IDB WORKING PAPER SERIES Nº IDB-WP-00956

Getting a Lift: The Impact of Aerial Cable Cars in La Paz, Bolivia

Sebastian Martinez
Raul Sanchez
Patricia Yañez-Pagans

Inter-American Development Bank

Office of Strategic Planning and Development Effectiveness

Infrastructure and Energy Sector

IDB Invest - Strategy and Development Department

December, 2018

Inter-American Development Bank

Getting a Lift: The Impact of Aerial Cable Cars in La Paz, Bolivia

Sebastian Martinez
Raul Sanchez
Patricia Yañez-Pagans

December, 2018

Cataloging-in-Publication data provided by the
Inter-American Development Bank
Felipe Herrera Library

Martinez, Sebastian.
Getting a lift: the impact of aerial cable cars in La Paz Bolivia / Sebastian Martinez, Raul Sanchez, Patricia Yañez-Pagans.
p. cm. — (IDB Working Paper Series ; 956)
Includes bibliographic references.
1. Aerial tramways-Bolivia. 2. Urban transportation-Bolivia. 3. Local transit-Bolivia. I. Sanchez, Raul. II. Yáñez-Pagans, Patricia. III. Inter-American Development Bank. Office of Strategic Planning and Development Effectiveness. IV. Title. V. Series.
IDB-WP-956

http://www.iadb.org

Copyright © 2018 Inter-American Development Bank. This work is licensed under a Creative Commons IGO 3.0 Attribution-NonCommercial-NoDerivatives (CC-IGO BY-NC-ND 3.0 IGO) license (http://creativecommons.org/licenses/by-nc-nd/3.0/igo/legalcode) and may be reproduced with attribution to the IDB and for any non-commercial purpose, as provided below. No derivative work is allowed.

Any dispute related to the use of the works of the IDB that cannot be settled amicably shall be submitted to arbitration pursuant to the UNCITRAL rules. The use of the IDB's name for any purpose other than for attribution, and the use of IDB's logo shall be subject to a separate written license agreement between the IDB and the user and is not authorized as part of this CC-IGO license.

Following a peer review process, and with previous written consent by the Inter-American Development Bank (IDB), a revised version of this work may also be reproduced in any academic journal, including those indexed by the American Economic Association's EconLit, provided that the IDB is credited and that the author(s) receive no income from the publication. Therefore, the restriction to receive income from such publication shall only extend to the publication's author(s). With regard to such restriction, in case of any inconsistency between the Creative Commons IGO 3.0 Attribution-NonCommercial-NoDerivatives license and these statements, the latter shall prevail.

Note that link provided above includes additional terms and conditions of the license.

The opinions expressed in this publication are those of the authors and do not necessarily reflect the views of the Inter-American Development Bank, its Board of Directors, or the countries they represent.

1300 New York Ave NW, Washington DC 20577

Getting a Lift: The Impact of Aerial Cable Cars in La Paz, Bolivia*

Sebastian Martinez† Raul Sanchez‡ Patricia Yañez-Pagans§

December 11, 2018

Abstract

This paper studies the effects of areal cable cars on mode of transport, time use and employment in the metropolitan area of La Paz, Bolivia. Using an instrumental variables approach, we estimate local average treatment effects of cable car use for residents who use the system due to proximity to a cable car station. Results suggest that cable-car users substitute private transport in favor of public transit and experience large savings in commute time, which is reallocated toward educational and recreational activities. Users also increase self-employment activities, potentially reflecting improved access to local labor markets. The positive effects of the cable-car are driven by residents of the city of El Alto, a city with high concentration of poor and indigenous households on the high plateau bordering La Paz. The economic benefits of the cable car outweigh costs by a ratio of 1.05 to 2.16.

Keywords: Cable Car, Mi Teleférico, Mass Transit, Travel Time, Employment

JEL codes: L92, O18, R41

*The authors are grateful to the Mi Teleférico Company for sharing the data used in this study. We thank Carola Alvarez, Gabriela Arteaga, Matias Cattaneo, Shirley Cañete, Mauricio Chumacero, Carlos Foronda, Oscar Mitnik, Raul Rodriguez, Jeffrey Wooldridge, and seminar participants at the Inter-American Development Bank and Mi Teleférico for helpful suggestions. All opinions are those of the authors and do not necessarily represent the views of Mi Teleférico or of the Inter-American Development Bank Group, its respective Executive Directors, or the governments they represent.

†Inter-American Development Bank. Email: smartinez@iadb.org.

‡Inter-American Development Bank (IDB Invest). Email: rsanchez@iadb.org.

§Inter-American Development Bank (IDB Invest). Email: patriciaya@iadb.org.

1 Introduction

The capital city of La Paz, Bolivia is situated in a canyon on the edge of the Andean highlands, approximately 3,650 meters above sea level. The metropolitan area has a population of roughly 1,8 million inhabitants, of which just over half live in the city of El Alto at 4,100 meters above sea level (INE, 2018). The commute between La Paz and El Alto involves navigating a single (toll) freeway or braving the narrow side streets that zigzag up and down the steep mountainous terrain separating the two cities. At peak commute hours, roads are congested with mini-buses, taxis and private vehicles, with average travel times for commuters in the metro area estimated at upwards of 40 minutes (Suarez Aleman and Serebrisky, 2017). Starting in 2014, an alternative approach to mass-transit was introduced with the installation of the Mi Teleférico (MT) aerial cable car system, ferrying passengers between the edge of El Alto and downtown La Paz in as little as 10 minutes from end to end stations.

In this paper we take a micro-econometric approach to studying the effects of MT using data from a representative sample of 3,575 households in La Paz and El Alto collected in 2016, approximately 2 years after the opening of the first MT line.[1] We estimate local-average treatment effects (LATE) of MT on mode of transport, time allocation decisions, employment outcomes, and income. We find that users of the MT experienced important shifts in transport mode, with a substitution of expenditures on private transport for public alternatives. Consistent with existing literature, we find significant travel time savings for MT riders, though our LATE estimates suggest substantively larger time savings for the subset of riders who use MT because of their dwelling's proximity to a station. These savings in time appear to have been reallocated to educational and recreational activities. Finally, we find increased self-employment and self-employment income from use of MT, which likely reflects increased access to labor market opportunities. Our cost-benefit analysis suggests that, under most reasonable scenarios, the benefits produced by MT outweigh its costs by a ratio of 1.05 to 2.16.

Estimating credible impacts of a mass transit system such as MT presents several challenges. By changing traffic patterns and affecting local economic growth, mass transit systems may well have general-equilibrium effects on outcomes such as travel times and economic conditions for all residents of the affected area.[2] Our

[1]This paper studies the impact of the first three lines of MT (Red, Green and Yellow lines) between 2014 and 2016. The system has since expanded to 7 lines as of June 2018 with 4 more in planning.

[2]For example, Gonzalez-Navarro and Turner (2018) find that subways lead to more decentralized

study sample is confined to a subset of households in La Paz and El Alto metropolitan areas, and as such will fail to capture such generalized effects. Furthermore, even in a partial equilibrium context, an individual's choice to use the cable-car is likely a function of multiple unobserved determinants. Without exogenous variation in cable car use, comparing the outcomes of riders versus non-riders may confound those unobserved variables with cable car usage, resulting in biased impacts. To reduce this potential bias, we implement an instrumental variables (IV) approach using distance to the nearest MT station as an arguably exogenous determinant of cable car ridership. Our regression models also control for a rich set of demographic and socio-economic covariates, as well as baseline public transport alternatives near the household. Given the topography of La Paz with steep terrain and pronounced variations in altitude within the same city, the regression models control for ease of access as measured by the variation in slope between a household and its nearest MT station. Under certain conditions, the resulting LATE estimates will be unbiased, but are unlikely to reflect the average treatment effects for the population of La Paz and El Alto. Thus, it is important to emphasize the nature of our estimates as LATEs at the outset.

The key (endogenous) treatment variable in our analysis is cable car ridership, defined as 1 if a household declared using MT in the month prior to the interview and 0 otherwise. With a binary treatment variable, we implement an efficient estimation method based on a three-stage IV approach proposed by Wooldridge (2002), which is more efficient in contexts with dichotomous endogenous variables when compared to the traditional two-step approach. In the absence of endogenous sorting of the population around stations, the distance of a residence to the nearest station is a strong predictor of cable car usage that is uncorrelated with unobserved variables, allowing us to identify consistent LATEs of cable car ridership. The absence of endogenous sorting, i.e. moving of residence because of MT, is a critical assumption underlying our analysis. The relatively short timeframe under consideration and our focus on the effects of the first three cable car lines between the system's inauguration in 2014 and the survey collected in 2016, makes this assumption more plausible. While we do not have data to control explicitly for baseline residence status, we present multiple robustness checks, including estimation of effects on the sub-sample of households that are property owners and

cities, and Duranton and Turner (2012) and Garcia-López et al. (2013) find that highways led to population growth in the United States and Spain, respectively.

may thus be less mobile in the short run.

This paper fits in an increasing but still limited causal literature on the microeconomic effects of urban transport systems. The reduced amount of studies in this area responds to the complexities inherent to constructing credible counterfactual scenarios, particularly in settings where large transport investments may affect the entire transport network, leaving little room for identifying pure control groups. It is also explained by the limited amount of transport specific household-level surveys that can allow to capture broader socioeconomic impacts, while also capturing transport behaviors. Traditionally, the transport sector has based investment decisions on engineering models or projections of travel time savings using origin-destination surveys and simulation exercises. Ex-post empirical studies computing actual travel time savings and looking at socio-economic effects are still relatively scarce (Yañez Pagans et al., 2018).

Most causal studies in the urban transport literature have focused on the impacts of subways and light rails in urban areas, many of them in developed economies, and show important effects on housing prices (Baum-Snow and Kahn, 2000; Gibbons and Machin, 2005; Billings, 2011), and some impacts on accessibility to employment (Holzer et al., 2003; Tyndall, 2017). A recent paper highlights the ability of these systems to have a transformative effect on cities and to encourage employment growth (Gonzalez-Navarro and Turner, 2018). Another strand of the literature has looked at the effects of Bus Rapid Transit (BRT) Systems, which are bus-based systems that operate in dedicated lanes. In this case, authors find evidence of modest effects on housing prices and employment, which some authors hypothesize might be due to their perceived lower level of permanence when compared to subways or light rails (Rodríguez and Targa, 2004; Vuchic, 2002). Within the urban transport literature, we have not identified causal studies looking at time allocation decisions or exploring changes in transportation mode through the use household survey data.

As aerial cable cars are relatively new in the region and are not used as primary transport systems in most cities, there is a limited set of studies exploring their causal effects. The most closely related paper by Suarez Aleman and Serebrisky (2017) analyzes a specific origin-destination travel survey to estimate travel time savings resulting for MT in La Paz, Bolivia. The authors compare travel times between trips with the same origin-destination pair taken with the MT versus trips completed with alternative transport modalities. They find that MT reduces travel

times by 22% on average. Outside of the Bolivian context, the case of Medellín (Metrocable) is probably the most widely studied. Qualitative evidence suggests that it led to improvements in urban integration and modernization of neighborhoods (Brand and Dávila, 2011; Goodship, 2015), accessibility and improved citizen security (Heinrichs and Bernet, 2014), improved quality of life (Roldan and Zapata, 2013), increased employment opportunities for the poor (Bocarejo et al., 2014), and improved in perceived pollution (Dávila and Daste, 2012). In terms of causal studies, (Bocarejo et al., 2014) implement a Difference-in-Differences (DID) strategy to quantify the impacts of the Metrocable on rent and transport and public utilities costs, finding no significant effects. Finally, Cerdá et al. (2012) and Canavire-Bacarreza et al. (2016) use DID methods to estimate effects on crime and homicide, finding significant declines in neighborhoods served by the cable car relative to comparable neighborhoods not connected to the cable car.

Our paper makes at least two contributions to the literature. First, we contribute to the limited causal evidence on the impacts of cable cars as mass-transit alternatives. Historically, cable cars have mainly been touristic attractions in high income countries. Yet in densely populated and complex topographical settings, cable cars offer multiple advantages over subways or light-rails systems. They can be built in a shorter amount of time, they do not require the displacement of large groups of people, and they are more suitable for cities with mountainous geographies (The Economist, 2017). However, some systems have been heavily subsidized and cable cars lack the same capacity as other mass transport alternatives. In addition to La Paz and Medellin, cable car systems have been implemented in Caracas (Venezuela), Cali (Colombia), Mexico City (Mexico) and Rio de Janeiro (Brazil). As cable cars are being considered as viable transport alternatives in other contexts, our study contributes to the thin evidence base available to help guide urban transport policy in the region. Second, we explore a set of outcomes that have not been studied in the urban transport causal literature before, including time allocation decisions. By looking beyond of the traditional outcomes expected from transport investments, such as travel time savings, we contribute to a more comprehensive understanding of the potential welfare impacts and cost-benefit balance resulting from these investments.

