those who used to have a wheelchair but do not have one now controls for some self-selection that matching estimates perhaps do not.

The Tobit, SUR and OLS regressions also include the added control variables of a dummy indicating whether or not anyone in the sample used to have a wheelchair in the past but currently are not using one and an ambition indicator variable. The OLS and Tobit estimations for weekly income are similar to the matching results. OLS estimation shows current wheelchair users making \$7.87 more per week, while the Tobit estimation has the treatment group making \$9.45 more per week, significant at the 1 percent level (Table 17). The Tobit estimation is used because of the large amount of censoring in the data. In the sample, there are a number of people who do not have any income, do not work at all or have not traveled in the past week. This implies censoring at a lower bound of zero. The Tobit takes into account an unobservable latent variable that is potentially negative. Theoretically people might trade negative hours working for more time do something else. The dummy variable for having a wheelchair in the past but not currently is has a coefficient of \$1.86 and \$2.69 for the OLS and Tobit estimations respectively, but not significant. The alternative specifications in the Appendix show that even under different econometric models, current wheelchair users allocate more time to working and have a potential to earn more weekly income than non-wheelchair users.

5.6 *Cost-Benefit Analysis*

Using the matching results a current wheelchair user is making over \$6 per week more than a similarly matched non-wheelchair user. \$6 multiplied by 50 working weeks per year results in an added \$300 per year for wheelchair users. Even if a wheelchair has an upward bound cost of \$500 and lasts only two years before it needs to be replaced it is still a cost-effective intervention. With a discount rate of 10 percent, and repair costs of \$20 in between years, a wheelchair produces a net present value of \$150.53 and an internal rate of return at 26 percent for the five years after a wheelchair is distributed[1]. With the positive results given and increased external validity through further research, policies and infrastructure should be in place that directly provide and empower the

[1] See Figure 8 in the Appendix for IRR and NPV calculations

disabled community. Given the cost-benefit analysis a wheelchair is a cost-effective policy intervention that governments and non-governmental organizations should be explicitly aware of.

6. Discussion

What are the impacts of a wheelchair in Addis Ababa, Ethiopia? The study conducted in Ethiopia has many assumptions and limitations, but the findings are encouraging and point to a need for further research in an area that has yet to be studied rigorously in the literature. I explored the question by analyzing data collected from physically disabled individuals both using a wheelchair and in need of a wheelchair across Addis Ababa and its surrounding developed area. By using nearest neighbor covariate matching methods, I find that wheelchair beneficiaries on average work over 1.75 hours per day and make roughly $6.22 more per week than a control group of similarly matched non-wheelchair users in need of a wheelchair (Table 2 and 3). The results are robust to different models and cannot be ignored. Even breaking the sample into distinct groups of current wheelchair users, past wheelchair users and never-owned wheelchair users, the results show that current wheelchair users have higher weekly income, increased probability of employment and work more per day. No matter the specification, the results point to a potential for large and significant development gains from a wheelchair.

Wheelchair allocation is a technological shock to beneficiaries. Jara-Diaz (2003) theorizes that a given amount of technology will change the combination of activities that can be performed, increasing the *Activity Possibility Frontier*. Wheelchairs push the technological feasibility constraint outward and enable a disabled person to more freedom. The encouraging results found from one of the first true impact evaluations of wheelchair allocation should be expanded upon. The results warrant more funding and research to provide validity to the results on a larger scale. Metts (2004) and Awan (2012) point out the potential economic gains that countries like Ethiopia can experience if disability is properly addressed. This study provides base evidence showing the gains of a wheelchair across probability of employment, time allocated to working activities, weekly income and distance traveled. Ali et al. (2010) find that people with disabilities are as likely as those without disabilities to express the desire for a job, but are less likely to be actively looking for a job. A wheelchair may be a catalyst for the physically disabled. The results of this provides both supportive and contrary evidence to current literature.

Further research through randomization across multiple time lines would better tease out how each outcome variable is affected by a wheelchair. Employment, time spent working and income can each be impacted differently by productivity, business training, social networks and other channels that are not controlled for in this study. Research that takes each one of the outcome variables systematically will paint a clearer picture of the mechanisms that a wheelchair works through. In this study wheelchair use is correlated with increased economic and societal outcomes. The results show an ATT that is significant across time allocated to working and weekly income. Repeating this study in other cities and countries will provide further evidence to the true benefits of owning a wheelchair.

