# Citizen security and urban commuting in Latin America[1]

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**Abstract**

Sustainable modes of transport, including both public transit and active transport, have been promoted as strategies to reduce greenhouse gas emissions. However, one factor that may influence their use is related to security concerns, although prior evidence on this topic is scarce and inconclusive. We explore whether perceived security in 10 large cities in Latin America is related to mode choice for commuting. We rely on the 2017 CAF Survey implemented by the Development Bank of Latin America, where individuals report their levels of satisfaction with neighborhood security. Our results suggest that individuals who feel more satisfied with their neighborhood security engage in more commuting by public transit, although this result holds only for male commuters. Our results suggest that strategies aimed at increasing security can alleviate concerns about neighborhood crime, increasing the use of public transit in Latin America.

Keywords: commuting; public transport; active transport; perceived security; Latin America

JEL Classification: R40 - J22 - O57

## 1. Introduction

[1] This paper has benefitted from funding from the Spanish Ministry of Science and Innovation (Project PID2019-108348RA-I00), and from the Government of Aragón (Grant S32_20R).

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In recent years, sustainable modes of transport have been promoted as a strategy to reduce greenhouse gas emissions from cars. The less-polluting modes of transport include the use of public transit and active transport, as well as car/bike sharing, carpooling, and electric scooters (Echeverria, Gimenez-Nadal and Molina, 2022). Despite its importance, the adoption of green, sustainable modes of transport has not been homogenous across regions. In fact, and contrary to the European trend, where there has been a steady decrease in the use of private transportation, the motorization rate in Latin America and the Caribbean has risen and the share of public transit continues to decline (Rivas et al., 2019). Among the reasons for this decrease is that users are dissatisfied with the quality of public transit in terms of duration, comfort, fares, and cleanliness, and the lack of an integrated system of public buses (Romero Lankao, 2007), along with limited modal integration of cycling. In turn, existing bicycle paths in the largest cities are limited to specific urban areas and do not connect the different socio-economic groups across the cities (Gomez et al., 2015).

A potential deterrent to the use of sustainable modes of transport in Latin America may be related to security. Security is a great concern in Latin America, and almost 30% of the population considers that lack of security is the main problem affecting their well-being, and is even more important than unemployment, inflation, or the provision of health and education (Latinobarometro, 2011). Furthermore, 60% of the population of the main cities of Latin America consider that the level of insecurity has increased in recent years (Sanguinetti et al., 2014). Thus, crime and the perception of its incidence may certainly influence individual behavior and decisions regarding transport in daily lives. But although the literature has explored the link between the choice of green modes of travel and crime rates, the evidence remains inconclusive (Ferrell and Mathur, 2012; Singleton and Wang, 2014; Halat et al., 2015; Hino et al., 2021).

A less-explored field of research is that of the relationship between the choice of mode of transport and subjective measures of security, which involve individual perceptions or feelings of insecurity and fear. Intuitively, individuals who feel that their neighborhood is safe may tend to walk or bike more, or use public transit more, because of lower perceived risk. However, only a few works have drawn attention to this link, and findings are mixed (Ingalls et al., 1994; Foster et al., 2014; Kerr et al., 2015; Lizárraga et al., 2022). The relationship between transport mode choice and perceived security is especially important for commuting, a complex phenomenon (Guell et al., 2012) associated with lower subjective well-being (Dickerson et al. 2014; Roberts et al. 2011), and greater stress (Frey and Stutzer 2008; Gottholmseder et al. 2009; Novaco and Gonzalez 2009; Wener et al. 2003). In the case of Latin America, longer commutes are associated with a higher probability of experiencing depression (Wang et al., 2019), and an increase in the probability of being a victim of violence (Silveira Neto and Moura, 2019). Thus, the relationship of commuting to perceived security deserves further attention.

Our main purpose is to explore the relationship between green commuting and perceived security in Latin American cities, captured by the self-reported level of satisfaction with neighborhood security. Our study relies on the 2017 CAF Survey (CAF, 2017) implemented by the Development Bank of Latin America, which focuses on employment and accessibility. Our sample consists of working individuals in 10 Latin American cities: Buenos Aires (Argentina), La Paz (Bolivia), Sao Paulo (Brazil), Bogota (Colombia), Quito (Ecuador), Lima (Peru), Montevideo (Uruguay), Panama City (Panama), Mexico City (Mexico), and Santiago (Chile). Green commuting is understood as trips from home to work made by sustainable modes of transport, that is, public (metro, train, bus) or active (walking and cycling).[2] In particular, we focus on three dimensions of green commuting: the probability of using a green mode of transport to commute; the weekly frequency of the commute using a green mode of transport; and the duration of the work trip when using a green mode of transport. With respect to security, the survey asks individuals to rank their level of satisfaction with their neighborhood security. We estimate Ordinary Least Squares (OLS) models at the individual-level for the pool sample of cities for both public and active transport.

Our contribution to the literature if threefold. First, we add to the scant evidence on perceived security and mode choice of travel. While all prior studies have analyzed this relationship for cities of developed countries, we focus on 10 cities of developing countries, where security concerns are of particular importance (Sanguinetti et al., 2014). Second, by relying on cross-country data we provide evidence for a variety of cities, while all prior works have provided evidence for only one city. The lack of homogenous and systematic information on several cities may be one factor behind the inconsistent

[2] The concept of "green commuting" is taken from Gimenez-Nadal and Molina (2019), Molina, Gimenez-Nadal and Velilla (2020) and Echeverria, Gimenez-Nadal and Molina (2022) and refers to more sustainable modes of transport in comparison to car driving. This term is broader than "non-motorized" transportation (or active travel) because it includes public transit as well.

findings in the literature (Foster and Giles-Corti, 2008). Third, to our knowledge, no prior work has documented the relationship between perceived security and mode choice in commuting. Only Ferrell and Mathur (2012) distinguish between work and non-work trips, but focus on crime rates rather than on subjective measures of security. Commuting in Latin America deserves further attention; individuals in these countries travel shorter distances but their commuting time is longer than in developed countries (Rivas et al., 2019).

The remainder of the paper is as follows. Section 2 presents a review of the literature. Section 3 presents the data and variables, Section 4 describes the empirical strategy, and Section 5 describes the results. Section 6 sets out our main conclusions.

## 2. Related Literature

The dependence on fossil fuel consumption in transportation accounts for one quarter of all energy-related greenhouse gas (GHG) emissions (UNEP, 2019), and has substantial negative impacts on health and the environment (WHO, 2006). To reverse this trend, sustainable modes of transport – in comparison to car driving – have been boosted in recent years. These less-polluting or "green" modes of transport include a variety of eco-friendly alternatives, such as the use of public transit, car-sharing, carpooling, and electric scooters, as well as active transport, the latter being the most environmentally friendly solution for personal mobility, since it involves 'zero carbon' (Stanley and Watkiss, 2003; Chapman, 2007).