The remainder of the paper is structured as follows. Section 2 describes the MT cable car intervention and context. In section 3 we describe the data used for the analysis, and section 4 describes our empirical strategy. Section 5 presents

the primary results and discusses robustness tests. Section 6 conducts a simple cost-benefit analysis, and section 7 concludes.

2 Mi Teleférico Aerial Cable Car

MI Teleférico (MT), is an aerial cable car system serving the metropolitan area of La Paz and El Alto, located in the Andes mountains in Bolivia and currently the largest cable car system in the world (Suarez Aleman and Serebrisky, 2017). The neighboring cities of La Paz and El Alto are the second and third most populous cities in Bolivia (INE, 2018) and are an economically integrated metropolitan area. For example, the international airport serving the entire metropolitan area is in El Alto and many residents commute between the two cities for work. La Paz, the government's center in the country, is in a canyon on the Choqueyapu River, with much of the city built on steep inclinations and hillsides. El Alto is a poorer, fast-growing and majority indigenous city made up largely of bedroom communities and industrial areas. El Alto is located on the relatively flat and open Altiplano plateau above the city of La Paz. Despite their proximity, travel between the two cities has always been a challenge due to a difference in elevation of about 400 meters (1,300 ft) and the treacherous terrain of the slopes that descend into La Paz.

Before the construction of the cable car, public transportation options between La Paz and El Alto were limited to taxis, buses and minibuses that were heavily crowded during rush hours. Commuters navigated winding streets with poor road safety and heavy traffic at peak hours. To address this situation, the idea of connecting the two cities with a cable car was proposed as early as the 1970s (Mi Teleférico, 2016).

In 2011, the Municipal Government of La Paz revived the cable-car proposal and carried out a ridership demand study to guide the possible design of a cable-car system, which could adapt well to the geographic conditions of the metropolitan area (Mi Teleférico, 2016). The study found that the city handles 1.7 million trips per day, including 350,000 trips between La Paz and El Alto. In 2012, Bolivian President Evo Morales drafted a bill for the construction of the cable car and sent it to the Plurinational Legislative Assembly, asking mayors from both cities to participate in the project.[3] The project cost for the first phase was US$ 234 million

[3]The project was constructed by the Austrian company Doppelmayr and it is operated by a government owned enterprise called "Mi Teleférico" and created in 2014 (Mi Teleférico, 2018).

and was financed by the country's National Treasury with an internal loan from the Central Bank of Bolivia (Stewart, 2017; Mi Teleférico, 2018). Phase I of the system consisted of three lines (Red Line, Yellow Line, and Green Line), completed in May of 2014. Upon completion, the 10-kilometer (6.2 miles) system was the longest aerial cable car system in the world. In 2015, a law approving the construction of Phase II was passed, increasing the number of new lines to six and committing US$ 450 million to the project. A seventh line was announced in February 2016, and an eighth was announced in July 2016 (Mi Teleférico, 2018). Based on its master plan, the completed system will reach a length of 33.8 kilometers (21 miles) with 11 lines and 39 stations. Over the years, the system has received multiple awards and recognition for being one of the most innovative transport systems in the Latin American Region.[4] It also entered in the Guinness World Record in 2018 for being the largest cable car network in the world.

MT is the first urban transit network to use cable cars as the backbone of the public transportation network (Neuman, 2017). At 3 bolivianos (approx. US$ 0.40) per ride, prices have been set to be competitive with the local bus system.[5] Each line can transport up to 6,000 people per hour, with cabins leaving every 12 seconds and seating up to 10 people. The system is open between 6 am and 11 pm daily. According to company statistics, the systems transported 100 million passengers since its first opening in 2014 until 2017, and the system transported up to a total of 84,830 passengers per day in 2018 (Mi Teleférico, 2018). Estimates indicate that the cable cars have cut commute times down from up to 1 hour to just 10 minutes between stations in La Paz and El Alto. Each cable car is equipped with solar panels to power the doors, lights, and Wi-Fi. The aerial transport network has not only proved popular among locals and tourists but is also praised to be a symbol of efforts to close the geographic and economic gap between Bolivia's indigenous and poor population in El Alto with mestizo and the middle class in La Paz (The Guardian, 2016).

[4] For example, in 2016 it received the award from the Smart City Business America Congress and Expo and in 2018 the system received the Latam Smart City Award, under the category of Sustainable Urban Development and Mobility, which is the most important award in the Latin American region for urban projects (Mi Teleférico, 2018).

[5] The cost of buses in La Paz (including buses, mini-buses and trufis) ranges from 1 to 3 bolivianos (Suarez Aleman and Serebrisky, 2017)

3 Data

We use a purpose-specific household survey collected in 2016 to study the impact of the first phase of the cable-car system. The survey covers a representative sample of households in the cities of La Paz and El Alto. The area of study was delimited in 6 impact areas following a two-step process. In the first step, 3 areas were identified, based on geographic proximity to: i) currently operating MT stations (Phase I); ii) stations under construction (Phase II); or iii) future stations (Phase III). Based on these areas, buffer zones were constructed considering the geographic distance to existing or future stations. In La Paz, 4 buffers were defined as follows: i) 0 km - 0.5 km from stations in Phase I and Phase II; ii) 0.5 km - 1km from stations in Phase I and Phase II; and iii) within 1 km of stations in Phase III; (iv) more than 1 km from the rest. For El Alto, buffers were defined as follows: i) 0 km - 1 km from stations in Phase I and Phase II; ii) 1 km – 2 km from stations in Phase I and Phase II; and iii) within 2 km of stations in Phase III; (iv) more than 2 km from rest. The difference in the size of the buffers for La Paz and El Alto considers accessibility on foot and the geographical dispersion of the two cities, under the notion that El Alto's flat terrain facilitates walking compared to the mountainous topography and steeply inclined streets of La Paz.

The sampling frame was based on the 2012 National Population and Housing Census. Primary Sampling Units (PSUs) were defined as the 6 impact areas and buffers, according to the distance to the Phase I, Phase II, Phase III stations (later phases according to the guidelines of the Master Plan) and remaining areas. The secondary sampling unit was the city block. Finally, the unit of measurement and analysis was the household, defined as the set of people who live in the same home and share at least the expenses in food and basic services (as water and sanitation and electricity). The criterion with which households were selected for the application of the survey was that at least one member of the household of 12 or more years of age had made a trip using any form of ground transportation in the past day. For each sampled household, the survey captured socio-demographic information of all persons including the head of household and spouse. To complete the transport modules, the survey randomly selected one household member over 12 years old who had completed at least one trip in the day before the interview. The total sample size was 3575 households distributed across 882 blocks. Figure 2 shows the geographic dispersion of the sample based on this sampling framework.

The survey collected a rich set of household demographic and socio-economic characteristics and included a transport module with detailed trip details from the last day as well as GPS coordinates for each household. As outcomes of interest, we focus in four sets of variables: (i) transport-related expenses; (ii) time allocation decisions for different activities; (iii) employment outcomes; and (iv) income outcomes. Types of transport-related expenses include expenses on public transportation services, such as urban public transport (bus, minibus, taxi). Private transport expenses correspond to expenses on fuel and lubricants for car and/or motorcycle, as well as repairs and maintenance of the vehicle. The survey also collected information of expenses on transport to educational centers including colleges, universities, institutes, etc. Time allocation decisions distinguishes how much time the person dedicated the day before the interview to activities such as working, studying, household, transportation, eating, sleeping, recreation and others. Employment outcomes are constructed from a labor module that asks if during the previous week the interviewee looked for a job, if he or she worked at least one hour, and if he or she is an independent employee. Income outcomes refer to total amount (in Bolivianos) that the individual receives in terms of salary, in kind, as independent employee, and his or her total income. We also compute total per capita household income. For the MT treatment variable, we consider a household to be user of the system if they report having used MT at least once a month.[6] We conduct robustness checks using other definitions of the variable, including weekly and yearly use.

In addition to the 2016 household survey, we add baseline geocoded information on alternative public transport modes in La Paz and El Alto, including minibus, micro[7], trufi and Puma Katari[8]. This information was extracted online from the Mayor's Office of Planning for Development (OMPD) of the Autonomous Municipal Government of La Paz, in 2013. We use this information to construct a variable that measures a household's pre-MT level of accessibility to public transportation. The variable computes the number of lines for each public transportation at a walking distance of 250 meters from the dwelling.

[6]Note that transport modes are reported only by the individual who answers the transportation module. We extrapolate use of MT for all household members based on this information.

[7]Micro is the traditional bus service that has an established route, but not assigned stops or schedule. Usually the buses that operate in the micro categories are old and are part of a specific transport union.

[8]Puma Katari is a new bus service, lunched by the local government in La Paz. Buses have a established route and designated stops. Buses are new, and the service has an organized schedule.

4 Empirical Strategy

To estimate causal effects of MT on the outcomes of interest we would ideally compare a population randomly assigned to use the cable-car against a population with no access to the system. In the absence of such an assignment, a naïve comparison might compare outcomes of populations that use the system to those who do not. The estimation would be:

$$Y_i \quad = \quad \beta_0 + \beta_{use} T_i + \lambda X_i + \epsilon_i \tag{1}$$

Where Y_i is the outcome of interest for household i. T_i is a binary variable that takes the value of 1 for users of MT and 0 otherwise, and X_i are all other covariates that affect the outcome variable. Under this specification, β_{use} would be the coefficient of interest or impact estimator.

The main concern with the previous approach is that MT users might be inherently different from non-users and any unobservable characteristics driving these differences that simultaneously affect the outcome variable could lead to an inconsistent parameter estimation. In other words, the error term (ϵ_i) could be correlated both with T_i and Y_i. Thus, to estimate the causal effects of MT we apply an instrumental variables (IV) approach which allows us to generate exogenous variation in the treatment variable and overcome the endogeneity problem mentioned above. We use the distance to the nearest MT station in operation in 2016 (the year of the survey) as an instrument for the use of the system. The minimum distance to an MT station is constructed using GPS coordinates for sample dwellings and MT stations. For example, Figure 3 shows the ten possible paths to existing stations for household i.[9] The instrument Z_i is the walking distance in kilometers between individual i's home and the nearest station (in this case the Sopocachi station).

We argue that the instrument (Z_i) satisfies two important conditions. First, a shorter distance to the MT system facilitates access, leading households to use or more frequently use the MT. Thus, our prior was that T_i and Z_i would be strongly correlated in a "first stage". Second, the distance to a MT station will satisfy the exclusion restriction, only affecting the outcome variables through MT usage, under certain conditions. Based on reports from local authorities, the location of

[9] Our analysis includes all the stations of the first three lines. These stations are: 16 de Julio, Cementerio, Central, Parque Mirador, Buenos Aires, Sopocachi, Del Libertador, Alto Obrajes, Obrajes 17, Irpavi.

MT stations was largely an ad-hoc process based primarily on the availability of space. Thus, stations were not necessarily located in the most desirable commercial centers, and their placement was akin to an exogenous shock for residents in the vicinity. However, if over time households change their location in response to where MT stations where placed, this would invalidate our empirical approach, since households living closer to the stations would be composed of individuals that value living near a station and may have different work and commute patterns that would directly affect our outcomes of interest. Data were not available on length of residence in the current location to condition on baseline residency status. As a robustness check, we focus only on the sample of households that are property owners and thus are likely to have higher transaction costs to relocate and show that results hold. Thus, at least in the short run context analyzed here, we argue that endogenous sorting is not likely a major threat to our identification.

A common procedure to estimate IV models is through a two-stage least squares model (2SLS) (Cameron and Trivedi, 2005), by which in a first step the use of MT or treatment variable (T_i) is regressed on a set of covariates X_i, including the instrument Z_i. Then, the predicted value of the treatment variable $\hat{T}_i$ is used as the main covariate of interest in a second step. Given that we have a dummy endogenous variable model (Heckman, 1978), Wooldridge (2002)[10] proposes a more efficient IV estimation procedure that follows a 3-stage procedure and considers the non-linear functional form. Therefore, following this method we estimate a binary model (Probit) in a first stage, regressing the use of MT (T_i) on other covariates X_i, including the instrument Z_i:

$$T_i = \gamma_0 + \gamma_{distance} Z_i + \eta X_i + u_i \quad (2)$$

From the first stage we obtain the predicted value of treatment $\hat{T}_i$. In a second stage, we estimate what would be the first stage of the traditional 2SLS model, using $\hat{T}_i$ as the instrument for the treatment:

$$T_i = \alpha_0 + \alpha_{use} \hat{T}_i + \delta X_i + e_i \quad (3)$$

From this second stage we obtain a new predicted value of the treatment $\hat{\hat{T}}_i$ that

[10] For more details please review Procedure 18.1 reported in page 623 of Wooldridge (2002). This methodology has also been implemented by Adams et al. (2009), Tan (2010), and Niimi (2016).

we then use it to estimate the final and third stage to compute the impact:

$$Y_i \quad = \quad \beta_0 + \beta_{use}\hat{\hat{T}}_i + \lambda X_i + \epsilon_i \tag{4}$$

The coefficient of interest is β_{use} and measures the impact of the use of MT on the outcomes of interest. Besides the efficiency gains from this procedure, the usual 2SLS standard error and test statistics are asymptotically valid. Also, it does not require the Probit model in the first stage to be correctly specified as long as the instrument is correlated with the treatment variable. The estimated treatment effect is interpreted as LATE, which in this context can be thought of as the effect of cable car ridership for those users who are induced to use the system thanks to the geographical proximity of their residence to a MT station.