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Appendix

Table 1: Summary Statistics

Variable	Current WC User	Not Current WC User	Difference	P-Value
Age	35.9	37.28	-1.38	0.419
Children	1.31	1.18	0.13	0.553
Siblings	4.11	3.95	0.16	0.6738
Parents Years of Schooling	1.32	0.94	0.38	0.3262
Single	0.413	0.5	-0.087	0.162
Married	0.47	0.4	0.07	0.249
War Victim Disability	0.124	0.1	0.024	0.541
Work Accident Disability	0.132	0.136	-0.004	0.935
Polio Disability	0.347	0.286	0.061	0.288
Infection Disability	0.124	0.086	0.038	0.313
Orthodox Religion	0.785	0.8	-0.015	0.768
Protestant Religion	0.116	0.057	0.059	.0901*
Muslim Religion	0.066	0.121	-0.055	0.131
Ambition	0.835	0.7	0.135	.0107**
Farthest Distance Traveled in Past Week	18.84	6.28	12.56	.0335**
Days Left House in a Week	5.08	4.39	0.69	.0424**
Time Spent Working	4.63	2.49	2.14	.000***
Time Spent Begging	0.74	2.14	-1.4	.0004***
Weekly Income	14.76	8.07	6.693	.0001***
Probability of Having a Job	0.645	0.443	0.202	.0010***
Years of Schooling	6.01	4.21	1.8	.0011***

Table 5: PSM on Outcome Variables

VARIABLES	(1) weeklyincome	(2) timeworking	(3) fardistance	(4) employed
ATT	7.439***	2.202***	12.372**	.207***
	(2.084)	(0.720)	(6.430)	(0.089)
Observations	260	260	260	260

*Matching covariates: age, gender, education, time disabled, siblings, religion, disability type
*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Weekly Income shown as $USD, Job is the probability of having a job
*Time spent working given in hours per day, Distance traveled in the past week, given in kilometers

Table 6: Estimation of Propensity Score

VARIABLES	(1) pscore currentwc
age	-0.02214*
	(0.01267)
gender	0.72342**
	(0.35887)
siblings	0.00083
	(0.04498)
education	0.08442***
	(0.03106)
orthodox	0.56465
	(1.30113)
protestant	1.12870
	(1.35781)
muslim	-0.08715
	(1.36915)
otherreligion	1.38563
	(1.80413)
polio	0.93549
	(1.16492)
otherdisability	0.76313
	(1.17697)
warworkinfection	1.30937
	(1.16072)
naturaldisability	0.84095
	(1.20120)
timedisabled	0.03406**
	(0.01454)
Constant	-2.64315
	(1.76620)
Observations	260

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 13: Rosenbaum Bounds for Weekly Income

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1	0.003529	0.003529	3.81579	3.81579	1.02947	7.26737
1.1	0.012459	0.000812	3.15789	4.60526	0.394737	8.10526
1.2	0.033252	0.000175	2.57895	5.26316	-0.174474	8.75868
1.3	0.07172	0.000036	1.98342	5.98789	-0.751052	9.44737
1.4	0.131173	7.00E-06	1.52631	6.47789	-1.15789	10.1413
1.5	0.210803	1.30E-06	1.05263	7.19211	-1.64368	10.7603
1.6	0.305807	2.50E-07	0.736842	7.68421	-2.02632	11.3684
1.7	0.408916	4.40E-08	0.303685	8.19842	-2.44737	12.1458
1.8	0.512382	7.90E-09	-1.10E-06	8.55263	-2.84658	12.6097
1.9	0.60961	1.40E-09	-0.394737	9.10947	-3.215	13.1579
2	0.696046	2.40E-10	-0.722631	9.41447	-3.55263	13.8158
2.1	0.769341	4.00E-11	-0.961579	9.86184	-3.84868	14.3947
2.2	0.829018	6.80E-12	-1.27526	10.2632	-4.03947	14.7368
2.3	0.875933	1.10E-12	-1.52632	10.6132	-4.28947	15.3613
2.4	0.911703	1.90E-13	-1.84211	11.0526	-4.60526	15.6579
2.5	0.938255	3.10E-14	-2.00658	11.3158	-4.86842	16.2105

gamma - log odds of differential assignment due to unobserved factors
sig+ - upper bound significance level
sig- - lower bound significance level
t-hat+ - upper bound Hodges-Lehmann point estimate
t-hat- - lower bound Hodges-Lehmann point estimate
CI+ - upper bound confidence interval (a= .95)
CI- - lower bound confidence interval (a= .95)