However, and despite its importance, the adoption of sustainable modes of transport has not been homogenous across regions. Contrary to the European trend, where there is a steady decrease in the use of private transportation, motorization rates in Latin American and the Caribbean (LAC) continue to rise. In this sense, LAC are among the regions with the highest share of $CO_2$ emissions per capita from transportation; transportation share of global energy-related $CO_2$ emissions in LAC countries was 37%, the highest among all regions in 2016. In turn, the share of public transit continues to decrease (Rivas et al., 2019).

Latin American countries show a much lower prevalence of active transport than many European regions, where the share of trips made by active transport can reach up to 40% in some cities (Pucher et al., 2010). A recent study analyzes the use of public, private, and active modes of transport in urban areas of eight Latin American countries (Argentina, Brazil, Chile, Colombia, Costa Rica, Ecuador, Peru, and Venezuela) and finds that trips by private transport are 48.2% of total travel time, while public transit represents 34.9% and active transport is only 16.9% (ELANS Study Group and Core Group members, 2020). Additionally, Delclòs-Alió et al. (2022) find that in Mexico City, Bogota, Santiago de Chile, Sao Paulo, and Buenos Aires, walking-only trips account for approximately 30% of trips, meaning that between 19% and 25% of residents in these cities meet the WHO physical activity guidelines solely from walking for transportation. Even more, Sá et al (2017) in a systematic review find the prevalence of walking as a mode of transport differs considerably across cities in Latin America and the Caribbean, ranging from 8.9% in Corrientes (Argentina) to 27.1% in Bogota (Colombia), while the prevalence of cycling ranges from 1.3% in Corrientes to 16.0% in Recife (Brazil).

The low prevalence of active transport could be partially related to supply-side factors conditioning sustainable commuting. In Latin America, bus transit systems have been highly prioritized compared to bike sharing programs and cycle paths. However, the provision of public transport faces some challenges, including low capacity, and the difficulty of attracting private enterprises and generating an integrated system of public buses (Romero Lankao, 2007). In addition, the limited modal integration with cycling prevents the more frequent use of bikes to commute (Gomez et al., 2015). In turn, existing cycling paths in the largest cities are limited to specific urban areas and do not connect the various socioeconomic groups across the cities (Gomez et al., 2015). However, during recent years many countries have begun to implement infrastructure initiatives to incorporate more use of bicycles to commute (Cervero et al., 2003; Baumann et al., 2013), leading to an increase in the prevalence of this mode of transportation (World Bank, 2015).

Prior works focusing specifically on commuting patterns in Latin America address a variety of topics. There is evidence suggesting that accessibility to opportunities to travel to work for cyclists is not the same across different socio-economic groups, indicating the presence of social and spatial inequalities related to the urban structure in Bogota (Rosas-Satizábal et al., 2020). In turn, commuters by bicycle are comparatively more exposed to behavioral-based safety risks in comparison to non-commuter cyclists, and suffer more frequent crashes, in Argentina, Colombia, and Mexico (Useche et al., 2021). Further, the literature documents gender differentials in commuting time in the São Paulo metropolitan region, suggesting that marital status exerts a strong influence on the commuting time of working women (Silveira Neto et al., 2015). In turn, greater exposure to public spaces with weak guardianship is related to a higher probability of being a victim of urban violence in Brazilian metropolitan regions (Silveira Neto and Moura, 2019). Regarding the relationship between the built environment and commuting, Gainza and Livert (2013) find for the city of Santiago de Chile that the use of public transit reduces the environmental impact of commuting, but the modal choice depends not only on the effectiveness of the transit system but also on the characteristics of the urban form and other socioeconomic determinants.

One deterrent to the use of sustainable modes of transport is related to security.[3] A strand of the literature has studied the link between the choice of modes of travel and security, measured objectively by crime rates or incidence of violence. However, the evidence is inconclusive as some studies report no relationship between crime and mode choice, while others find significant associations. Singleton and Wang (2014) draw some possible explanations behind these mixed results, which could be related to the low variation in crime across study areas, that may yield non-significant effects on travel behavior, or that security may be a factor conditioning only some travel, such as discretionary trips with strong possibilities for substitution, or the travel choices of certain groups of people. At the same time, security concerns may be secondary in relation to other factors affecting travel decisions, such as travel time, schedule feasibility, or comfort. The use of objective measures of crime may be less effective than similar subjective measures, given that security concerns could be better captured by individual perceptions varying from person to person. In addition, the lack of homogenous and systematic information for several cities may be one factor behind the inconsistent findings in the literature (Foster and Giles-Corti, 2008).

Some of the evidence linking crime and mode of choice suggests that the link between the crime index and choice of travel mode is not significant. This is the case, for example, of Halat et al. (2015) who explored this link for the city of Chicago (US). In contrast, Ferrell and Mathur (2012) show that crime rates have an influence on the propensity to choose non-automotive modes of transportation for home-based trips. Specifically, they

[3] Singleton and Wang (2014) differentiate safety from security because these concerns are often inadequately distinguished. While the former refers to individuals being protected from traffic, the latter refers to individuals being protected from crime and urban violence.

find that high-crime neighborhoods are positively associated with transit mode choice and negatively associated with travel by walking. In this line, Singleton and Wang (2014) show that higher levels of crime are negatively associated with walking during discretionary trips in Portland (US). More recently, Hino et al. (2021) provide evidence that walking to school among children is positively associated with crime security in Chiba (Japan).

A less explored field of research considers how the choice of mode of transport relates to subjective measures of security, reflecting individual perceptions or feelings of insecurity or fear. This dimension is important, as perceptions of neighborhood insecurity may influence individual decisions regarding transport. Intuitively, individuals who feel that their neighborhood is safe may tend to walk or use a bicycle more because of lower perceived risk. In this line, Owen et al. (2004), in a meta review, indicate that perceived security is among the most important environmental qualities for walking. Furthermore, it has been shown that self-reported neighborhood characteristics, including safety from crime, are a reliable measure of capturing the neighborhood environment (Echeverria et al., 2004).

Despite its relevance to individual travel behaviors, only a few works have paid attention to this link, and findings are mixed.[4] Kerr et al. (2015) study the relationship between self-reported feelings of safety and walking, in Chicago (US), but find no significant association. In contrast, Lizárraga et al. (2022) report that perceived security has a positive effect on the choice of walking as the preferred travel mode for university students in Granada (Spain). Foster et al. (2014) indicate that feelings of fear of crime significantly discourage individuals from choosing walking as a mode of transport in Perth (Australia). The work of Ingalls et al. (1994) centers on bus transit use, and reports that fear for personal safety in residents of Greensboro (US) is a major deterrent of ridership, despite that the bus service itself is perceived as safe. In addition, studies have documented that perception and fear of crime is likely to vary across sociodemographic groups (Hale, 1996). For instance, women, elderly people, and ethnic minorities tend to

[4] A different but related strand of the literature has analyzed the relationship between crime and perceptions of crime, and walking as physical activity (Satariano et al., 2010; Joh et al., 2012; Hong and Chen, 2014), but the evidence is also inconclusive (Foster and Giles-Corti, 2008).

feel more vulnerable and may express greater concern for personal safety (Covington and Taylor, 1991).