5 Results

5.1 Descriptive Statistics

Table 1 presents descriptive statistics of the sample. In terms of geographic distribution, 57% of the sample comes from El Alto, while 43% comes from La Paz. Most heads of household are men (77%), 57% report to be indigenous, 25% have completed university studies or more, 67% are property owners, and the average household size is four. Regarding the use of MT, 36% of respondents report having used the cable car system at least once per month.[11] The average minimum distance to a MT station is 4 km, but there is large variation, with the closest households being less than 500 meters away and the most distant more than 16 kilometers away.

With respect to the outcome variables we see that, on average, total per capita expenditure on transport per month is around 123 bolivianos (approx. $18 dollars) and this represents almost 7% of the minimum wage in the country.[12] In terms

[11] For a representative sample of households in La Paz and El Alto, Suarez Aleman and Serebrisky (2017), find that the model share of MT in 2015 was 2% of trips, equivalent to the modal share of taxi rides. Minibuses (57%), walking (19%), private car (6%), buses (5%), and trufis (5%) were the other primary modes of transport reported for trips within the metropolitan area (4% reported other). These numbers compare to the modal share reported in the evaluation survey used in this paper where MT represents 3.24% of trips taxis (2.11%), minibuses (76.7%), walking (2.5%), private car (3.28%), buses (4.02%) and trufis (4.95%).

[12] For 2016, the minimum wage in the country was 1,805 bolivianos, which is equivalent to 262 US dollars.

of time allocation decisions, transport time consumes on average 1.4 hours per day, while time devoted to educational activities is 1.3 hours, probably because we are looking at the entire sample of head of households and most them are not studying anymore. Finally, regarding employment outcomes, 82% of household heads report having worked at least one hour in the past week. The average per capita household income is around 1,300 bolivianos (approx. 188 dollars) and those working independently earn more than those working as employees (1800 vs. 1100 bolivianos respectively).

We also explore in more detail what is the profile MT users, considering their frequency of use of this system, and compare them with non-users. Table A.1 in the Appendix shows that a larger proportion of more frequent users (i.e. daily, weekly or monthly) is in La Paz versus less frequent users (i.e. bimonthly to annually, 46% vs. 39%). More frequent users have also higher income, higher levels of education, and there is a lower proportion of indigenous population. Less frequent users are located at larger distances to MT stations when compared to frequent travelers, thus suggesting that the instrument of distance might be relevant to predict the use of this transport system. Regarding non-users, the descriptive statistics reported in Table A.1 suggest that they are older than users, have lower levels of income, and seem more dependent on private modes of transportation. They also devote more time to household chores and a larger proportion is unemployed or worked less than 1 hour in the past week. In terms of distance, interestingly they are not located at larger distances to MT stations than those that use the system less frequently, which suggests that although distance seems to be an important predictor of frequency of use of MT, there might be other personal and household-level characteristics influencing the demand for this service.

5.2 Main Results

Table 2 reports the estimation of the first two stages of model specified in equations 3 and 4. The estimated coefficients $\gamma_{distance}$ refers to the effect of distance to the nearest station on the use of MT, obtained from the binary model (Probit) regressing the use of MT on covariates X_i and the instrument Z_i. The results indicate that living one kilometer further from the nearest station reduces the probability of using MT by 7%. These results persist if we consider only the sample of La Paz or El Alto (columns 2 and 3 of Table 2, respectively). Moreover, α_{use}, refers to the effect of

the predicted probability of using MT ($\hat{T}_i$, from the previous step) on T_i. The effect of the predicted probability of using MT (obtained from the previous step) on the use of MT is equal to 1.000. Because this stage is similar to the first stage of a traditional instrumental variables approach, we also report the F-test associated to the model. This statistic is equal to 60.36, indicating that the estimation presents strong estimates to be used in the following stage. Our preferred specification includes the covariates for city, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, variation of the slope along the way from the household to the closest MT station[13], the number of available lines of public transportation (transport accessibility measure) prior to the existence of MT, and reception of non-labor income such as remittances and transfers from social programs.

Table 2 presents the results for household transport per capita expenditures. The survey asked households to provide information on how they distributed their transport expenditures across different transport modes (private versus public) and according to the motive of use (in particular, they asked about transport expenditures for educational purposes). The information is reported in monthly bolivianos. We observe that OLS estimates report small but statistically significant effects on total expenditures for public or private transportation of approximately the same dimension of opposite signs. For instance, those who use MT spend on average 10.11 bolivianos more on public transport, and they spend 9.27 bolivianos less on private transportation. As discussed before, OLS estimates may be subject to endogeneity. Implementing the three-stages approach (IV-3 stages) discussed in section 4, we find a significant increase in public transport expenditures of 62.46 bolivianos, and a reduction in private transport expenditures of 50.66 bolivianos. These results suggest that MT promoted a shift in transport mode, leading individuals to adopt more public transportation and making less use of private vehicles. This modal change is quite important from the perspective of urban mobility and is

[13]Given the mountainous terrain of the city and pronounced changes in altitude, particularly in La Paz, the slope between a house and MT station is included as a proxy of ease of access to a Mi Teleférico station. We construct the slope variable as the standard deviation of the altitudes calculated every 50 meters along the road between the dwelling and the MT station. We also include a city-level indicator to capture any other differences by city.

usually one of the main objectives of urban transport interventions. Our results also show a significant increase, of around 16 bolivianos, in transport expenditures for educational purposes. This could be related to the improved accessibility to some educational centers that the MT can bring.

We are also interested in capturing any heterogenous effects across the cities of La Paz and El Alto, given very different transport and socio-economic characteristics of the two cities. La Paz is the center of government activities in the country and concentrates most of the employment centers in the metropolitan area. El Alto is a city that has experienced large increases in population, mainly migrants from rural areas. It is composed largely by lower income populations and has fewer infrastructure services relative to La Paz. With the opening of MT, the residents of El Alto may have gained increased access to La Paz. The results in Table 3 disaggregated by city of residence confirm this hypothesis. Residents of El Alto experience considerable increases in expenditure on public transportation which is offset by decreases in private transport because of MT, whereas estimated changes for residents of La Paz are not statistically different from zero. In the case of educational transport expenditures, the direction of impacts is positive for El Alto and negative for La Paz, but they are not precisely estimated.

Table 4 presents the set of results related to time allocation of the head of household, measured in number of minutes per day that are devoted to different types of activities. On average, cable car users report spending 70 minutes less per day on transportation. Considering that the average one-way commute time is two hours in some LAC cities (Saliez et al., 2012), this change represents approximately 75% of the travel time. In the context of La Paz and El Alto, average travel times are 84.7 to 88 minutes, respectively, with commuters in the top quintile of travel time distribution (not including MT users) averaging 181.38 to 186.90 minutes daily. Thus, while the LATE coefficient on travel time appears large for the average commuter in the sample, it represents a reduction of approximately 47% (in both cases) for those individuals with longer commutes. We speculate that "compliers" who are induced to use MT because of their dwelling's proximity to a station may be precisely those with most to gain in terms of time savings.[14] We

[14]Also note that time use data are noisy, and the 95% confidence interval for the IV estimate of travel time is 34.6 to 106 minutes. The OLS estimate on transportation time of -12 minutes may be closer to the expected treatment effect on an average user (vis-à-vis the LATE for compliers), and is much more consistent with the 9 minute average travel time savings reported by Suarez Aleman and Serebrisky (2017).

also observe statistically significant reductions in the time devoted to lunch break, approximately 52 minutes of savings. In Bolivia, it is customary for workers to return home for the mid-day meal, which is the primary meal of the day. Given the way this survey question was posted, we interpret these results as suggesting that people using MT are probably spending less time in their commutes traveling back home or to a restaurant at midday for lunch.[15] Freeing up time that was previously devoted to transportation allows individuals to allocate this extra time to other activities. Consistent with this fact, we observe increases in the amount of time that the household head devoted to recreational activities (32 minutes increase per day) and in their time devoted to educational activities (120 minutes increase per day). The results also confirm that the benefits of MT use accrue to the inhabitants of El Alto, who report a 95 minute-reduction per day in transportation time. If we also consider the 68 minutes they save on lunch break, total time savings for residents of El Alto who use MT due to geographic proximity is over two and a half hours per day, time that is reallocated primarily to study.

We next explore whether MT usage leads to changes in employment outcomes for the head of the household. As reported in Table 5, we do not observe any changes in employment search for unemployed individuals, either for the whole sample or in La Paz and/or El Alto. This is probably due to the high levels of informal employment in the country and the fact that most heads of household were employed in some type of activity to begin with. For individuals that are employed, we see that MT increases the rate of those that work more than one hour per day by 15%, but these results are marginally significant. At the same time, there are strongly significant increases in the rate of those who work in independent employment of 48%. As in previous outcomes, the probability of working as self-employed increases significantly in El Alto (almost 80%), compared to La Paz (which is not significant). Given impacts on self-employment, we evaluate whether these changes led to increased household income. Results are reported in Table 6. There are significant increases in income for the head of the household, with an estimated LATE of 3,052 bolivianos (approximately US$434) from independent labor. Taken together, these results suggest that increased access to labor markets may allow individuals to gain new employment opportunities and increase income,

[15] Question A16 of the questionnaire asks, “Please indicate how much time you spent YESTERDAY on the following activities”, and the options are: Sports/recreation, fun; Sleep; Eat; Transport; Home and family; Study; To work; Others

particularly in the informal sector. While estimates are noisy and lack statistical significance when we divide the sample by city, the magnitude of the coefficients again suggests that gains accrue most strongly to residents of El Alto.

Given that the city of El Alto has a higher concentration of poor and indigenous populations, it could be inferred from the previous results that MT created more benefits for lower income households and this may eventually have a positive effect in reducing inequality. To complement this analysis, we run separate regressions for two groups of households: those in the bottom 25% of the asset index distribution and those above this threshold. Results can be provided upon request, but we do not find any statistically significant differences across these two groups. Since we do not have baseline information on income or assets, and that income/wealth may be endogenous at endline, we argue that these results need to be taken with caution. The geographic stratification of the sample (La Paz vs. El Alto) seems to be the best alternative under the assumption that household location is exogenous.

5.3 Robustness tests

We conducted several robustness checks, which are reported in the appendix. First, we divide the sample between households that are property owners and those that are not. This serves to reduce concerns about endogenous location decisions, by which households could be choosing their location in response to the setting of MT stations. If this were to occur, our estimated LATEs would be biased by endogenous sorting, potentially capturing more highly skilled individuals or those prone to use the transport system more often. By focusing on property owners, we use a sample of households that has an arguably higher cost for relocating relative to households that rent. Results from this analysis are reported in Tables B.1 to B.5 Results on the sub-sample of owners are consistent with our main findings. As observed in Table B.2, living one kilometer form the MT station reduces the probability of using the system between seven and nine percent, depending if the household head is a property owner or not. Most of the results we observed for the whole sample are also reflected in the population of property owners. The only exception is that we do not see significant impacts for property owners on increases in the time devoted to recreational activities, although this may be explained by reduced statistical power.

The second robustness check uses an alternative definition of the treatment

variable. In the base specification we defined whether a household was user of MT if they reported that they used the system at least once in a month. Alternatively, we construct two other treatment variables considering whether they report using the system weekly or yearly. Results, also reported in Tables B.1 to B.5, show that results are robust to both definitions of treatment.