Table 14: Rosenbaum Bounds for Time Working

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1	0.000352	0.000352	2.25	2.25	0.5	3.5
1.1	0.001496	0.000068	1.75	2.75	0.25	3.75
1.2	0.004778	0.000013	1.25	3	-4.70E-07	4
1.3	0.012257	2.30E-06	1.25	3.25	-4.70E-07	4
1.4	0.026491	4.00E-07	0.75	3.25	-4.70E-07	4.25
1.5	0.049961	6.80E-08	0.5	3.5	-4.70E-07	4.25
1.6	0.084429	1.10E-08	0.250001	3.5	-4.70E-07	4.5
1.7	0.130469	1.90E-09	4.70E-07	3.75	-0.25	4.5
1.8	0.18732	3.10E-10	-4.70E-07	4	-0.5	4.5
1.9	0.253055	5.10E-11	-4.70E-07	4	-0.749999	4.75
2	0.324956	8.30E-12	-4.70E-07	4	-0.75	4.75
2.1	0.399964	1.30E-12	-4.70E-07	4.25	-1	5
2.2	0.475096	2.10E-13	-4.70E-07	4.25	-1	5
2.3	0.547753	3.40E-14	-4.70E-07	4.25	-1.25	5.25
2.4	0.615898	5.30E-15	-4.70E-07	4.25	-1.25	5.25
2.5	0.678123	8.90E-16	-4.70E-07	4.5	-1.5	5.5

gamma - log odds of differential assignment due to unobserved factors
sig+ - upper bound significance level
sig- - lower bound significance level
t-hat+ - upper bound Hodges-Lehmann point estimate
t-hat- - lower bound Hodges-Lehmann point estimate
CI+ - upper bound confidence interval (a= .95)
CI- - lower bound confidence interval (a= .95)

Table 15: Rosenbaum Bounds for Farthest Distance

Gamma	sig+	sig-	t-hat+	t-hat-	CI+	CI-
1	0.384013	0.384013	0.25	0.25	-1.25	2
1.1	0.563382	0.226586	-0.05	0.65	-1.6	2.4
1.2	0.717278	0.121576	-0.5	1	-2	2.75
1.3	0.830889	0.060249	-0.75	1.4	-2.25	3
1.4	0.905503	0.027948	-1	1.5	-2.5	3.5
1.5	0.950168	0.01227	-1.25	2	-2.85	3.75
1.6	0.974983	0.005145	-1.5	2	-3	4
1.7	0.987956	0.002075	-1.6	2.5	-3.25	4.5
1.8	0.994406	0.00081	-2	2.5	-3.5	4.825
1.9	0.99748	0.000307	-2	2.95	-3.6	5.25
2	0.998895	0.000114	-2.25	3	-4	5.5
2.1	0.999526	0.000041	-2.5	3.25	-4.05	6
2.2	0.999801	0.000015	-2.5	3.5	-4.5	6.5
2.3	0.999918	5.20E-06	-2.6	3.65	-4.5	6.9
2.4	0.999967	1.80E-06	-3	3.95	-4.85	7
2.5	0.999987	6.10E-07	-3	4	-5	7.5

gamma - log odds of differential assignment due to unobserved factors
sig+ - upper bound significance level
sig- - lower bound significance level
t-hat+ - upper bound Hodges-Lehmann point estimate
t-hat- - lower bound Hodges-Lehmann point estimate
CI+ - upper bound confidence interval (a= .95)
CI- - lower bound confidence interval (a= .95)