Studies analyzing how security, objectively or subjectively measured, is associated with different modes of transport have looked at travel in general, with a few exceptions. For instance, Singleton and Wang (2014) focus on discretionary trips, Kim et al. (2007) on trips between home and light rail stations, and Hino et al. (2021) on trips to school. Ferrell and Mathur (2012) distinguish between work and non-work trips and find differences across types of travel. Specifically, in neighborhoods with high crime rates the odds of choosing walking over driving decrease far less in the case of work trips than in the case of non-work trips (17% over 61%). This may be indicative of a more inelastic response of commuters to crime in their mode choice of travel. However, no prior work has documented the relationship between perceived security and mode choice in commuting.

Regarding the role of socio-demographic characteristics in individual travel behavior, prior evidence has shown that socio-economic characteristics and household-level variables are key factors (Plaut, 2005; Sener et al., 2009; Adams, 2010; McQuaid and Chen, 2012; Buehler and Pucher, 2012; Aldred et al., 2016; Gimenez-Nadal and Molina, 2016; Gimenez-Nadal et al., 2020, Goel et al., 2022). In addition, prior studies show that daily commuting is significantly related to market work hours (Schwanen and Dijst, 2002; Gutierrez-i-Puigarnau and van Ommeren, 2010; Gimenez-Nadal and Molina, 2014). Thus, we consider respondent's age, gender, level of education (primary, secondary, and higher education) and daily hours of paid work. We include variables to account for family composition (presence of a partner, household size, and number of children under age 18), as well as for the level of household income (expressed in USD) and the ownership of a motorized vehicle (either car or motorcycle) and of a bicycle.

## 3. Data and Variables

We use data from a survey implemented by the Development Bank of Latin America (CAF). The Bank coordinates an annual survey of a group of Latin American cities, since 2008. The survey is organized by thematic modules, some of which remain invariant across editions. These include information on socioeconomic information from the respondents, as well as a set of characteristics at the household level. It also gathers data on access, quality, and spending on services such as garbage collection, water, sanitation, and electricity, along with indicators of housing type and quality. The CAF survey is designed to ensure the representativeness of the population. These data-sets have been used to provide evidence on different topics for Latin America, for example, on commuting patterns and depression (Wang et al., 2019), reciprocity, and willingness to pay taxes (Ortega et al., 2016), or informal employment and depression (Huynh et al., 2022), among others.

We use the CAF Survey 2017 wave (CAF, 2017) because it centers on employment and accessibility[5] and gathers information on the main activity engaged in by the individual during the week (defined as the activity that takes the most of his/her time), and on the characteristics of the travel to the main activity, including mode of transport, weekly frequency, and duration of the trip.[6] The 2017 edition covers 10,687 individuals between 20 and 60 years of age in 11 large cities of Latin America: Buenos Aires (Argentina), La Paz (Bolivia), Sao Paulo (Brazil), Bogota (Colombia), Quito (Ecuador), Lima (Peru), Montevideo (Uruguay), Panama City (Panama), Mexico City (Mexico), Santiago (Chile), and Caracas (Venezuela).

Because we are interested in analyzing commuting patterns, we focus on those individuals who report working as their main activity. Our sample amounts to 4,138 working individuals residing in Buenos Aires, La Paz, Sao Paulo, Bogota, Quito, Lima, Montevideo, Panama City, Mexico City and Santiago[7] (see Table A.1 for the distribution of the sample across cities).

Our analysis focuses on green commuting, that is, work trips made by public transit (metro, train, and bus) and active (walking and cycling) modes of transport. In particular, we focus on three dimensions of green commuting that are our dependent variables in the empirical exercise. First, a variable that indicates if the person uses, or not, public and active modes of transport. In this case, the survey question is *"Which mode (or combination of modes) of transport do you usually use to travel from home to work?"*.

[5] The data-set is available at: https://scioteca.caf.com/handle/123456789/1400

[6] The use of time-use information to analyze transportation behavior has steadily increased in recent years (Gimenez-Nadal and Molina, 2014; 2016; Jara-Díaz and Rosales-Salas, 2015; Gimenez-Nadal et al., 2018a, 2018b, 2022; Echeverria et al., 2022).

[7] We do not include Caracas (Venezuela) in our sample because the survey data does not report information on Venezuela's exchange rate, making it impossible to express monetary values in USD dollars.

Second, a variable that captures the weekly frequency of the commute by public and active transport. In this case, the survey question is *"How many days a week do you normally make this trip?"*. Third, a variable that indicates the duration (in minutes) of the work trip by public and active transport. In this case, the survey question is "*How long does it take you on average (in minutes) to make this trip?".*

Given that our main purpose is to explore the relationship between green commuting and satisfaction with neighborhood security, we focus on the question provided in the CAF survey that asks individuals to rank their level of satisfaction with the security of their own neighborhood, ranging from 1 ("not at all satisfied") to 10 ("completely satisfied"). In addition, the survey also asks about the level of satisfaction with proximity to public modes of transit, and with life in general, information that is used to control for inter-personal differences in scales (Ferrer-i-Carbonell and Frijters, 2004).

Table 1 reports descriptive statistics of the variables used in our analysis. Panel (A) indicates that 48% of individuals use public transit to commute, while 32% report using an active mode of transport. Individuals commute by public transit an average of 2.5 days a week, and an average of 1.7 days a week by an active mode. The average duration of the daily trip is longer when individuals use public transit (23.1 minutes vs. 7.8 minutes walking or cycling). Panel (B) shows the self-reported levels of satisfaction. On a scale from 1 to 10, individuals report an average satisfaction level with neighborhood security of 5.9, while the satisfaction level with proximity to public transit and overall life-satisfaction is slightly higher (7.4 and 7.8, respectively).