We also analyze the results of a traditional IV estimation, such as

$$T_i = \alpha_0 + \alpha_{distance} Z_i + \delta X_i + e_i \tag{5}$$

$$Y_i = \beta_0 + \beta_{use} \hat{T}_i + \lambda X_i + \epsilon_i \tag{6}$$

The results included in Tables C.1 to C.5 confirm the stability of the results regardless of the IV estimation approach used. Finally, we apply the inverse hyperbolic sine (IHS) transformation to our continuous outcome variables, such as expenditure and income, to minimize the influence of outliers, while also avoiding the problem that the logarithm of zero is undefined (Tables D.1 to D.4).[16] This alternative functional form (which also allows us to interpret coefficients as elasticities); does not show significant differences compared to our preferred specification included in section 5.2, with the only exception that the decrease observed in private transport expenditure is no longer significant in this specification. Finally, we include square quadratic terms of the instrumental variable as additional instruments in the regression model and the main conclusions do not change.[17]

5.4 Modal Change Analysis

One of the questions that remains after implementing a new transportation system, is the degree to which the beneficiaries stop using the previously available means of public transportation. To answer this question and given that we only have information from one round of data, we add two interaction terms to our original model. The first one captures the use of public transport, which is approximated by baseline information (i.e. 2013) on the number of available lines of other modes of public transportation within a radius of 250 meters around the dwelling. The second interaction considers whether the household owns a private vehicle. The coefficient of the treatment variable (β) gives the effect of MT with respect to those that did not

[16]The IHS transformation of y_i is equal to $y_i^* = \log\left(y_i + (y_i^2+1)^{\frac{1}{2}}\right)$. See Burbidge et al. (1988) for details.

[17]Results can be made available upon request.

have good access to public transportation or do not have a car. The main effects of "availability of public transport" or "private car ownership" estimate the effect on the outcome variable of each additional line of public transportation that is available to a household within a 250 meters buffer or of having a vehicle. Finally, the interaction term reports the marginal or differential effect of MT between those who already had access to other means of public transportation or have a private vehicle versus those that do not. The total treatment effect for those that are well connected or have a car is computed as the sum between the main treatment effect (beta) and the interaction term. For the case of the availability of public transport lines we evaluate this total effect at the median of the distribution and at the 90th percentile. The results of this exercise are included in appendix tables E.1-E.4 and F.1-F.4 and we combine the tables by the set of outcomes originally analyzed. As presented in Table E.1, the effect of MT on expenses on public transport (for those who do not have access to public transportation) is equal to 78.64 Bolivianos, which is larger than the average effect found in previous models, suggesting that impacts are larger for those who were not well connected to public transportation at baseline. Each additional line of either trufi, bus or mini bus increases the expenditures on public transportation in 0.88 Bolivianos. The interaction term is negative, significant, and equal to -2.29 Bolivianos, suggesting that impacts are smaller for those that were better connected to public transport versus those that were not. The effect of MT on public transportation expenditure for the median value of the distribution of availability of public transport lines is 64.89 Bolivianos and the effect for the 90th percentile is just 19.06 Bolivianos. In all the outcomes analyzed (Tables E.1 to E.4), we observe similar results. The interaction term is always in the opposite direction of the treatment effect but that coefficients are relatively small. Point estimates at the median and the 90th percentile of the distribution are significant but of smaller magnitude. Overall, these findings suggest that MT users are substituting the usage of other means of public transportation for the cable car.

Table F.1 to F.4 report the results for the analysis exploring the substitutability for those that own a private vehicle. The estimated interactions in this case also go in opposite direction of the main treatment effect, but coefficients are much larger in magnitude. For example, in Table F.1 we can see that for those that do not own a car the average treatment effect on public transportation expenditure is equal to 70.35 Bolivianos. In addition, owning a car significantly increases the expenditures reported on private transport (107.23 Bolivianos per month). The interaction term

indicates that the treatment effect on public transportation expenditures for those that own a private vehicle is smaller in magnitude compared to those that do not own a car by 55.91 Bolivianos. When we look at the treatment effect for those that own a vehicle we see a significant and positive effect of MT on public transport expenditure, but the point estimate is small and reports an increase of only 14.43 bolivianos per month. Given the magnitude of the coefficients, these results suggest that substitutability from private vehicle to MT is small and that most of the gains are coming from households that do not have a private vehicle.

6 Cost-Benefit Analysis

This section reports multiple benefit-cost ratios (BCRs) of MT based on the impact estimates obtained in section 5. To calculate these ratios, we construct two different models that vary across the definition of benefits. In the first model, time savings are the main benefit considered. In the second model, we add transport expenditure savings.[18] In both models, costs correspond to those of providing the service and were extracted from an operational report (Mi Teleférico, 2016). It is important to mention that costs of providing the service include the debt service; therefore, no project investment costs are included. For both models, we construct multiple sensitivity scenarios that vary some of the assumptions taken to construct the baseline scenario. Overall, results suggest that the economic benefits of MT outweigh the costs. Of course, the major caveat of this analysis is that the estimated benefits are LATEs affecting a specific segment of the population.

The baseline scenario values time savings with the average labor income reported by the head-of households in the survey sample. This includes data from wages or self-employed income. In addition, we assume that the average number of trips per day per person is two. Finally, we use the average effect estimated for time savings in transportation, which is equivalent to 70 minutes per day (a lower bound estimate if we ignore time saved on the lunch break). Taking all this information into account, the CBRs presented in Table 7 indicate that benefits are almost 2.16 times the project costs. Changing the number of trips to 4, while keeping the rest constant, puts the CBRs between 1.08 and 0.99. A second scenario consid-

[18]Based on the findings, and given the transport mode change, transport expenditures increase rather than decrease. This is because the MT is more expensive relatively to other modes of public transportation. Additional information about the construction of these scenarios can be found in Appendix G

ers the country's minimum wage for 2016, which is lower than the average labor income of the sample.[19] In this case, ratios are around 1.00 on average. A third sensitivity analysis assumes travel time savings are 50% lower than the estimated values (45 minutes) and report CBRs between 1.08 and 0.99. In general, results are lower than the baseline scenario but do not vary widely across the scenarios.

Finally, we construct two scenarios to showcase the most positive and negative settings under reasonable albeit conservative assumptions. For the worst-case scenario, we assume 4 trips per day plus the minimum wage and obtain results below 1. We argue that this is a highly unusual scenario given that 97% of survey respondents indicate they made 2 or less trips in the day prior to the interview. The most positive scenario calculates BCRs considering the travel time savings estimated for the populations with the largest gains in accessibility (El Alto) and also adjusts the values of labor income for this population, considering that average incomes reported for El Alto households are lower than for La Paz. The results show that benefits in this case are more than 2.63 times the size of project costs.

7 Discussion

Urban transport problems are prevalent in many Latin American and Caribbean (LAC) cities. With 80% of its population living in cities, LAC is the most urbanized region in the world (Saliez et al., 2012). While infrastructure investments in urban areas of LAC have been increasing over the past years (Infralatam, 2018), the supply of high high-quality public transport systems have not kept pace with the growth in transport demand. Limited investments, together with partial urban and transport planning, has led to high rates of informality in passenger transport systems and an aging vehicle fleet that result in important levels of congestion, reduced traffic safety, and air quality problems (Yañez Pagans et al., 2018).[20] In addition, the average one-way commute time reached up to two hours in some cities, imposing considerable time and monetary costs to both freight and passenger transport (Saliez et al., 2012). Finally, according to the Clean Air Institute (Clear Air Institute,

[19]Information was obtained from the Decreto Supremo 2748, approved on May 1st, 2016. The minimum wage for 2016 was Bs.1,805, the sample average is Bs. 2,470.

[20]The region has an average of around 90 vehicles per 1,000 people that exceeds those of Africa, Asia, and the Middle East (de la Torre et al., 2009). In addition, in 2010, LAC reported an average rate of 25.3 fatalities per 100,000 inhabitants, compared to 16.1 deaths per 100,000 inhabitants for high income countries in North America (Scholl et al., 2013).

2013), air pollution levels in many LAC cities exceed WHO guidelines for major pollutants creating risks to human health, life expectancy, and productivity.

As a significant share (43%) of passenger travel in LAC cities is still conducted by public transit (CAF, 2010), interventions that seek to improve transportation and accessibility provide an opportunity to promote social equity and reduce urban poverty. Give financing gaps and the need to improve operational and managerial efficiency in the transport sector, the role of both public and private actors is essential to respond to the current challenges. Among the possible set of urban transport interventions, aerial cable cars are an innovative alternative for certain cities in the region, allowing improved transport links for low income areas on the outskirts and mountainous areas with centers of economic activity. Cable cars are cheaper to build than subway lines and less invasive than other surface transportation systems. They tend to be more energy efficient and environmentally friendly, as they do not pollute. Given the panoramic views they offer, they can also become tourist attractions. Despite these advantages, however, questions remain about their economic viability given high subsidies and limited capacity relative to other mass transport systems. This paper quantifies the socioeconomic impacts of La Paz and El Alto's aerial cable car mass transit system, MT. While other cities have implemented cable cars as complementary transport modes, La Paz is the first to use cable cars as one of the primary pillars of the urban transit system. With its steep hillside neighborhoods, where alternative modes of mass transit such as subterranean metros, light rail or dedicated busways would be technically unfeasible or too costly, cable cars seem more suited. Using household survey data and distance to the nearest MT station as an arguably exogenous explanatory factor for cable car ridership, we implement an instrumental variables estimation to quantify impacts on transport costs, time allocation decisions, employment, and labor income. To reduce concerns about potentially dynamic location decisions that might direct more mobile people to areas closer to the systems, we conduct separate estimations for households that are owners of their dwelling and are less likely to move over time versus those that are not.

Results indicate that the use of MT has significantly reduced the time that people spend in transit, freeing up time for leisure and educational activities. These results can provide some insights about the value of travel time and how transport interventions might lead to some development impacts in the longer term, such as facilitating or promoting a more educated population or influencing the health and

happiness status of the population thanks to increased leisure time. Estimated impacts suggest that there has been a shift in people's mode of transportation, as we identify increases in public transport expenditures and decreases in private transport expenditures. As the MT system continues expanding in the coming years and the population values the time savings and quality of its service, these effects may have important implications for traffic congestion in the city and thus for air quality and traffic safety. Findings also indicate that improved accessibility has translated in more employment opportunities, more specifically, higher self-employed occupations and income. Since we do not observe changes in the time devoted to work or increases in the probability of working, we interpret these results as a substitution effect, by which people switch to more lucrative self-employed work when granted increased accessibility to labor markets.

Given that some areas in the metropolitan area have gained more in terms of accessibility thanks to MT, compared to their baseline situation, we test for heterogeneous effects across the populations of La Paz and El Alto. Results show that the benefits of MT accrue most clearly to the residents of El Alto, who until the opening of MT in 2014 endured a lengthy and arduous commute into la Paz. Increased accessibility to La Paz is important for El Alto residents as most employment centers and economic activity is in La Paz, moreover La Paz has a wider offer of leisure and entertainment activities appealing to El Alto households. In addition, a substitution analysis suggest that users might be substituting other public transportation modes with MT, but that substitution effects for those with private vehicles is small. The results of our cost benefit analysis indicate that benefits are between 1.05 and 2.16 the costs of providing the service.

Moving forward, there are additional areas of research that are promising in this field and that will be useful to improve the operation of these systems. Generating evidence on how tariffs could be accommodated to maximize demand considering peak and non-peak hours would allow operators to increase efficiency in the use of a system with essentially fixed supply. In addition, from the social mobility perspective, how these systems contribute to the integration of neighborhoods and reduce segmentation is a relevant question. Finally, this analysis could be extended were data to become available after the opening of additional MT lines using panel data methods to estimate longer run impacts of MT and measuring alternative outcomes such as property prices.

References

Adams, R., Almeida, H., and Ferreira, D. (2009). Understanding the relationship between founder–CEOs and firm performance. *Journal of empirical Finance*, 16(1):136–150.

Baum-Snow, N. and Kahn, M. (2000). The effects of new public projects to expand urban rail transit. *Journal of Public Economics*, 77(2):241–263.

Billings, S. B. (2011). Estimating the value of a new transit option. *Regional Science and Urban Economics*, 41(6):525–536.

Bocarejo, J., Portilla, I., Velásquez, J., Cruz, M., Peña, A., and Oviedo, D. (2014). An innovative transit system and its impact on low income users: the case of the Metrocable in Medellín. *Journal of Transport Geography*, 39:49–61.

Brand, P. and Dávila, J. D. (2011). Mobility innovation at the urban margins: Medellín's metrocables. *City*, 15(6):647–661.

Burbidge, J. B., Magee, L., and Robb, A. L. (1988). Alternative transformations to handle extreme values of the dependent variable. *Journal of the American Statistical Association*, 83(401):123–127.

CAF (2010). Observatorio de Movilidad Urbana para América Latina. Corporación Andina de Fomento.
.http://publicaciones.caf.com/media/1130/0.pdf Accessed 30 July 2018.

Cameron, A. C. and Trivedi, P. K. (2005). *Microeconometrics: methods and applications*. Cambridge university press.

Canavire-Bacarreza, G., Duque, J. C., and Urrego, J. A. (2016). Moving citizens and deterring criminals: Innovation in public transport facilities.