Table 16: Seemingly Unrelated Regression Results for Time Allocation

VARIABLES	(1) SUR timeworking	(2) SUR timebegging	(3) SUR timesocial	(4) SUR timeouthouse
currentwc	1.93554***	-1.19695***	-0.71220*	0.17886
	(0.60932)	(0.42895)	(0.40777)	(0.33128)
pastwcnocurrentwc	-0.21518	-0.05499	-0.74379	0.06724
	(0.70368)	(0.49538)	(0.47092)	(0.38258)
age	0.24582**	-0.06278	-0.12763	-0.07372
	(0.11598)	(0.08165)	(0.07762)	(0.06306)
agesq	-0.00368***	0.00107	0.00125	0.00074
	(0.00126)	(0.00089)	(0.00084)	(0.00069)
education	0.01512	-0.19196***	0.09773**	0.02499
	(0.05735)	(0.04037)	(0.03838)	(0.03118)
timedisabled	0.02073	0.00536	-0.01400	0.02723*
	(0.02801)	(0.01972)	(0.01875)	(0.01523)
single	2.79761*	0.83950	0.07441	1.03326
	(1.57922)	(1.11174)	(1.05685)	(0.85860)
married	3.46677**	0.22801	0.58563	1.04474
	(1.50867)	(1.06207)	(1.00963)	(0.82024)
divorced	1.70524	2.91536**	0.36315	0.61320
	(1.73173)	(1.21910)	(1.15891)	(0.94152)
Disability	X	X	X	X
Religion	X	X	X	X
Observations	260	260	260	260
R-squared	0.20090	0.30069	0.12153	0.11468

*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Time allocation given in number of 60 minute intervals per day

Table 17: Weekly Income Results

VARIABLES	(1) OLS weeklyincome	(2) Tobit weeklyincome	(3) Heckman weeklyincome	(4) select
currentwc	7.870***	9.447***	7.790	
	(2.047)	(2.282)	(6.406)	
pastwcnocurrentwc	1.862	2.957	1.311	
	(2.397)	(2.666)	(7.552)	
age	0.729*	0.849*	0.781	
	(0.401)	(0.444)	(1.255)	
agesq	-0.009**	-0.010**	-0.009	
	(0.004)	(0.005)	(0.014)	
children	-1.235*	-1.494*		0.098*
	(0.696)	(0.781)		(0.058)
parenteduc	0.624**	0.643*	1.020	
	(0.301)	(0.335)	(0.990)	
education	0.072	0.058	0.060	
	(0.206)	(0.228)	(0.646)	
timedisabled	0.337***	0.411***	0.307	
	(0.096)	(0.107)	(0.302)	
single	5.298	8.641	0.548	
	(3.518)	(6.337)	(20.085)	
married	-1.381	1.065	-5.220	
	(3.883)	(6.382)	(20.358)	
Constant	-30.846**	-34.295**	-34.505	0.833***
	(15.180)	(15.590)	(54.385)	(0.110)
Live With	X	X	X	X
Disability	X	X	X	X
Religion	X	X	X	X
Observations	260	260	260	260
R-squared	0.300			

*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Weekly income shown as $USD

Table 18: Farthest Distance Traveled in the Past Seven Days

VARIABLES	(1) OLS fardistance	(2) Tobit fardistance	(3) Heckman fardistance	(4) select
currentwc	12.954*	11.045	15.663	
	(7.582)	(7.850)	(39.625)	
pastwcnocurrentwc	-3.627	-9.329	-1.336	
	(8.899)	(9.264)	(47.192)	
age	1.213	1.372	1.609	
	(1.457)	(1.529)	(7.886)	
agesq	-0.016	-0.019	-0.020	
	(0.016)	(0.017)	(0.087)	
children	2.408	2.592		0.040
	(2.566)	(2.650)		(0.064)
parenteduc	-0.757	-0.668	-0.864	
	(1.119)	(1.155)	(5.826)	
education	0.426	0.265	0.356	
	(0.769)	(0.800)	(4.104)	
timedisabled	-0.189	-0.071	-0.314	
	(0.360)	(0.376)	(1.960)	
Constant	-29.725	-11.767	59.263	1.115***
	(53.287)	(46.743)	(390.125)	(0.123)
Live With	X	X	X	X
Disability	X	X	X	X
Religion	X	X	X	X
Observations	260	260	261	261
R-squared	0.092			

*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Farthest distance traveled in the past week, given in kilometers