## 4. Empirical Strategy

We explore the relationship between choice of mode of transport for commuting and self-reported satisfaction with neighborhood security in Latin American cities, conditional on socio-demographic and family characteristics. We estimate Ordinary Least Squares (OLS) models at the individual level for the pool sample of cities. Each of these regressions are estimated for both public and active transport. In particular, we consider three alternative dependent variables ($C_i$): i) a variable that indicates if the person uses, or not, public (or active) transport to commute; ii) a variable that indicates how many days per week the person commutes by public (or active) transport; iii) a variable that indicates the amount of time (in minutes) devoted to commuting by public (or active) transport.[8] We estimate the following model[9]:

$$C_i = \alpha + \beta X_i + \eta F_i + \theta SS_i + \eta SP_i + \varphi SL_i + \gamma FE_c + \varepsilon_i \quad (1)$$

where $i$ denotes the individual and $c$ the city. $SS_i$ indicates the level of individual self-reported satisfaction with neighborhood safety. $\theta$ is our main parameter of interest. Further, $SP_i$ indicates the individual level of self-reported satisfaction with the proximity between his/her house and modes of transport. $SL_i$ indicates the individual level of self-reported satisfaction with his/her overall life. These variables range from 1 ("not at all satisfied") to 10 ("completely satisfied").[10]

We include city indicator variables in the vector $FE_c$ (with Buenos Aires city as the reference category) to assess differences in the green commuting behavior of individuals across cities, after controlling for socio-demographic and family characteristics and for levels of satisfaction reported. $\varepsilon_i$ are individual unmeasured factors. Standard errors are robust, and the error term is clustered at the city level. Observations are weighted using individual survey weights.[11]

$X_i$ is a vector of individual socio-demographic variables, including age (and its square), a variable indicating the gender of the individual, a vector including education

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[8] We express the time variables in logarithms to interpret the estimated coefficients as elasticities. We add 1 to time-dependent variables to avoid problems computing logarithms for individuals who do not commute by public or active transport.

[9] It may be possible that those individuals commuting by active or public modes increase other's perceived security levels, and thus the estimated relationship suffers from problems of reverse causality. However, it is true that prior evidence addressing the relationship between crime and sustainable transport have focused on modelling crime as the independent variable. This is in line with a meta review (Owen et al., 2004) indicating that perceived security is among the most important environmental qualities for walking. However, this line of research has reported results that can only be interpreted as correlations and not causal effects, and thus we acknowledge this limitation for our current analysis.

[10] As a robustness test, we have excluded "life satisfaction" as a covariate, given that it could be a "bad control" in the spirit of Angrist and Pischke (2009) or a "collider" in the spirit of Cinelli, Forney, and Pearl (2022). However, our results are robust in sign and magnitude, with the exception of the regressions that model if the person uses, or not, active transport to commute – when it becomes significant. Given that prior evidence has linked active travel and life satisfaction (e.g. Morris, 2015), we have decided to include this covariate in our main estimations in order to avoid an omitted variable bias. Results are available upon request.

[11] We also estimate our set of regressions accounting for survey design (i.e. sampling weights, clustered sampling, and stratification). Results are reported in Table A.2 of the Appendix. The magnitude of estimated coefficients is the same, while some changes in statistical significance are observed mainly in city indicators. Given the robustness of the results, we present as our main results the estimations using only sampling weights, to account for robust and clustered-by-city standard errors.

level (composed of three indicator variables: if the individual has primary education –reference category-; if the individual has primary education and/or secondary, and if the individual has higher education), and the number of work hours in the week. $F_i$ is a vector of family variables, including the presence of a partner (either married or cohabitating), household size, number of children, monthly total household income, and two indicator variables that take value 1 if the individual lives in a household in which there is at least one motorized vehicle (either car or motorcycle) and if there is at least one bicycle. Socio-demographic and household characteristics of the respondents are included to control for the observed heterogeneity of individuals.

Panel (C) shows individual socio-characteristics. In our sample, individuals are, on average, 38.4 years old, and 61% of them are men. Regarding education, 12% have primary education (completed or not), 48% secondary education (completed or not), and 40% have higher education (completed or not). Individuals work, on average, 8.5 hours a day. Panel (D) reports household-level characteristics: 52% of individuals live with a partner, family size is four members, with one child. Total monthly income is, on averagem $3,087. Regarding the ownership of vehicles, 49% of individuals have at least one car or motorcycle, while 42% have at least one bicycle.

We perform a robustness analysis for our set of estimations considering other methods of estimation. First, for the regressions on the dependent variables indicating if the person uses, or not, public (or active) transport to commute, we report linear logistic models (see Panel (A) of Table A.3). Second, for the regressions on the dependent variables indicating the weekly frequency of commuting by public (or active) transport, we estimate linear ordered logit models (see Panel (B) of Table A.3).[12] Third, for the regressions on the dependent variables indicating the amount of time (in minutes) devoted to the commute by public (or active) transport, we estimate Tobit models to account for potential left-censoring, because the sample includes individuals not commuting by public or active modes of transport (see Panel (C) of Table A.3). Prior evidence, although for a different dependent variable, suggests that estimating ordered latent models or OLS models makes little difference to the estimates (Ferrer-i-Carbonell and Frijters, 2004), while other

[12] We have also estimated a count model for the weekly frequency of the commute by public (or active) transport. Results are robust, and are available upon request.

studies have found similar results when comparing OLS models to Tobit models in the study of time-allocation decisions (Frazis and Stewart, 2012; Gershuny, 2012; Gimenez-Nadal and Molina, 2014, 2016). As a consequence, and for the sake of simplicity, we rely on OLS regressions to derive our main results.

## 5. Results

Table 2 shows the results of estimating Equation (1) at the individual-level for the pool sample of cities, and by mode of transport (public and active).[13] Panel (A) shows the results for a variable indicating if the person uses, or not, each mode of transport, Panel (B) shows the results for a variable indicating the weekly frequency of the commute by each mode of transport, and Panel (C) shows the results for a variable indicating the duration of the commute by each mode of transport. Column (1) in all Panels refers to estimations for commuting by public transit, while Column (2) in all Panels refers to estimations for commuting by active transport.[14]

Regarding our main variable of interest, Panel (A) shows that the self-reported level of satisfaction with security is significantly and positively associated with the use of public transit, but no significant association is found for commuting time by active transport. That is, individuals who are more satisfied with neighborhood security are on average more likely to commute by public transit. In particular, a one-unit increase on the scale of satisfaction with neighborhood security is related to an average 0.8 percentage point increase in the probability of using public transit to commute. Further, satisfaction with the proximity of the home to modes of transport is negatively associated with the use of public transit but positively associated with the use of active transport. A one-unit increase on the scale of satisfaction with proximity to modes of transport is related to a 4.4 percentage point decrease in the probability of using public transit, and to a 4 percentage point increase in the probability of using active modes of transport. Individuals who feel more satisfied with their life have, on average, 2% more chances of commuting by active means. Panel (B) shows that the level of satisfaction with security

[13] Our main results and estimates of interest are robust in sign and magnitude to model specification (see Table A.3 in the Appendix for reported estimates on linear logistic regressions in Panel (A), linear ordered logit regressions in Panel (B), and Tobit regressions in Panel (C)). Very few differences are observed with respect to estimates in Table 2, with the majority of them being significant at low (i.e., 10%).