Cerdá, M., Morenoff, J. D., Hansen, B. B., Tessari Hicks, K. J., Duque, L. F., Restrepo, A., and Diez-Roux, A. V. (2012). Reducing violence by transforming neighborhoods: a natural experiment in medellín, colombia. *American journal of epidemiology*, 175(10):1045–1053.

Clear Air Institute (2013). Economic Infrastructure Investment Data. Transport. Data retrieved from:
https://www.cleanairinstitute.org/blog-1.

Dávila, J. D. and Daste, D. (2012). Medellin's aerial cable-cars: Social inclusion and reduced emissions. *UNEP-IPSRM Cities, Decoupling and Urban Infrastructure*.

Duranton, G. and Turner, M. A. (2012). Urban growth and transportation. *Review of Economic Studies*, 79(4):1407–1440.

Estado Plurinacional de Bolivia (2016). Decreto Supremo 2748. http://www.gacetaoficialdebolivia.gob.bo/index.php/edicions/ver/854NEC.

Garcia-López, M.-À., Viladecans-Marsal, E., and Holl, A. (2013). Suburbanization and highways: When the Romans, the Bourbons and the first cars still shape Spanish cities.

Gibbons, S. and Machin, S. (2005). Valuing rail access using transport innovations. *Journal of urban Economics*, 57(1):148–169.

Gonzalez-Navarro, M. and Turner, M. A. (2018). Subways and urban growth: evidence from earth. *Journal of Urban Economics*, 108:85–106.

Goodship, P. (2015). The impact of an urban cable car transport system on the spatial configuration of an informal settlement. In *Proceedings of the 10th International Space Syntax Symposium*.

Heckman, J. (1978). Dummy endogenous variables in a simultaneous equation system. *Econometrica*, 46(4):931–959.

Heinrichs, D. and Bernet, J. S. (2014). Public transport and accessibility in informal settlements: Aerial cable cars in medellín, colombia. *Transportation research procedia*, 4:55–67.

Holzer, H. J., Quigley, J. M., and Raphael, S. (2003). Public transit and the spatial distribution of minority employment: Evidence from a natural experiment. *Journal of Policy Analysis and Management*, 22(3):415–441.

INE (2018). Instituto Nacional de Estadística (INE). http://datos.ine.gob.bo/binbol/RpWebEngine.exe/Portal?BASE=CPV2012COM&lang=ESP. Accessed June 3, 2018.

Infralatam (2018). Economic Infrastructure Investment Data. Transport. http://en.infralatam.info/dataviews/227373/transport Accessed 15 April 2018.

Mi Teleférico (2016). Plan de Negocio de la Empresa Estrategica de Transporte por Cable “Mi Teleférico”. Technical report.

Mi Teleférico (2018). Un Instrumento de Cambio para los Bolivianos. Memoria Institucional 2017-2018. Empresa Estatal de Transporte por Cable “Mi Teleférico”. Technical report.

Neuman, W. (2017). With Subway in the Sky, Valley Meets Plateau. Technical report. TheNewYorkTimes.https://www.nytimes.com/2014/08/17/world/americas/with-subway-in-the-sky-valley-meets-plateau.html.

Niimi, Y. (2016). The “costs” of informal care: an analysis of the impact of elderly care on caregivers’ subjective well-being in japan. *Review of Economics of the Household*, 14(4):779–810.

Rodríguez, D. and Targa, F. (2004). Value of accessibility to Bogotá’s bus rapid transit system. *Transport Reviews*, 24(5):587–610.

Roldan, J. S. V. and Zapata, J. C. A. (2013). El sistema metrocable linea k y su impacto en la calidad de vida de la población de la comuna uno en la ciudad de medellin: análisis de percepción entre los años 2004-2008. *Revista Movimentos Sociais e Dinâmicas Espaciais*, 2(1):74–94.

Saliez, F., Gerez, A., and Acosta, C. (2012). The State of Latin American and Caribbean Cities 2012: Towards a new urban transition. *Naples: UNHABITAT*.

Scholl, L., Guerrero, A., Quintanilla, O., and Celse L’Hoste, M. (2013). Approach paper: Comparative case studies: Idb supported urban transport projects. Technical report, Inter-American Development Bank.

Stewart, H. (2017). Mi Teleférico: What to Know About Bolivia’s Subway in the Sky. Technical report. Published in Culture Trip. Available at: https://theculturetrip.com/south-america/bolivia/articles/mi-teleferico-what-to-know-about-bolivias-subway-in-the-sky.

Suarez Aleman, A. and Serebrisky, T. (2017). ¿Los teleféricos como alternativa de transporte urbano? Ahorros de tiempo en el sistema de teleférico urbano más grande del mundo: La Paz-El Alto (Bolivia).

Tan, Z. (2010). Marginal and nested structural models using instrumental variables. *Journal of the American Statistical Association*, 105(489):157–169.

The Economist (2017). Subways in the sky: Why Latin America is seeing a cable-car boom. The Americas. https://www.economist.com/the-americas/2017/10/26/why-latin-america-is-seeing-acable-car-boom. Accessed 31 July, 2018.

The Guardian (2016). Subway's in the sky: has La Paz's cable car made a real difference in the city? Resilient Cities. Technical report. Available at: https://www.theguardian.com/cities/2016/feb/10/la-paz-cable-difference-city-subway-sky.

Tyndall, J. (2017). Waiting for the R train: Public transportation and employment. *Urban studies*, 54(2):520–537.

Vuchic, V. R. (2002). Bus semirapid transit mode development and evaluation. *Journal of Public Transportation*, 5(2):71.

Wooldridge, J. (2002). *Econometric Analysis of Cross Section and Panel Data*. Econometric Analysis of Cross Section and Panel Data. MIT Press.

Yañez Pagans, P., Martinez, D., Mitnik, O. A., Scholl, L., and Vazquez, A. (2018). Urban Transport Systems in Latin America and the Caribbean: Challenges and Lessons Learned. Technical Note NºIDB-TN-01518. Inter-American Development Bank.

Figures

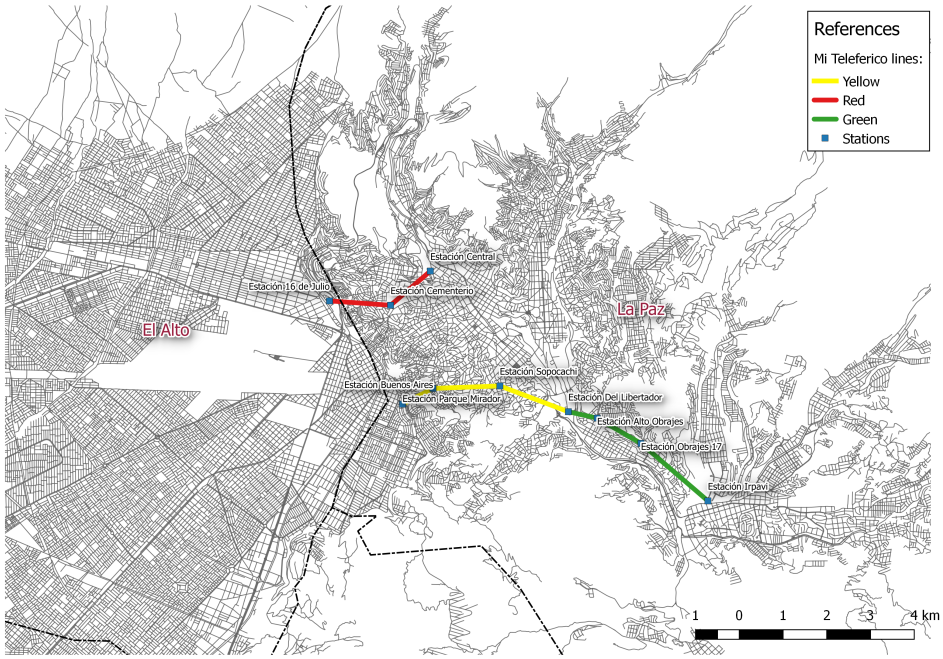

Figure 1: Map of Mi Teleferico lines (2014-2016)