Table 19: Weekly Income with Added Controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS
VARIABLES	weeklyincome	weeklyincome	weeklyincome	weeklyincome	weeklyincome	weeklyincome	weeklyincome
currentwc	6.69398***	8.51860***	8.12030***	7.75452***	7.39341***	7.08373***	7.57874***
	(1.70465)	(1.95483)	(1.94979)	(2.07054)	(2.11451)	(2.03056)	(2.14187)
pastwcnowno		4.40426*	3.65082	3.35680	3.46100	1.91499	3.25284
		(2.34479)	(2.35332)	(2.40608)	(2.44693)	(2.38592)	(2.48037)
age			0.92442***	0.83843**	0.60062	0.52391	0.64181
			(0.33369)	(0.37819)	(0.39604)	(0.39031)	(0.40047)
agesq			-0.01065***	-0.01019**	-0.00825*	-0.00718*	-0.00859*
			(0.00382)	(0.00424)	(0.00433)	(0.00425)	(0.00437)
children				0.32230	-0.03202	-1.55984**	-0.06385
				(0.58746)	(0.60745)	(0.68529)	(0.64607)
education				-0.02046	-0.06960	0.11466	-0.05535
				(0.19760)	(0.19809)	(0.20217)	(0.20599)
timedisabled				0.08109	0.24312**	0.31952***	0.24280**
				(0.08048)	(0.09835)	(0.09656)	(0.09955)
					(7.19435)	(6.94805)	(7.28620)
Constant	8.06837***	6.24375***	-10.98810	-10.34251	-10.73948	-17.09326	-14.88721
	(1.16066)	(1.50923)	(6.67654)	(7.15865)	(10.47027)	(11.89987)	(13.35218)
Disability					X	X	X
Live With						X	X
Religion							X
Observations	261	261	261	260	260	260	260
R-squared	0.05619	0.06893	0.09648	0.10111	0.16769	0.25557	0.17647

*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Weekly Income is shown as $USD

Table 20: Probability of a Job with Added Controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	LPM	LPM	LPM	LPM	LPM	LPM	LPM
VARIABLES	job	job	job	job	job	job	job
currentwc	0.20177***	0.25438***	0.21731***	0.19275***	0.18046**	0.17235**	0.18581**
	(0.06086)	(0.06996)	(0.06846)	(0.07234)	(0.07588)	(0.07150)	(0.07667)
pastwcnowno		0.12700	0.06724	0.05158	0.04996	0.00657	0.03030
		(0.08391)	(0.08263)	(0.08407)	(0.08781)	(0.08402)	(0.08879)
age			0.03102***	0.02494*	0.01992	0.01350	0.02164
			(0.01172)	(0.01321)	(0.01421)	(0.01374)	(0.01433)
agesq			-0.00043***	-0.00040***	-0.00035**	-0.00027*	-0.00037**
			(0.00013)	(0.00015)	(0.00016)	(0.00015)	(0.00016)
children				0.03392*	0.02915	-0.02413	0.03123
				(0.02053)	(0.02180)	(0.02413)	(0.02313)
education				0.00272	0.00241	0.01448**	0.00571
				(0.00690)	(0.00711)	(0.00712)	(0.00737)
timedisabled				0.00271	0.00511	0.00675**	0.00535
				(0.00281)	(0.00353)	(0.00340)	(0.00356)
Constant	0.44286***	0.39024***	-0.05640	0.01621	-0.00608	-0.22536	-0.12197
	(0.04144)	(0.05401)	(0.23442)	(0.25012)	(0.37574)	(0.41904)	(0.47794)
Disability					X	X	X
Live With						X	X
Religion							X
Observations	261	261	261	260	260	260	260
R-squared	0.04071	0.04915	0.11182	0.12249	0.14286	0.26180	0.15619

*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 21: Time Spent Working with Added Controls