[14] Regarding our set of controls, we observe that the mean VIF (variance inflation factor) is 6.62, indicating that our estimation does not suffer from multicollinearity, considering the general rule of thumb that a VIF below 10 is reasonable.

is also significantly and positively associated with the weekly frequency that individuals ride the bus to commute. A one-unit increase on the scale of satisfaction with security is related to an increase of 0.033 in the weekly frequency use of public transit, which may be interpreted as an increase in the use of this mode of transport. In turn, there is a negative and significant correlation with the frequency of active commuting. Further, satisfaction with the proximity to modes of transport is negatively (positively) associated with the frequency of use of public (active) transport. Individuals who feel more satisfied with life commute, on average, less frequently by active means. Panel (C) shows that individuals more satisfied with the security of their neighborhood commute on average for longer times by public transit. In particular, a one-unit increase on the scale of satisfaction with security is correlated with a 3.2% increase in the time commuting by public transit. In turn, no significant association is found for commuting time by active transport. Consistent with the results of Panels (A) and (B), individuals who feel more satisfied with the proximity to modes of transport commute shorter times on public transit (19.4% fewer minutes) and longer times by active transport (6.6% more minutes), while individuals who feel more satisfied with their life engage, on average, in shorter active commutes (4.3% fewer minutes).

Regarding the rest of the explanatory variables, estimates reported in Columns (1) and (2) of Panel (A) indicate that being male is significantly and negatively associated with the use of public and active transport, while being older and having secondary or higher education is significantly and negatively associated with active commuting – in comparison to having primary education. Further, individuals living in larger families are more likely to ride the bus to go to work, but a larger number of children in the family is negatively associated with the use of public transit. Living with a partner is significantly and negatively related to active commuting. As expected, individuals living in households with higher levels of income and access to a motorized vehicle are less likely to use both public and active transport to commute. In contrast, owning a bicycle is significantly and positively related to commuting by active transport.

Estimates reported in Columns (1) and (2) of Panel (B) show that being male is significantly and negatively related to a more frequent use of public transit, while having secondary or higher education is positively associated with frequency. Older and more educated individuals use active transport to commute less often. Similar to results in Panel

(A), individuals living in larger families use public transit more often to go to work, but a larger number of children in the family is negatively related to that. In addition, individuals living with a partner commute less frequently by active means. Individuals reporting higher levels of family income commute less frequently by bus, but no relationship is found to the frequency of active commuting. Owners of a motorized vehicle commute less frequently by both public and active modes, while owners of a bicycle engage in active commuting more frequently.

In Columns (1) and (2) of Panel (C) we observe that being male is significantly and negatively related to commuting time by public and active transport. Age is significantly and negatively associated with commuting time by public transit, while being more educated is significantly and negatively related to commuting time by active transport. Similar to results in Panel (A) and (B), individuals living in larger families commute for longer time by public transit, but for less time when there are more children in the family. In addition, individuals living with a partner engage in shorter commuting times by active modes. Individuals reporting higher levels of family income and with a motorized vehicle commute for less time by bus and active modes, while owners of a bicycle engage in longer active commutes.

The importance of socio-demographic and socio-economic characteristics in the use of public and active transport is in line with prior evidence for the region. Prior works also find gender (Rosas-Satizábal et al., 2020; ELANS Study Group and Core Group members, 2020) and age (ELANS Study Group and Core Group members, 2020) differences in active transportation. Further, income and socio-economic level is negatively related to the use of public transit to commute, in the sense that low-income workers are the main users of public transit (Gainza and Livert, 2013).

Our pool estimation using city indicators allows us to assess differences in the use of green modes of transport to commute. In general, we observe that residents of La Paz, Lima, and Panama City (Bogota and Mexico City) engage in less (more) public and active commuting than residents in Buenos Aires. In contrast, individuals living in Quito, Montevideo, and Santiago, commute more by public transit but less by active modes in comparison to individuals living in Buenos Aires, while the opposite is observed for the city of Sao Paulo.

Lastly, we examine heterogeneous effects by estimating Eq. (1) separately for male and female commuters. Table 3 reports the gendered results for the use, or not, of each sustainable mode of transport to commute, Table 4 shows the gendered results for the weekly frequency of the commute by each mode of transport, and Table 5 reports the gendered results for the duration of the commute by each mode of transport. Our estimates indicate that in all commuting specifications (i.e., use, frequency, and time) there are differential gender effects in the case of public transit. That is, in all estimations, we observe a positive and significant relationship between perceived security and commuting by public transit for men, but not for women. This may indicate that our main results are governed by the perceptions of male commuters. A possible explanation is that men are more likely to be able to choose transport modes, in comparison to women, because they are the ones who mostly use private transport. This result could be related to traditional cultural patterns. However, we find no associations between perceived security and commuting by active transit for men or for women.

In sum, our findings indicate that individuals who feel more satisfied with their neighborhood security engage in more commuting by public transit. When examining heterogeneous effects, we observe that this result is found only for men. On the other hand, we do not find a robust relationship between satisfaction with neighborhood security and active commuting. In addition, we find consistent evidence of the factors associated with green commuting, independently of the measure used to capture commuting behavior (i.e., use, frequency, time). In the case of public transit, having more children, and higher household income, being owner of a motorized vehicle and more satisfied with proximity to modes of transport are negatively related to commuting by public modes, while family size is positively related. Being more educated, living with a partner, having higher income, and reporting higher levels of life satisfaction are negatively associated with active commuting. In contrast, owning a bicycle and being more satisfied with proximity to modes of transport are positively associated. Furthermore, there is consistent evidence of the factors related to green commuting across modes of transport. Specifically, higher family income levels and ownership of a motorized vehicle are negatively related to both public and active commuting.

## 6. Conclusions

Sustainable modes of transport, including both public and active transport, have been promoted as strategies to reduce greenhouse gas emissions. One factor that may influence their use is related to security concerns, since if individuals feel that their neighborhood is not secure, they may avoid using public transit or walking for commuting trips, as a way to avoid potential problems of theft or aggression. The problem of neighborhood insecurity is important in the context of Latin American countries, since they suffer comparatively higher rates of crime and problems of citizen security. If countries and governments want to boost the use of public transit and active modes of travel, an analysis of the extent of neighborhood insecurity related to the use of these green modes of transport is necessary.