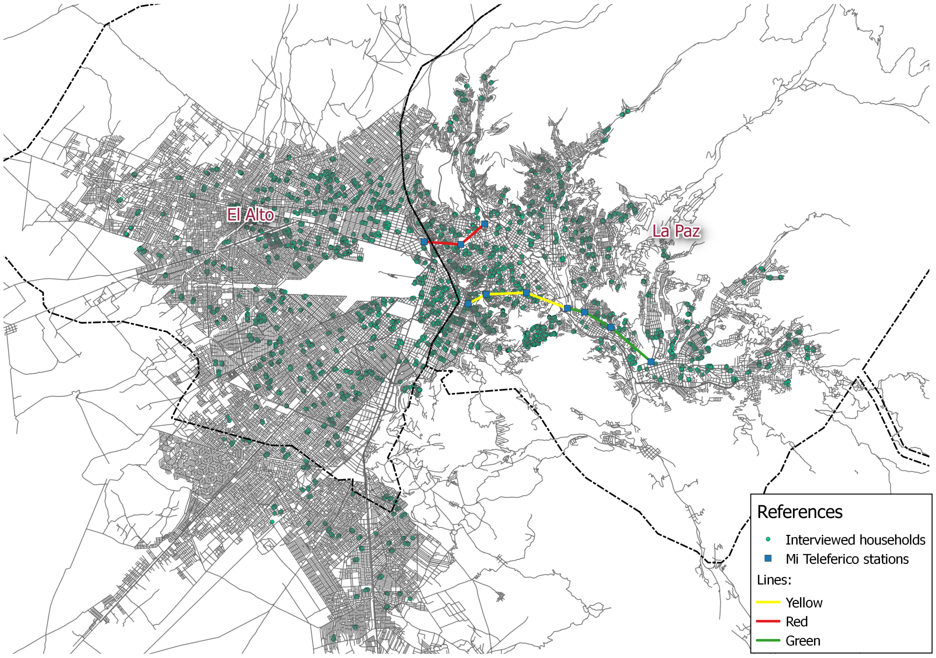

Figure 2: Spatial distribution of the sample

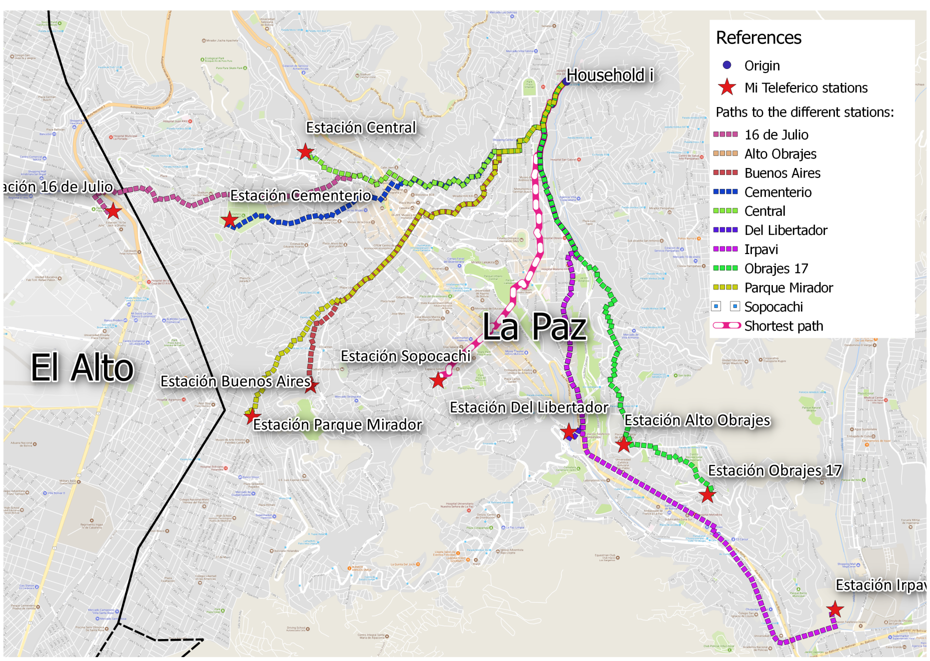

Figure 3: Construction of the instrument

Tables

Table 1: Summary statistics

	Whole sample		La Paz (1)		El Alto (2)		Mean differenece p-value
	Mean	SD	Mean	SD	Mean	SD	(1)-(2)
Exogenous variables:							
La Paz	0.43	0.50	1.00	0.00	0.00	0.00	.
Male	0.77	0.42	0.74	0.44	0.79	0.40	0.00
Age	47.71	14.80	50.60	14.99	45.49	14.27	0.00
Single	0.10	0.30	0.12	0.32	0.09	0.29	0.01
Married/cohabiting	0.73	0.44	0.70	0.46	0.76	0.43	0.00
Separated/divorced	0.08	0.26	0.09	0.28	0.07	0.25	0.01
Widow	0.09	0.29	0.09	0.29	0.09	0.28	0.53
Indigenous	0.57	0.49	0.29	0.45	0.79	0.41	0.00
Less than secondary	0.23	0.42	0.13	0.33	0.30	0.46	0.00
Comp. secondary and technical	0.41	0.49	0.42	0.49	0.40	0.49	0.24
Incomp. and comp. university	0.22	0.41	0.32	0.46	0.14	0.35	0.00
Master and PhD.	0.02	0.16	0.05	0.21	0.01	0.10	0.00
Disable	0.03	0.18	0.03	0.18	0.03	0.17	0.46
Asset index	-0.00	1.87	0.78	2.16	-0.60	1.32	0.00
Own automobile	0.21	0.41	0.28	0.45	0.16	0.37	0.00
Owner of the property	0.66	0.47	0.69	0.46	0.63	0.48	0.00
N^o of household members	4.00	1.75	3.88	1.70	4.09	1.78	0.00
St. dev. of elevation	0.04	0.03	0.05	0.04	0.03	0.01	0.00
N^o lines pub. trans.	10.73	14.09	16.12	17.78	6.58	8.27	0.00
Remittances/transfers	0.19	0.39	0.22	0.42	0.16	0.36	0.00
Expenses on transportation during last month (per capita):							
Public	88.63	83.35	99.47	88.89	80.29	77.82	0.00
Private	25.47	97.25	33.34	101.81	19.41	93.17	0.00
For education	8.66	34.31	9.21	36.30	8.24	32.71	0.40
Total	122.76	135.18	142.02	135.92	107.94	132.75	0.00
Time dedicated to (in minutes):							
Working	250.98	252.54	233.55	252.42	264.40	251.87	0.00
Studying	83.19	158.40	98.48	173.52	71.42	144.65	0.00
Household	291.20	175.76	302.47	179.75	282.53	172.18	0.00
Transport	87.00	51.74	84.70	49.04	88.78	53.66	0.02
Lunch break and meals	105.69	40.94	104.02	39.72	106.99	41.82	0.03
Sleeping	435.02	65.44	443.45	64.32	428.52	65.58	0.00
Recreation	47.74	70.95	47.86	71.93	47.65	70.20	0.93
Other	139.17	128.52	125.47	124.13	149.71	130.85	0.00
Income:							
Salary	1110.29	2274.26	1212.33	2761.43	1031.74	1809.04	0.02
In kind	14.62	136.25	12.16	113.21	16.52	151.61	0.34
Self-employment	1834.19	4631.02	1617.31	4369.04	2001.13	4817.41	0.01
Total income	2959.10	4751.39	2841.80	4778.30	3049.39	4729.79	0.20
Per capita income	1376.44	1707.37	1410.08	1935.67	1350.54	1508.29	0.30
Work:							
Look for job?	0.01	0.09	0.01	0.10	0.01	0.07	0.07
Worked ≥ 1 hr last week	0.82	0.38	0.77	0.42	0.86	0.34	0.00
Self-employed	0.44	0.50	0.37	0.48	0.48	0.50	0.00
Endogenous variables:							
Use Mi Teleférico (month)	0.36	0.48	0.38	0.48	0.34	0.48	0.04
Instrument:							
Min. dis. to station (in *km*)	4.39	3.30	2.38	1.74	5.93	3.39	0.00
Sample size	3,566		1,551		2,015		

Table 2: Estimation of the first two stages of the preferred specification

	1^{st} stage	2^{nd} stage		Obs.
	$\gamma_{distance}$	α_{use}	$F-test$	
Total sample	-0.074***	1.000***	60.357	3,566
	(0.010)	(0.129)	0.000	
La Paz	-0.107***	0.986***	15.811	1,551
	(0.027)	(0.248)	0.000	
EL Alto	-0.055***	0.996***	19.807	2,015
	(0.013)	(0.224)	0.000	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

$\gamma_{distance}$ refers to the effect of distance to the nearest station (Z_i) on the use of MT (T_i), obtained from the binary model (Probit) on covariates X_i (equation 2). α_{use} corresponds to the effect of the predicted probability of using MT ($\hat{T}_i$, from the previous step) on T_i, according to equation (3).

Robust standard errors in parentheses.

Table 3: Household per capita expenditure in transport (Bolivianos per month)

	β_{use}				Obs.
	Public	Private	Education	Total	
OLS (total sample)	10.114***	-9.268***	1.926	2.772	3,566
	(2.974)	(2.858)	(1.403)	(4.303)	
IV-3 stages:					
Total sample	62.461***	-50.663***	15.878**	27.676	3,566
	(21.577)	(18.065)	(7.419)	(28.215)	
La Paz	-56.039	-29.075	-11.460	-96.575	1,551
	(46.576)	(37.776)	(15.958)	(63.574)	
El Alto	62.926*	-81.094**	16.204	-1.964	2,015
	(35.332)	(34.700)	(12.411)	(47.076)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).

Robust standard errors in parentheses.

Table 4: Time allocation decisions (Minutes per day - Head of household)

	β_{use}								Obs.
	Working	Studying	Household	Transportation	Lunch break	Sleeping	Recreation	Others	
OLS (total sample)	3.869	25.448***	-15.247**	12.111***	-2.752**	-2.804	0.037	-20.662***	3,566
	(8.933)	(5.817)	(6.145)	(1.855)	(1.396)	(2.285)	(2.476)	(4.325)	
IV-3 stages:									
Total sample	-34.694	120.027***	-2.363	-70.573***	-52.252***	20.827	32.466*	-13.438	3,566
	(67.640)	(39.685)	(47.430)	(18.301)	(12.822)	(17.241)	(19.476)	(33.210)	
La Paz	134.375	-37.748	98.226	-9.209	-67.860**	-27.327	-3.691	-86.766	1,551
	(137.160)	(96.283)	(106.291)	(26.268)	(27.059)	(33.551)	(36.648)	(70.731)	
El Alto	-35.213	141.406**	-30.387	-95.874**	-68.677***	20.361	32.988	35.396	2,015
	(120.132)	(69.367)	(78.073)	(37.579)	(24.885)	(30.000)	(34.703)	(62.929)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).

Robust standard errors in parentheses.

Table 5: Employment outcomes (household head)

	β_{use}			Obs.
	Looked for job	Worked ≥ 1 hour	Self-employed	
OLS (total sample)	0.003	-0.001	-0.015	3,566
	(0.003)	(0.011)	(0.017)	
IV-3 stages:				
Total sample	0.031	0.151*	0.483***	3,566
	(0.024)	(0.085)	(0.147)	
La Paz	0.053	0.031	0.204	1,555
	(0.061)	(0.187)	(0.263)	
El Alto	0.045	0.067	0.798***	2,020
	(0.044)	(0.140)	(0.296)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).

Robust standard errors in parentheses.

Table 6: Head of household income and household per capita income

	β_{use}					Obs.
	Salary	In kind	Independent	Total	Income per capita	
OLS (total sample)	-90.790	3.893	111.359	24.462	63.867	3,566
	(78.711)	(5.274)	(186.314)	(185.921)	(64.907)	
IV-3 stages:						
Total sample	-601.211	-7.770	3,052.270**	2,443.289	409.065	3,566
	(621.300)	(31.725)	(1,527.897)	(1,503.347)	(417.634)	
La Paz	-2,665.083*	-54.336	2,076.682	-642.737	-728.083	1,551
	-847.449	-12.919	6,180.968	5,320.600	667.825	
El Alto	(1,604.363)	(59.126)	(1,711.212)	(1,965.196)	(824.898)	2,015
	(1,291.857)	(52.402)	(3,803.410)	(3,703.034)	(872.023)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).

Robust standard errors in parentheses.

Table 7: Benefit-Cost ratios

Sensitivity scenarios	Model 1 Time savings / Services Provision Costs	Model 2 Time savings + Transport Expenditure Savings / Service Provision Costs
Baseline scenario Wage = Sample average Trips/day = 2 Time savings = 70 min	2.16	2.06
Scenario 1 Wage = Sample average Trips/day = 4 Time savings = 70 min	1.08	0.99
Scenario 2 Wage = Country's minimum wage Trips/day = 2 Time savings = 70 min	1.05	0.96
Scenario 3 Wage = Sample average Trips/day = 2 Time savings = 35 min	1.08	0.99
Most positive Scenario Wage = Sample average El Alto Trips/day = 2 Time savings = 94 min	2.63	2.54
Most negative Scenario Wage = Country's minimum wage Trips/day = 4 Time savings = 70 min	0.52	0.43

Appendix

A Additional Tables

Table A.1: Summary statistics by type of user

	Daily, weekly and monthly (1)		Bimonthly, quarterly, and annual (2)		Never users (3)		Mean differenece p-value		
	Mean	SD	Mean	SD	Mean	SD	(1)-(2)	(2)-(3)	(1)-(3)
Exogenous variables:									
La Paz	0.46	0.50	0.39	0.49	0.44	0.50	0.00	0.03	0.34
Male	0.79	0.41	0.78	0.41	0.75	0.43	0.86	0.10	0.04
Age	46.97	14.22	45.81	14.17	49.41	15.46	0.07	0.00	0.00
Single	0.12	0.33	0.10	0.29	0.09	0.29	0.07	0.68	0.01
Married/cohabiting	0.73	0.45	0.75	0.44	0.73	0.44	0.35	0.37	0.95
Separated/divorced	0.07	0.26	0.07	0.26	0.08	0.27	0.80	0.69	0.44
Widow	0.08	0.27	0.08	0.28	0.10	0.30	0.76	0.16	0.05
Indigenous	0.55	0.50	0.64	0.48	0.55	0.50	0.00	0.00	0.98
Less than secondary	0.19	0.39	0.25	0.43	0.25	0.43	0.00	0.90	0.00
Comp. secondary and technical	0.41	0.49	0.45	0.50	0.38	0.49	0.05	0.00	0.19
Incomp. and comp. university	0.27	0.45	0.18	0.39	0.19	0.39	0.00	0.80	0.00
Master and PhD.	0.03	0.18	0.02	0.13	0.02	0.15	0.04	0.34	0.15
Disable	0.02	0.15	0.03	0.16	0.04	0.20	0.61	0.08	0.01
Asset index	0.43	1.92	-0.22	1.70	-0.25	1.84	0.00	0.73	0.00
Own automobile	0.23	0.42	0.20	0.40	0.20	0.40	0.06	0.92	0.03
Owner of the property	0.64	0.48	0.61	0.49	0.70	0.46	0.15	0.00	0.00
N^o of household members	4.14	1.77	4.09	1.72	3.83	1.73	0.49	0.00	0.00
St. dev. of elevation	0.04	0.03	0.04	0.03	0.04	0.03	0.42	0.68	0.13
N^o lines pub. trans.	11.97	14.59	9.94	14.71	10.09	13.19	0.00	0.80	0.00
Remittances/transfers	0.15	0.36	0.19	0.39	0.22	0.41	0.02	0.06	0.00
Expenses on transportation during last month (per capita):									
Public	98.25	89.37	83.53	80.85	83.08	78.43	0.00	0.90	0.00
Private	22.93	76.73	24.45	96.21	28.25	112.61	0.69	0.42	0.15
For education	11.05	38.89	6.94	34.06	7.54	29.82	0.01	0.66	0.01
Total	132.23	129.62	114.92	129.53	118.86	142.42	0.00	0.51	0.01
Time dedicated to (in minutes):									
Working	252.16	248.64	257.85	251.95	246.15	256.28	0.61	0.29	0.53
Studying	104.00	168.56	90.00	167.67	61.28	140.27	0.06	0.00	0.00
Household	277.24	168.00	283.26	174.61	307.78	181.67	0.43	0.00	0.00
Transport	95.12	52.92	83.98	49.69	81.61	50.94	0.00	0.28	0.00
Lunch break and meals	103.51	38.02	105.94	43.99	107.47	41.57	0.18	0.41	0.01
Sleeping	434.16	63.47	438.60	59.51	433.77	70.09	0.11	0.10	0.88
Recreation	50.17	68.18	49.26	68.95	44.78	74.27	0.77	0.16	0.05
Other	123.63	118.78	131.11	126.86	157.17	135.28	0.17	0.00	0.00
Income:									
Salary	1190.23	2028.46	1044.75	1818.91	1076.96	2669.19	0.10	0.76	0.22
In kind	19.88	167.37	6.90	66.70	14.33	134.61	0.03	0.14	0.34
Self-employment	1997.72	4682.47	1955.23	5620.21	1624.59	3919.63	0.85	0.10	0.02
Total income	3207.82	4614.60	3006.88	5551.95	2715.88	4363.23	0.37	0.17	0.00
Work:									
Look for job?	0.01	0.10	0.00	0.04	0.01	0.10	0.01	0.02	0.87
Worked ≥ 1 hr last week	0.83	0.37	0.85	0.35	0.79	0.41	0.23	0.00	0.00
Self-employed	0.42	0.49	0.49	0.50	0.42	0.49	0.00	0.00	0.79
Instrument:									
Min. dist. to station (in km)	3.74	3.07	4.88	3.30	4.67	3.41	0.00	0.17	0.00
Sample size	1,286		817		1474				

B Robustness

Table B.1: Estimation of the first two stages for robustness tests

	1^{st} stage	2^{nd} stage		Obs.
	$\gamma_{distance}$	α_{use}	$F - test$	
Ownership property:				
Owner	-0.068***	1.018***	34.535	2,342
	(0.012)	(0.173)	0.000	
No owner	-0.086***	1.010***	27.919	1,224
	(0.017)	(0.191)	0.000	
Different temporal definitions of the treatment variable:				
Annual use	-0.045***	1.024***	27.115	3,566
	(0.009)	(0.196)	0.000	
Weekly use	-0.060***	1.003***	23.344	3,566
	(0.012)	(0.208)	0.000	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

$\gamma_{distance}$ refers to the effect of distance to the nearest station (Z_i) on the use of MT (T_i), obtained from the binary model (Probit) on covariates X_i (equation 2). α_{use} corresponds to the effect of the predicted probability of using MT ($\hat{T}_i$, from the previous step) on T_i, according to equation (3).