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	OLS	OLS	OLS	OLS	OLS	OLS	OLS
VARIABLES	timeworking	timeworking	timeworking	timeworking	timeworking	timeworking	timeworking
currentwc	2.138***	2.319***	1.974***	1.885***	2.015***	1.962***	1.935***
	(0.510)	(0.589)	(0.573)	(0.607)	(0.634)	(0.612)	(0.642)
pastwcnowno		0.437	-0.108	-0.172	-0.042	-0.386	-0.084
		(0.706)	(0.691)	(0.705)	(0.734)	(0.719)	(0.744)
age			0.221**	0.208*	0.202*	0.152	0.192
			(0.098)	(0.111)	(0.119)	(0.118)	(0.120)
agesq			-0.003***	-0.003***	-0.003**	-0.003**	-0.003**
			(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
children				0.183	0.155	-0.337	0.139
				(0.172)	(0.182)	(0.207)	(0.194)
education				0.001	-0.007	0.057	0.004
				(0.058)	(0.059)	(0.061)	(0.062)
timedisabled				0.016	0.024	0.040	0.022
				(0.024)	(0.029)	(0.029)	(0.030)
Constant	2.486***	2.305***	-0.436	-0.354	-2.305	-0.889	-2.288
	(0.347)	(0.455)	(1.961)	(2.098)	(3.140)	(3.586)	(4.005)
Disability					X	X	X
Live With						X	X
Religion							X
Observations	261	261	261	260	260	260	260
R-squared	0.063	0.065	0.137	0.145	0.170	0.251	0.179

*Standard errors in parentheses
*Coefficients are given as hours per day
*** p<0.01, ** p<0.05, * p<0.1

Table 22: Farthest Distance Traveled with Added Controls

VARIABLES	(1) OLS fardistance	(2) OLS fardistance	(3) OLS fardistance	(4) OLS fardistance	(5) OLS fardistance	(6) OLS fardistance	(7) OLS fardistance
currentwc	12.18220**	12.22637*	9.32275	8.95203	10.23928	10.97720	12.30992*
	(5.76472)	(6.65584)	(6.82636)	(6.89442)	(7.04292)	(7.31286)	(7.37660)
pastwcnowno		0.10660	-1.82301	-1.77731	-0.76702	-0.69452	-1.40328
		(7.98358)	(8.09207)	(8.11922)	(8.21119)	(8.51466)	(8.57288)
age			1.05502	0.69333	1.09046	1.08266	1.32433
			(1.16153)	(1.20678)	(1.29248)	(1.37865)	(1.39087)
agesq			-0.01165	-0.00867	-0.01292	-0.01303	-0.01516
			(0.01337)	(0.01360)	(0.01466)	(0.01517)	(0.01528)
job			10.25671*	8.34269	8.58063	8.47374	8.05076
			(6.11307)	(6.46698)	(6.50609)	(6.61015)	(6.65487)
children				1.72100	1.78446	2.01601	1.42288
				(1.99723)	(2.01891)	(2.13634)	(2.16696)
parenteduc				-0.67399	-0.75321	-1.04172	-0.86957
				(0.95391)	(0.96034)	(1.00830)	(1.04504)
ambition				5.16644	5.00495	4.27733	4.28633
				(7.68387)	(7.70426)	(7.92880)	(7.96771)
timedisabled					-0.24680	-0.33399	-0.31141
					(0.27627)	(0.34761)	(0.35051)
Constant	6.18929	6.14512	-18.41202	-13.85720	-17.58544	-16.66156	-34.23968
	(3.92510)	(5.13863)	(22.93072)	(24.57387)	(25.30306)	(37.39671)	(47.35456)
Disability						X	X
Religion							X
Observations	261	261	261	261	260	260	260
R-squared	0.01695	0.01695	0.03333	0.04020	0.04342	0.07572	0.08880

*Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1
*Farthest distance traveled in the past week, given in kilometers