We explore the relationship between green commuting and perceived security in Latin American cities, captured by the self-reported level of satisfaction with neighborhood security. Our study relies on the 2017 CAF Survey (CAF, 2017) implemented in 10 Latin American cities, and we focus on three dimensions of green commuting: the probability of using a green mode of transport; the weekly frequency of the commute using a green mode of transport; and the duration of the work trip when using a green mode of transport. Our results indicate that individuals who feel more satisfied with their neighborhood security engage in more commuting by public transit, but not in more active commuting. In particular, we find a positive and significant relationship between perceived security and commuting by public transit for men, but not for women. In contrast, we find no associations between perceived security and commuting by active transit for either men or women. Furthermore, we find consistent evidence of the factors associated with green commuting, independently of the measure used to capture commuting behavior (i.e., use, frequency, time).

Our results may encourage policymakers to improve citizen insecurity, especially in areas with problems with crimes, not only for health and well-being issues, but also to pursue paths of sustainable growth. Increased citizen security may boost the use of green modes of transport, leading to some degree of decarbonization of countries in Latin America. But although our results may be interesting for policy makers, we must acknowledge that subjective neighborhood security, as an exposure variable, may attract limited attention. In this sense, from a policy perspective, objective neighborhood security can be improved by urban design and public policy, but subjective neighborhood security is very difficult to change by policymakers. Hence, building a relationship between subjective neighborhood security and sustainable mobility may be more valuable from a theoretical perspective. There are several directions to address this issue. One would be to examine the transit access in terms of transit use and see whether the access-use association differs across different levels of perceived safety (e.g., moderations). Another possibility is to examine the different effects of objective security versus subjective security. Unfortunately, the current data does not allow us to do this analysis, and thus we leave this issue for future research.

One limitation of our analysis is that we cannot control for the unobserved heterogeneity of individuals, which is important in this context, since unobserved factors (e.g., preferences, previous experience, parents' background) may condition decisions about the kind of transport individuals use, and the satisfaction levels reported. One way to overcome this limitation is to use data with a panel structure. An extension of the current research could examine how the COVID-19 pandemic has changed the behavior of individuals regarding the use of public transit. Social distancing is likely to limit public transit capacity, which opens an opportunity to boost active transport as the main alternative to the use of the private car. In this context, governments and policy makers should carry out the necessary policies to increase the use of active transport in the daily lives of the population. Otherwise, the post-pandemic situation may be a backward step in the use of sustainable means of transport, since the distrust associated with the use of public transit may lead to a much greater use of private cars.

The analysis and results shown here mark possible directions for future research. The fact that we are using a multi-country survey may be adding some level of bias to the analysis, as these surveys are much less accurate than Official surveys in drawing reliable conclusions. Also, one aspect that is important in the current context is that of the built environment, a factor that should be controlled for in our estimated models as the 10 cities included in the analysis are very different – despite being from the same LAC region. However, the geographical information in the survey is not sufficiently detailed as to account for the built environment, which represents an important limitation of the current analysis. Differences between active transport infrastructure in developed cities and developing ones may also be a relevant point to address. In this sense, the scarcity of infrastructure for active mobility – and in cases where infrastructure exists, its poor safety

— may be influencing the results. All these limitations are important, and mark directions for possible future research.

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**Table 1. Descriptive Statistics**

| | Mean | Std. Dev. | Min. | Max. |
|---|---|---|---|---|
| **Panel (A): commuting characteristics** | | | | |
| if uses public transport | 0.48 | 0.50 | 0 | 1 |
| if uses active transport | 0.32 | 0.47 | 0 | 1 |
| weekly frequency of commuting by public (number of days) | 2.5 | 2.7 | 0 | 7 |
| weekly frequency of commuting by active (number of days) | 1.7 | 2.6 | 0 | 7 |
| time commuting by public transit (minutes) | 23.1 | 33.9 | 0 | 180 |
| time commuting by active transport (minutes) | 7.8 | 19.1 | 0 | 180 |
| **Panel (B): self-reported satisfaction** | | | | |
| satisfaction with security | 5.9 | 2.6 | 1 | 10 |
| satisfaction with proximity to transport | 7.4 | 2.3 | 1 | 10 |
| satisfaction with life | 7.8 | 1.7 | 1 | 10 |
| **Panel (C): socio-demographic characteristics** | | | | |
| age | 38.4 | 10.8 | 20 | 60 |
| male | 0.61 | 0.49 | 0 | 1 |
| primary education | 0.12 | 0.32 | 0 | 1 |
| secondary education | 0.48 | 0.50 | 0 | 1 |
| higher education | 0.40 | 0.49 | 0 | 1 |
| daily hours of work | 8.5 | 2.6 | 1 | 24 |
| **Panel (D): household characteristics** | | | | |
| in couple | 0.52 | 0.50 | 0 | 1 |
| household size | 3.72 | 1.74 | 1 | 9 |
| number of children < 18 years old | 0.97 | 1.13 | 0 | 7 |
| total household income (USD) | 3,087.1 | 3,3383.0 | 100 | 2,075,997 |
| owner of a motorized vehicle | 0.49 | 0.50 | 0 | 1 |
| owner of a bicycle | 0.42 | 0.49 | 0 | 1 |
| number of individuals | | 4,138 | | |

Note: Sample consists of working individuals aged 20 to 60 years old travelling to work, from the CAF Survey 2017. Composition of the sample by city is detailed in Table A.1 of Appendix. Self-reported levels of satisfaction are scaled from 1 (“not at all satisfied”) to 10 (“completely satisfied”).