Robust standard errors in parentheses.

Table B.2: Household per capita expenditure in transport (Bolivianos per month)

	β_{use}				Obs.
	Public	Private	Education	Total	
Ownership property:					
Owner	68.669**	-58.004**	21.339*	32.005	2,342
	(28.354)	(25.059)	(11.075)	(38.361)	
No owner	50.033	-32.807	9.512	26.737	1,224
	(31.937)	(25.672)	(8.357)	(40.055)	
Different temporal definitions of the treatment variable:					
Annual use	111.397***	-63.285**	23.721**	71.833*	3,566
	(35.254)	(25.761)	(11.746)	(41.272)	
Weekly use	124.949**	-115.079***	34.640*	44.510	3,566
	(51.133)	(44.116)	(18.214)	(63.311)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

Following the three-stage procedure, $\gamma_{distance}$ refers to the estimate of the effect of distance to the nearest station on the use of MT, obtained from the binary model (Probit) regressing the use of MT (T_i) on other covariates X_i, including the instrument (equation 2).

α_{use} corresponds to the effect of the predicted probability of using MT ($\hat{T}_i$, obtained from the previos step) on T_i, according to equation (3).

β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).

Standard errors in parentheses.

Table B.3: Time allocation decisions (Minutes per day - Head of household)

	β_{use}								Obs.
	Working	Studying	Household	Transportation	Lunch break	Sleeping	Recreation	Others	
Ownership property:									
Owner	-77.394	161.957***	11.474	-80.051***	-51.320***	20.553	29.867	-15.086	2,342
	(90.333)	(59.000)	(63.013)	(26.056)	(16.375)	(23.188)	(25.823)	(43.569)	
No owner	49.568	56.123	-34.383	-53.097**	-50.418***	17.571	32.921	-18.286	1,224
	(99.760)	(47.241)	(68.122)	(23.020)	(19.163)	(25.022)	(27.919)	(49.125)	
Different temporal definitions of the treatment variable:									
Annual use	-52.292	212.156***	-46.451	-92.147***	-72.573***	33.209	54.839*	-36.741	3,566
	(99.997)	(65.376)	(70.633)	(28.831)	(21.306)	(25.869)	(28.883)	(49.003)	
Weekly use	-25.796	171.955**	27.295	-150.460***	-104.475***	42.901	59.392	-20.813	3,566
	(138.495)	(84.625)	(98.076)	(45.818)	(31.533)	(37.314)	(42.563)	(69.381)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).

Standard errors in parentheses.

Table B.4: Employment outcomes (household head)

	β_{use}			Obs.
	Looked for job	Worked ≥ 1 hour	Self-employed	
Ownership property:				
Owner	0.038	0.188	0.513***	2,342
	(0.029)	(0.116)	(0.194)	
No owner	0.016	0.140	0.371*	1,224
	(0.044)	(0.117)	(0.209)	
Different temporal definitions of the treatment variable:				
Annual use	0.039	0.221	0.753***	3,566
	(0.035)	(0.137)	(0.238)	
Weekly use	0.058	0.306*	0.984***	3,566
	(0.051)	(0.179)	(0.341)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).

Standard errors in parentheses.

Table B.5: Head of household income and household per capita income

	β_{use}					Obs.
	Salary	In kind	Independent	Total	Income per capita	
Ownership property:						
Owner	-1,259.339*	8.423	3,895.982**	2,645.066	439.257	2,341
	(711.879)	(46.565)	(1,884.751)	(1,781.740)	(542.073)	
No owner	333.622	-23.443	2,237.591	2,547.770	536.901	1,224
	(1,046.800)	(34.490)	(2,578.271)	(2,587.773)	(652.140)	
Different temporal definitions of the treatment variable:						
Annual use	-1,627.771**	-1.985	3,079.938*	1,450.182	319.445	3,566
	(766.147)	(43.325)	(1,864.421)	(1,753.519)	(547.851)	
Weekly use	-716.499	-31.505	7,497.363**	6,749.359*	1,583.363	3,566
	(1,440.283)	(76.007)	(3,668.065)	(3,621.232)	(978.347)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).

Standard errors in parentheses.

C Instrumental variables (IV) approach

C.1 First stage of the IV model

Table C.1: Estimation of the first stage for the preferred specification

	$\alpha_{distance}$	$F-test$	Obs.
Total sample	-0.025***	61.982	3,566
	(0.003)	0.000	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.
Robust standard errors in parentheses.

C.2 IV approach: estimation results of the IV for different outcomes

Table C.2: IV approach: household per capita expenditure in transport (Bolivianos per month)

	β_{use}				Obs.
	Public	Private	Education	Total	
OLS (total sample)	10.114***	-9.268***	1.926	2.772	3,566
	(2.974)	(2.858)	(1.403)	(4.303)	
IV	71.636***	-45.364***	17.264**	43.536	3,566
	(21.485)	(16.920)	(7.196)	(27.476)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

Robust standard errors in parentheses.

Table C.3: IV approach: time allocation decisions (Minutes per day - Head of household)

	β_{use}								Obs.
	Working	Studying	Household	Transportation	Lunch break	Sleeping	Recreation	Others	
OLS (total sample)	3.869	25.448***	-15.247**	12.111***	-2.752**	-2.804	0.037	-20.662***	3,566
	(8.933)	(5.817)	(6.145)	(1.855)	(1.396)	(2.285)	(2.476)	(4.325)	
IV	-27.124	127.767***	-21.104	-68.131***	-51.214***	22.345	38.351**	-20.891	3,566
	(67.848)	(39.627)	(48.436)	(18.247)	(12.833)	(17.312)	(19.306)	(33.729)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers. Robust standard errors in parentheses.

Table C.4: IV approach: employment outcomes (household head)

	β_{use}			Obs.
	Looked for job	Worked ≥ 1 hour	Self-employed	
OLS (total sample)	0.003	-0.001	-0.015	3,566
	(0.003)	(0.011)	(0.017)	
IV	0.027	0.144	0.517***	3,566
	(0.023)	(0.090)	(0.149)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

Robust standard errors in parentheses.

Table C.5: IV approach: head of household income and household per capita income

	β_{use}					Obs.
	Salary	In kind	Independent	Total	Income per capita	
OLS (total sample)	-90.790	3.893	111.359	24.462	63.867	3,566
	(78.711)	(5.274)	(186.314)	(185.921)	(64.907)	
IV	-845.594	-5.971	2,897.112**	2,045.547	448.117	3,566
	(575.547)	(29.370)	(1,408.849)	(1,370.796)	(399.295)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

Robust standard errors in parentheses.

D Inverse hyperbolic sine transformations (IHS)

Table D.1: Estimation of the first two stages of the preferred specification under the IHS approach

	1^{st} stage	2^{nd} stage		Obs.
	$\gamma_{distance}$	α_{use}	$F-test$	
IV-3 stages	-0.074***	1.000***	60.357	3,566
	(0.010)	(0.129)	0.000	
La Paz	-0.107***	0.986***	15.811	1,551
	(0.027)	(0.248)	0.000	
El Alto	-0.055***	0.996***	19.807	2,015
	(0.013)	(0.224)	0.000	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

$\gamma_{distance}$ refers to the effect of distance to the nearest station (Z_i) on the use of MT (T_i), obtained from the binary model (Probit) on covariates X_i (equation 2). α_{use} corresponds to the effect of the predicted probability of using MT ($\hat{T}_i$, from the previous step) on T_i, according to equation (3).

Robust standard errors in parentheses.

Table D.2: Inverse hyperbolic sine transformations of household per capita expenditure in transport (Bolivianos per month)

	β_{use}				Obs.
	Public	Private	Education	Total	
OLS (total sample)	0.180***	-0.017	0.202***	0.134***	3,566
	(0.042)	(0.028)	(0.059)	(0.037)	
IV-3 stages	0.792**	-0.121	1.362***	0.784**	3,566
	(0.328)	(0.204)	(0.441)	(0.309)	
La Paz	-1.404*	0.226	-0.322	-1.309*	1,551
	(0.804)	(0.444)	(0.826)	(0.693)	
El Alto	0.921*	0.006	1.371*	0.805	2,015
	(0.542)	(0.347)	(0.778)	(0.526)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).

Robust standard errors in parentheses.

Table D.3: Inverse hyperbolic sine transformations of time allocation decisions (Minutes per day - Head of household)

	β_{use}								Obs.
	Working	Studying	Household	Transportation	Lunch break	Sleeping	Recreation	Others	
OLS (total sample)	0.113	0.576***	-0.025	0.199***	-0.010	0.004	0.190**	-0.338***	3,566
	(0.120)	(0.102)	(0.036)	(0.034)	(0.015)	(0.008)	(0.093)	(0.088)	
IV-3 stages:	-0.293	2.403***	-0.092	-1.553***	-0.557***	0.085	1.399*	-0.849	3,566
	(0.907)	(0.740)	(0.268)	(0.361)	(0.131)	(0.056)	(0.729)	(0.618)	
La Paz	0.741	-1.077	-0.134	-0.699	-0.780**	-0.061	-0.178	-2.343	1,551
	(1.838)	(1.637)	(0.509)	(0.601)	(0.326)	(0.097)	(1.426)	(1.500)	
El Alto	-0.133	3.276**	-0.176	-2.242***	-0.785***	0.050	2.016	-1.227	2,015
	(1.599)	(1.338)	(0.460)	(0.779)	(0.261)	(0.084)	(1.328)	(1.116)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.

β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).

Robust standard errors in parentheses.

We don not include inverse hyperbolic sine transformations of employment outcomes, because these are dummy variables.

Table D.4: Inverse hyperbolic sine transformations of head of household income and household per capita income

	β_{use}					Obs.
	Salary	In kind	Independent	Total	Income per capita	
OLS (total sample)	0.103	0.033	-0.057	0.061	0.233***	3,566
	(0.139)	(0.039)	(0.151)	(0.115)	(0.088)	
IV-3 stages	-2.652**	0.176	4.250***	1.642**	0.842	3,566
	(1.138)	(0.278)	(1.290)	(0.827)	(0.576)	
La Paz	-3.279	-0.587	2.400	-0.643	-1.145	1,551
	(2.189)	(0.547)	(2.314)	(2.066)	(1.669)	
El Alto	-5.182**	0.336	6.993***	1.820	0.031	2,015
	(2.255)	(0.580)	(2.624)	(1.321)	(0.847)	

Covariates X_i included: La Paz, gender of household head (male), age, married or cohabiting, separated or divorced, widowed, indigenous, complete primary and incomplete secondary education, complete secondary and technical, incomplete and complete university, master's and Ph.D., physical condition (disable), asset index, own automobile, owner of the property of residence, number of household members, altitude variation, accessibility to public transportation, and reception of other kind of income such as remittances and transfers.
β_{use} coefficient corresponds to the estimation of equation (1) obtained by Ordinary least squares (OLS) and equation (4) from process 18.1 proposed by Wooldridge, 2002 (IV-3 stages).
Robust standard errors in parentheses.

E Substitutability

Table E.1: Household per capita expenditure in transport (Bolivianos per month)

	Public	Private	Education	Total
β_{use}	78.636***	-63.589***	20.516**	35.563
	(29.154)	(23.912)	(9.712)	(37.267)
Availability	0.878**	-0.891***	0.197	0.184
	(0.376)	(0.325)	(0.123)	(0.498)
$\beta_{use} \times$ Availability	-2.291**	1.831**	-0.657**	-1.117
	(1.026)	(0.815)	(0.326)	(1.289)
Point estimate:				
90 percentile	19.064***	-15.984***	3.435	6.515
	(6.164)	(4.577)	(2.220)	(7.412)
Median	64.889***	-52.603***	16.574**	28.860
	(23.158)	(19.105)	(7.808)	(29.692)

Point estimates are evaluated at the median and 90 percentile of the Availability of public transportation, which are equal to 6.00 and 26.00, respectively.