Figure 1: Bar Graph Time Working

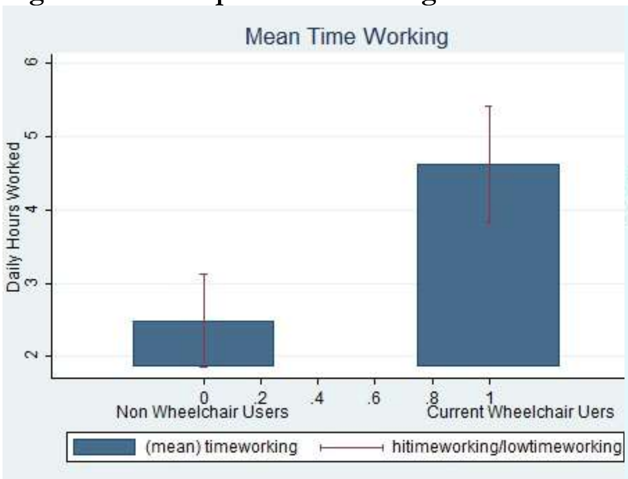

Figure 2: Kernel Density Time Working

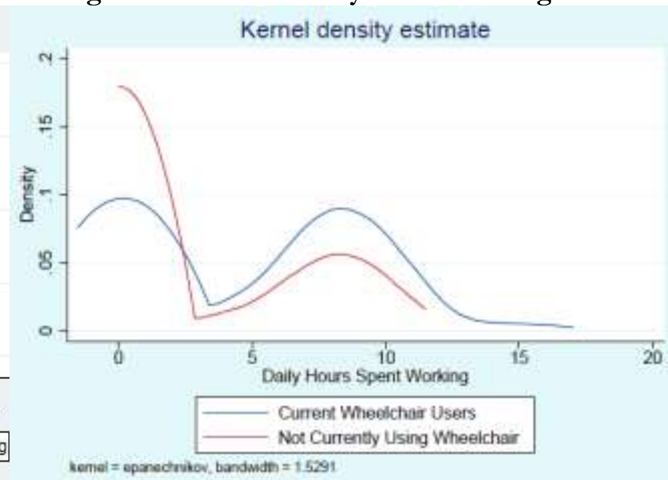

Figure 3: Bar Graph Weekly Income

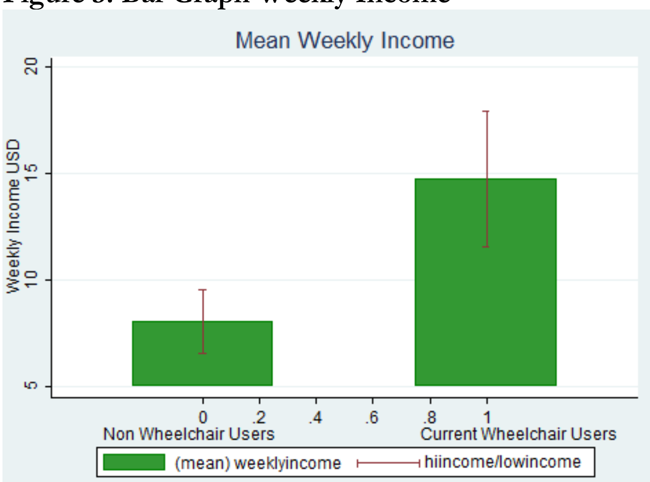

Figure 4: Kernel Density Weekly Income

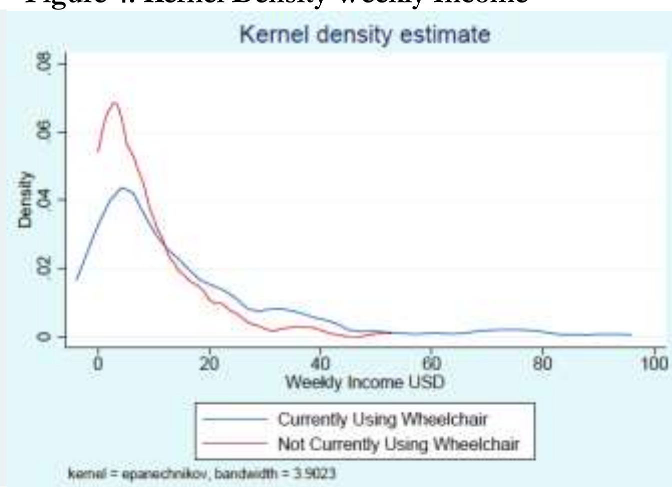

Figure 5: Bar Graph Farthest Distance Traveled

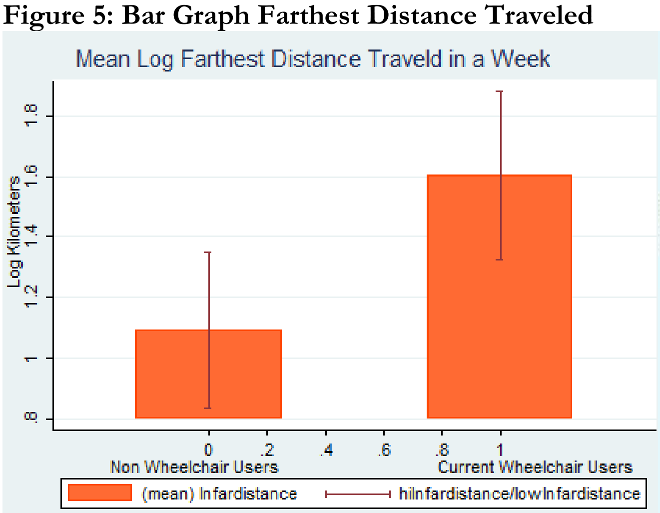

Figure 6: Kernel Density Farthest Distance

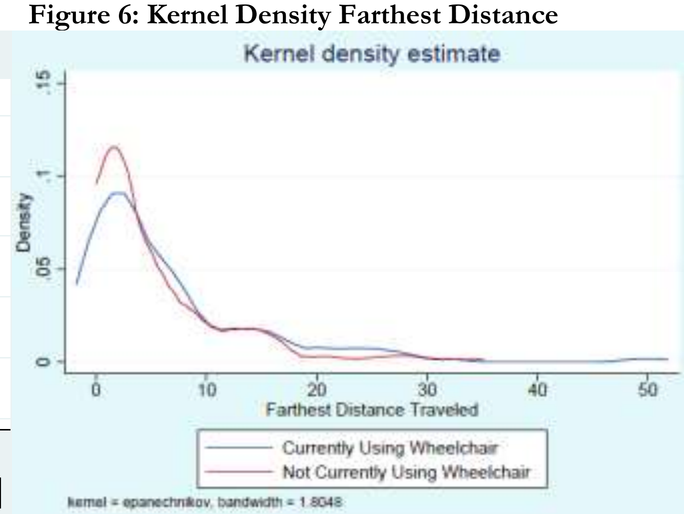

Figure 7: Time Allocation Survey

Name ____________

ID ____________

Mark the correct letter indicating the activity performed yesterday at the given times

Going To School	Doing Homework/ Studying	Performing Household Chores	Worshipping at a Church/Mosque	At the Doctor	Buying things at the Marketplace	Asking for Help	Playing With Friends	Physical Therapy	Coffee/Wedding or other Gatherings	Watching Television or Radio	Washing/ Bathing	Cooking	Eating	Working	Traveling anywhere	Sleeping	Recreation/Sport	OTHER