Table E.2: Time allocation decisions (Minutes per day - Head of household)

	Working	Studying	Household	Transportation	Lunch break	Sleeping	Recreation	Others
β_{use}	-52.721	154.529***	3.185	-94.604***	-68.286***	27.891	43.097*	-13.091
	(88.346)	(52.380)	(61.978)	(25.463)	(17.286)	(22.519)	(25.410)	(43.391)
Availability	-0.594	1.801***	0.679	-1.455***	-1.043***	0.098	0.546	-0.033
	(1.171)	(0.688)	(0.817)	(0.326)	(0.225)	(0.298)	(0.339)	(0.583)
$\beta_{use} \times$ Availability	2.554	-4.887***	-0.786	3.404***	2.271***	-1.001	-1.506*	-0.049
	(2.989)	(1.764)	(2.096)	(0.882)	(0.588)	(0.766)	(0.852)	(1.464)
Point estimate:								
90 percentile	13.671	27.463**	-17.247	-6.101	-9.233***	1.874	3.946	-14.372*
	(17.770)	(11.610)	(12.623)	(5.123)	(3.485)	(4.557)	(5.030)	(8.165)
Median	-37.400	125.206***	-1.530	-74.180***	-54.659***	21.887	34.062*	-13.386
	(70.745)	(42.049)	(49.644)	(20.284)	(13.826)	(18.015)	(20.384)	(34.733)

Point estimates are evaluated at the median and 90 percentile of the Availability of public transportation, which are equal to 6.00 and 26.00, respectively.

Table E.3: Employment outcomes (household head)

	Looked for job	Worked ≥ 1 hour	Self-employed
β_{use}	0.039	0.193*	0.623***
	(0.032)	(0.113)	(0.198)
Availability	0.000	0.003*	0.008***
	(0.000)	(0.001)	(0.003)
β_{use} $\times$ Availability	-0.001	-0.006	-0.020***
	(0.001)	(0.004)	(0.007)
Point estimate:			
90 percentile	0.012*	0.039*	0.109***
	(0.006)	(0.023)	(0.040)
Median	0.032	0.157*	0.504***
	(0.025)	(0.090)	(0.158)

Point estimates are evaluated at the median and 99 percentile of the Availability of public transportation, which are equal to 6.00 and 26.00, respectively.

Table E.4: Head of household income and household per capita income

	Salary	In kind	Independent	Total	Income per capita
β_{use}	-707.537	-8.679	3832.902*	3116.686	510.217
	(811.272)	(41.767)	(2036.943)	(1998.416)	(549.414)
Availability	-4.215	-0.299	50.791*	46.276*	10.679
	(10.574)	(0.577)	(26.567)	(26.102)	(7.101)
$\beta_{use} \times$ Availability	15.061	0.129	-110.576	-95.386	-14.328
	(27.149)	(1.434)	(71.523)	(70.311)	(19.243)
Point estimate:					
90 percentile	-315.949**	-5.332	957.928**	636.647*	137.684
	(159.712)	(6.354)	(380.308)	(370.961)	(129.384)
Median	-617.171	-7.907	3169.447**	2544.369	424.248
	(650.938)	(33.235)	(1615.907)	(1584.478)	(437.749)

Point estimates are evaluated at the median and 90 percentile of the Availability of public transportation, which are equal to 6.00 and 26.00, respectively.

F Car ownership

Table F.1: Household per capita expenditure in transport (Bolivianos per month)

	Public	Private	Education	Total
β_{use}	70.350***	-52.719**	17.738**	35.369
	(25.095)	(21.085)	(8.632)	(33.011)
Car	9.728	107.226***	5.140	122.095***
	(10.701)	(11.753)	(4.038)	(16.375)
$\beta_{use} \times$ car	-55.917**	14.573	-13.185	-54.529
	(25.202)	(25.029)	(9.414)	(36.927)
Point estimate:				
Car=1	14.433**	-38.146***	4.553	-19.160
	(6.347)	(12.167)	(3.883)	(14.273)

Table F.2: Time allocation decisions (Minutes per day - Head of household)

	Working	Studying	Household	Transportation	Lunch break	Sleeping	Recreation	Others
β_{use}	-38.856	134.870***	0.434	-82.109***	-60.163***	24.466	35.933	-14.575
	(78.332)	(46.217)	(54.853)	(21.671)	(15.184)	(20.032)	(22.619)	(38.471)
Car	3.166	42.301**	-4.724	-39.795***	-21.539***	12.547	9.346	-1.303
	(34.411)	(20.478)	(23.803)	(9.057)	(6.591)	(8.721)	(9.780)	(16.842)
$\beta_{use} \times$ car	29.498	-105.210**	-19.822	81.768***	56.077***	-25.793	-24.573	8.055
	(78.474)	(46.993)	(54.395)	(21.338)	(15.137)	(20.110)	(22.480)	(38.700)
Point estimate:								
Car=1	-9.358	29.660**	-19.388	-0.341	-4.086	-1.327	11.360**	-6.520
	(19.264)	(12.818)	(12.847)	(3.884)	(3.096)	(4.842)	(5.570)	(9.555)

Table F.3: Employment outcomes (household head)

	Looked for job	Worked ≥ 1 hour	Self-employed
β_{use}	0.035	0.174*	0.561***
	(0.028)	(0.099)	(0.172)
Car	0.009	0.092**	0.347***
	(0.012)	(0.043)	(0.074)
$\beta_{use} \times$ car	-0.023	-0.161	-0.547***
	(0.028)	(0.098)	(0.171)
Point estimate:			
Car=1	0.012*	0.013	0.013
	(0.007)	(0.023)	(0.035)

Table F.4: Head of household income and household per capita income

	Salary	In kind	Independent	Total	Income per capita
β_{use}	-646.216	-7.698	3655.638**	3001.725*	512.008
	(722.260)	(36.485)	(1788.431)	(1753.714)	(485.305)
Car	-169.421	-3.661	2821.810***	2648.727***	645.782***
	(361.137)	(14.539)	(952.578)	(948.226)	(248.021)
$\beta_{use} \times$ car	318.994	-0.509	-4.3e+03**	-4.0e+03**	-729.665
	(761.546)	(36.365)	(1975.753)	(1948.171)	(522.831)
Point estimate:					
Car=1	-327.221	-8.207	-621.040	-956.469*	-217.657
	(259.552)	(12.871)	(518.324)	(542.212)	(170.122)

G Cost-benefit analysis

To calculate benefit-cost ratios (CBRs), we construct two different models that vary across the definition of benefits. Following the transport literature, the main benefit considered is households' average time savings, which is extracted from the estimated impacts. In order to monetize the value of time savings we use different levels of the usage of Mi Teleferico.

In the first model, time savings are the main benefits considered. In the second model, we add transport expenditure savings. Along the analysis, we consider the following assumptions:

- Number of working days per month: 20.
- Number of minutes per working day: $8hs \times 60 = 480$
- Minimum daily wage: $60. Source: Estado Plurinacional de Bolivia (2016).
- Minimum daily wage per minute: $\$60/480 = \$0.125$.
- Average monthly salary obtained from the survey: $2,897.
  - Salary per minute: $\$2,897/20/480 = \$0.30$.
- Monthly average net income for independent worker: $2,042.
  - Net income for independet worker per minute: $\$2,042/20/480 = \$0.21$.
- Average income: $(\$0.30 + \$0.21)/2 = \$0.26$.
- Users of Mi Teleférico per day: 66,491; users by year: 24,269,215.

In both models, costs correspond to those of providing the service and were extracted from an operational report (Mi Teleférico, 2016). These costs already include the debt service; therefore, no project investment costs are included.

- Total costs per trip: $4.18.
  - Service Provision in 2016: $101,365,610.
  - Provision costs per trip: $\$101,365,610/24,269,215 = \$4.18$.

In what follows, we construct multiple sensitivity scenarios that vary some of the assumptions taken to construct the baseline scenario.

G.1 Baseline

The baseline scenario values time savings obtanied from the average labor income reported by the household heads in the survey, giving two trips per day. This includes data from bot,h wages or self-employed income. In addition, we use the average effect estimated for time savings in transportation, which is equivalent to 70 minutes per day (a lower bound estimate if we ignore time saved on the lunch break). Taking all this information into account, the CBRs presented in Table 7 indicate that benefits are almost 2.16 times the project costs.

1. CBR of model 1: $\$9.00/\$4.18 = 2.16$.
   - Total benefits per trip: $9.00
     - Savings of travel times obtained from the main regression: 70 min.
     - Number of travels per day: 2.
     - Value of saving travel time per day and per trip: $(\$0.26 \times 70)/2 = \$9.00$.
2. CBR of model 2: $\$8.62/\$4.18 = 2.06$.
   - Total benefits per trip: $\$9.00 - \$0.37 = \$8.62$.
     - Reduction of monthly private transportation expenses: $55.45
     - Increase in monthly public transport expenses: $70.37
     - Net savings of transportation expenses: -$14.92.
     - Net savings of transport costs per trip per day: -$0.37

G.2 Scenario 1

Changing the number of trips to four, while keeping the rest constant, puts the CBRs between 1.08 and .99.

1. Model 1: this scenario considers that the person might have four trips per day. Therefore, the total benefits are equal to $(\$0.26 \times 70)/4 = \$4.50$. Considerar-ing the same costs as in subsection G.1, we obtain a CBR of $\$4.50/\$4.18 = 1.08$.
2. Model 2: this model deducts to the original benefits of four trips per day ($4.50) the net savings of transport costs per trip per day ($0.37). Therefore, the total benefits per trip are equal to $4.19; giving us a CBR of 0.99.

G.3 Scenario 2

A second scenario considers the country's minimum wage for 2016, which is lower than the average labor income of the sample. In this case, ratios are around 1 on average.

1. CBR of model 1: $\$4.38/\$4.18 = 1.05$.
    - Total benefits per trip (computed as the value of saving travel time per day and per trip): $(\$0.125 \times 70)/2 = \$4.38$.
2. CBR of model 2: $\$4.00/\$4.00 = 0.96$.
    - Total benefits per trip (computed as the value of saving travel time per day and per trip minus the net savings of transport costs per trip per day): $\$4.38 - \$0.37 = \$4.18$.

G.4 Scenario 3

A third sensitivity analysis assumes travel time savings are 50% lower than the estimated values (35 minutes) and report CBRs between 1.08 and 0.99. In general, results are lower than the baseline scenario but do not vary widely across the scenarios.

1. CBR of model 1: $\$4.50/\$4.18 = 1.08$.
    - Total benefits per trip: $(\$0.257 \times 35)/2 = \$4.50$.
2. CBR of model 2: $\$4.12/\$4.18 = 0.99$.
    - Total benefits per trip: $\$4.50 - \$0.37 = \$4.12$.

G.5 Most positive scenario

The most positive scenario calculates CBRs considering the travel time savings estimated for the populations with the largest gains in accessibility, El Alto. We also adjust the values of labor income for this population, considering that average incomes reported for El Alto households are lower than in La Paz. Basic information included in the current analysis

- Average monthly salary in El Alto, obtained from the survey: $2,477.

  - Daily salary: \$0.26.

- Independent monthly average net income in El Alto: \$1,922.

  - Daily net income: \$0.20.

- Average income: \$0.23.

- Savings of travel times for the El Alto: 96 min.

The results show that benefits in this case are more than 2.50 times the size of project costs:

1. CBR of model 1: $\$11.00/\$4.18 = 2.63$.

   - Total benefits per trip: $(\$0.23 \times 96)/2 = \$11.00$.

2. CBR of model 2: $10.62/\$4.18 = 2.54$.

   - Total benefits per trip: $\$11.00 - \$0.37 = 10.62$.

G.6 Worst-case scenario

For the worst-case scenario, we assume four trips per day plus the minimum wage and obtain results below 1. We argue that this is a highly unusual scenario given that 97% of survey respondents indicate they made two or less trips in the day prior to the interview.

1. CBR of model 1: $\$2.19/\$4.18 = 0.52$.

   - Total benefits per trip: $(\$0.125 \times 70)/4 = \$2.19$.

2. CBR of model 2: $\$1.81/\$4.18 = 0.43$.

   - Total benefits per trip: $\$2.19 - \$0.37 = 1.81$.

Overall, results suggest that the economic benefits of MT outweigh the costs. Of course, the major caveat of this analysis is that the estimated benefits are LATEs affecting a specific segment of the population. All the results are included in table 7.