A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q		Z

What Day Was Yesterday ____________

1:00 AM		1:00 PM	
1:30 AM		1:30 PM	
2:00 AM		2:00 PM	
2:30 AM		2:30 PM	
3:00 AM		3:00 PM	
3:30 AM		3:30 PM	
4:00 AM		4:00 PM	
4:30 AM		4:30 PM	
5:00 AM		5:00 PM	
5:30 AM		5:30 PM	
6:00 AM		6:00 PM	
6:30 AM		6:30 PM	
7:00 AM		7:00 PM	
7:30 AM		7:30 PM	
8:00 AM		8:00 PM	
8:30 AM		8:30 PM	
9:00 AM		9:00 PM	
9:30 AM		9:30 PM	
10:00 AM		10:00 PM	
10:30 AM		10:30 PM	
11:00 AM		11:00 PM	
11:30 AM		11:30 PM	
12:00 PM		12:00 AM	
12:30 PM		12:30 AM	

Figure 8: Cost-Benefit Analysis of a Wheelchair

Year	Costs	Benefits	Total Benefits	Discount Factor	Present Value
0	$500	$100	($400)	1.00	-$400.00
1	$20	$300	$280	0.91	$254.55
2	$20	$300	$280	0.83	$231.40
3	$500	$100	($400)	0.75	-$300.53
4	$20	$300	$280	0.68	$191.24
5	$20	$300	$280	0.62	$173.86
				NPV =	$150.53

Discount Rate = 10.00%

IRR= 26% IRR is the discount rate that returns a net present value of $0