**Table 2.** Linear Regression of Green Commuting in Latin American Cities

| | Panel (A) | | Panel (B) | | Panel (C) | |
|---|---|---|---|---|---|---|
| | **(1)**<br>**Public** | **(2)**<br>**Active** | **(1)**<br>**Public** | **(2)**<br>**Active** | **(1)**<br>**Public** | **(2)**<br>**Active** |
| ***satisfaction with*** | | | | | | |
| security | 0.008** | -0.007 | 0.033* | -0.053* | 0.032*** | -0.016 |
| | (0.003) | (0.004) | (0.017) | (0.028) | (0.006) | (0.012) |
| proximity to transport | -0.044*** | 0.040*** | -0.221*** | 0.228*** | -0.194*** | 0.066** |
| | (0.006) | (0.011) | (0.027) | (0.056) | (0.017) | (0.026) |
| life | -0.002 | -0.020** | -0.002 | -0.109** | -0.009 | -0.043*** |
| | (0.007) | (0.006) | (0.024) | (0.047) | (0.022) | (0.010) |
| ***socio-demographics*** | | | | | | |
| age | -0.012 | -0.009*** | -0.061 | -0.058*** | -0.051* | -0.016 |
| | (0.007) | (0.002) | (0.045) | (0.010) | (0.025) | (0.010) |
| age squared | 0.000 | 0.000*** | 0.001 | 0.001*** | 0.001* | 0.000 |
| | (0.000) | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) |
| male | -0.102*** | -0.040** | -0.323* | -0.069 | -0.341*** | -0.094* |
| | (0.028) | (0.017) | (0.146) | (0.100) | (0.102) | (0.046) |
| secondary education | 0.037 | -0.080*** | 0.468* | -0.367** | 0.180 | -0.131* |
| | (0.033) | (0.024) | (0.250) | (0.149) | (0.220) | (0.059) |
| higher education | 0.062 | -0.145*** | 0.446* | -0.812*** | 0.321 | -0.228** |
| | (0.037) | (0.020) | (0.230) | (0.111) | (0.176) | (0.078) |
| daily hours of work | -0.000 | -0.001 | -0.002 | 0.002 | 0.011 | -0.001 |
| | (0.002) | (0.004) | (0.013) | (0.015) | (0.012) | (0.013) |
| ***household characteristics*** | | | | | | |
| in couple | 0.052 | -0.076** | 0.267 | -0.403** | 0.207 | -0.208** |
| | (0.032) | (0.026) | (0.178) | (0.153) | (0.128) | (0.079) |
| household size | 0.026*** | 0.002 | 0.134*** | 0.033 | 0.088** | -0.011 |
| | (0.008) | (0.006) | (0.038) | (0.037) | (0.035) | (0.013) |
| number of children | -0.040*** | -0.002 | -0.205*** | -0.002 | -0.106** | -0.012 |
| | (0.008) | (0.014) | (0.040) | (0.071) | (0.040) | (0.040) |
| total household income | -0.000* | -0.000* | -0.000* | -0.000 | -0.000* | -0.000** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| owner of a motorized vehicle | -0.224*** | -0.102*** | -1.248*** | -0.550*** | -0.820*** | -0.352*** |
| | (0.028) | (0.026) | (0.131) | (0.164) | (0.105) | (0.091) |
| owner of a bicycle | -0.013 | 0.064** | -0.092 | 0.357** | -0.060 | 0.192* |
| | (0.015) | (0.026) | (0.088) | (0.150) | (0.049) | (0.085) |
| ***city (ref.: Buenos Aires, Arg.)*** | | | | | | |
| La Paz (Bolivia) | -0.499*** | -0.038 | -2.500*** | -0.232 | -1.832*** | -0.098 |
| | (0.018) | (0.024) | (0.073) | (0.153) | (0.068) | (0.055) |
| Sao Paulo (Brazil) | 0.058*** | -0.059*** | 0.461*** | -0.185** | 0.131** | -0.173*** |
| | (0.008) | (0.014) | (0.051) | (0.071) | (0.044) | (0.047) |
| Bogotá (Colombia) | 0.014*** | 0.048*** | 0.266*** | 0.436*** | 0.170*** | 0.275*** |
| | (0.004) | (0.005) | (0.028) | (0.035) | (0.017) | (0.020) |
| Quito (Ecuador) | 0.096*** | -0.049*** | 0.654*** | -0.044 | 0.367*** | -0.194*** |
| | (0.008) | (0.012) | (0.037) | (0.071) | (0.035) | (0.032) |
| Lima (Peru) | -0.130*** | -0.031* | -0.526*** | -0.028 | -0.478*** | -0.048 |
| | (0.019) | (0.015) | (0.085) | (0.101) | (0.064) | (0.046) |
| Montevideo (Uruguay) | 0.051*** | -0.058*** | 0.420*** | -0.202*** | 0.156*** | -0.161*** |
| | (0.006) | (0.006) | (0.029) | (0.036) | (0.028) | (0.012) |
| Panama City (Panama) | -0.025* | -0.210*** | 0.081 | -0.998*** | 0.009 | -0.495*** |
| | (0.012) | (0.014) | (0.059) | (0.082) | (0.033) | (0.051) |
| Mexico City (Mexico) | 0.187*** | 0.132*** | 1.287*** | 0.937*** | 0.960*** | 0.853*** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.008) | (0.005) | (0.029) | (0.029) | (0.026) | (0.026) |
| Santiago (Chile) | 0.028*** | -0.087*** | 0.277*** | -0.358*** | 0.224*** | -0.167*** |
| | (0.006) | (0.009) | (0.027) | (0.049) | (0.018) | (0.026) |
| Constant | 1.105*** | 0.601*** | 5.358*** | 2.973*** | 4.133*** | 1.567*** |
| | (0.141) | (0.057) | (0.786) | (0.456) | (0.391) | (0.222) |
| VIF (mean) | | | 6.62 | | | |
| R-squared | 0.136 | 0.094 | 0.134 | 0.095 | 0.154 | 0.082 |
| Number of individuals | 4,138 | 4,138 | 4,138 | 4,138 | 4,138 | 4,138 |

Note: Sample consists of working individuals aged 20 to 60 years old travelling to work, from the CAF Survey 2017. Composition of the sample by city is detailed in Table A.1 of Appendix. Estimates from OLS regressions in all panels. Dependent variables in Panel (A) are indicator variables that take the value of 1 if the person commutes using public or active transport, respectively. Dependent variables in Panel (B) indicate how many days per week the person commutes by public or active transport, respectively. Dependent variables in Panel (C) indicate the amount of time (in log of minutes) spent by the individual in daily commuting by public or active transport, respectively. Self-reported levels of satisfaction are scaled from 1 ("not at all satisfied") to 10 ("completely satisfied"). Regressions are weighted using individual survey weights. Robust standard errors clustered at the city level in parentheses.

* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

**Table 3.** Linear Regression of the Use of Green Commuting in Latin American Cities by Gender

| | Public | | Active | |
|---|---|---|---|---|
| | **Men** | **Women** | **Men** | **Women** |
| ***satisfaction with*** | | | | |
| security | 0.012** | 0.002 | -0.010 | -0.004 |
| | (0.004) | (0.004) | (0.006) | (0.005) |
| proximity to transport | -0.039*** | -0.050*** | 0.040*** | 0.040** |
| | (0.006) | (0.007) | (0.011) | (0.012) |
| life | -0.007 | 0.006 | -0.020* | -0.020*** |
| | (0.008) | (0.009) | (0.010) | (0.005) |
| ***socio-demographics*** | | | | |
| age | -0.011 | -0.011 | -0.016*** | 0.003 |
| | (0.011) | (0.011) | (0.003) | (0.007) |
| age squared | 0.000 | 0.000 | 0.000*** | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| male | 0.035 | 0.017 | -0.081*** | -0.077* |
| | (0.031) | (0.045) | (0.017) | (0.041) |
| secondary education | 0.075* | 0.011 | -0.136*** | -0.152*** |
| | (0.034) | (0.048) | (0.009) | (0.037) |
| higher education | 0.000 | -0.002 | 0.003 | -0.007 |
| | (0.004) | (0.004) | (0.006) | (0.007) |
| daily hours of work | -0.011 | -0.011 | -0.016*** | 0.003 |
| | (0.011) | (0.011) | (0.003) | (0.007) |
| ***household characteristics*** | | | | |
| in couple | 0.042 | 0.037 | -0.116*** | -0.026 |
| | (0.032) | (0.045) | (0.034) | (0.031) |
| household size | 0.027*** | 0.022* | -0.001 | 0.006 |
| | (0.007) | (0.010) | (0.009) | (0.011) |
| number of children | -0.031** | -0.051** | 0.005 | -0.008 |
| | (0.010) | (0.016) | (0.015) | (0.024) |
| total household income | -0.000* | -0.000 | -0.000* | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| owner of a motorized vehicle | -0.280*** | -0.115** | -0.129*** | -0.065* |
| | (0.027) | (0.042) | (0.030) | (0.031) |
| owner of a bicycle | -0.013 | -0.018 | 0.073* | 0.049*** |
| | (0.021) | (0.018) | (0.038) | (0.015) |
| ***city (ref.: Buenos Aires, Arg.)*** | | | | |
| La Paz (Bolivia) | -0.439*** | -0.574*** | -0.056* | -0.023 |
| | (0.013) | (0.034) | (0.025) | (0.034) |
| Sao Paulo (Brazil) | 0.040*** | 0.063*** | -0.033* | -0.096*** |
| | (0.010) | (0.010) | (0.016) | (0.013) |
| Bogotá (Colombia) | 0.026*** | -0.009 | 0.071*** | 0.007 |
| | (0.005) | (0.016) | (0.009) | (0.018) |
| Quito (Ecuador) | 0.116*** | 0.070** | -0.028** | -0.080*** |
| | (0.005) | (0.024) | (0.011) | (0.018) |
| Lima (Peru) | -0.109*** | -0.187*** | -0.041** | -0.005 |
| | (0.014) | (0.026) | (0.014) | (0.020) |
| Montevideo (Uruguay) | 0.013* | 0.080*** | -0.022*** | -0.099*** |
| | (0.007) | (0.012) | (0.007) | (0.007) |
| Panama City (Panama) | 0.023** | -0.131*** | -0.176*** | -0.269*** |
| | (0.010) | (0.020) | (0.013) | (0.028) |

| | | | | |
|---|---|---|---|---|
| Mexico City (Mexico) | 0.204*** | 0.155*** | 0.173*** | 0.076*** |
| | (0.010) | (0.010) | (0.012) | (0.016) |
| Santiago (Chile) | 0.055*** | -0.035** | -0.095*** | -0.072*** |
| | (0.007) | (0.011) | (0.011) | (0.006) |
| Constant | 0.964*** | 1.164*** | 0.662*** | 0.391** |
| | (0.260) | (0.188) | (0.073) | (0.152) |
| R-squared | 0.143 | 0.128 | 0.111 | 0.077 |
| Number of individuals | 2,529 | 1,609 | 2,529 | 1,609 |

Note: Sample consists of working individuals aged 20 to 60 years old travelling to work, from the CAF Survey 2017. Composition of the sample by city is detailed in Table A.1 of Appendix. Estimates from OLS regressions by gender in all panels. Dependent variables: indicator that take the value of 1 if the person commutes using public or active transport, respectively. Self-reported levels of satisfaction are scaled from 1 ("not at all satisfied") to 10 ("completely satisfied"). Regressions are weighted using individual survey weights. Robust standard errors clustered at the city level in parentheses.
* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

**Table 4.** Linear Regression of the Weekly Frequency of Green Commuting in Latin American Cities by Gender

| | Public | | Active | |
|---|---|---|---|---|
| | **Men** | **Women** | **Men** | **Women** |
| ***satisfaction with*** | | | | |
| security | 0.063** | -0.015 | -0.068 | -0.030 |
| | (0.024) | (0.040) | (0.041) | (0.025) |
| proximity to transport | -0.208*** | -0.233*** | 0.233*** | 0.220*** |
| | (0.040) | (0.021) | (0.056) | (0.058) |
| life | -0.021 | 0.035 | -0.102 | -0.114** |
| | (0.040) | (0.027) | (0.059) | (0.036) |
| ***socio-demographics*** | | | | |
| age | -0.056 | -0.055 | -0.097*** | 0.015 |
| | (0.068) | (0.042) | (0.027) | (0.044) |
| age squared | 0.001 | 0.000 | 0.001*** | -0.000 |
| | (0.001) | (0.000) | (0.000) | (0.001) |
| male | 0.310 | 0.579 | -0.450** | -0.194 |
| | (0.221) | (0.333) | (0.153) | (0.224) |
| secondary education | 0.308 | 0.477* | -0.892*** | -0.609** |
| | (0.233) | (0.258) | (0.066) | (0.231) |
| higher education | 0.008 | -0.022 | 0.025 | -0.028 |
| | (0.017) | (0.028) | (0.020) | (0.032) |
| daily hours of work | -0.056 | -0.055 | -0.097*** | 0.015 |
| | (0.068) | (0.042) | (0.027) | (0.044) |
| ***household characteristics*** | | | | |
| in couple | 0.261 | 0.099 | -0.614*** | -0.128 |
| | (0.175) | (0.220) | (0.178) | (0.216) |
| household size | 0.151*** | 0.100 | 0.019 | 0.047 |
| | (0.029) | (0.068) | (0.056) | (0.066) |
| number of children | -0.177** | -0.244** | 0.024 | 0.005 |
| | (0.059) | (0.079) | (0.086) | (0.124) |
| total household income | -0.000* | -0.000 | -0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| owner of a motorized vehicle | -1.530*** | -0.685*** | -0.736*** | -0.303* |
| | (0.140) | (0.188) | (0.191) | (0.151) |
| owner of a bicycle | -0.098 | -0.114 | 0.395 | 0.293*** |
| | (0.116) | (0.109) | (0.218) | (0.072) |
| ***city (ref.: Buenos Aires, Arg.)*** | | | | |
| La Paz (Bolivia) | -2.240*** | -2.766*** | -0.368** | -0.070 |
| | (0.073) | (0.168) | (0.154) | (0.198) |
| Sao Pablo (Brazil) | 0.345*** | 0.530*** | -0.067 | -0.351*** |
| | (0.072) | (0.045) | (0.083) | (0.043) |
| Bogotá (Colombia) | 0.374*** | 0.097 | 0.500*** | 0.294** |
| | (0.039) | (0.064) | (0.067) | (0.095) |
| Quito (Ecuador) | 0.800*** | 0.515*** | -0.047 | 0.004 |
| | (0.024) | (0.114) | (0.058) | (0.104) |
| Lima (Peru) | -0.383*** | -0.846*** | -0.200* | 0.365** |
| | (0.073) | (0.119) | (0.092) | (0.124) |
| Montevideo (Uruguay) | 0.163*** | 0.634*** | -0.132** | -0.277*** |
| | (0.036) | (0.050) | (0.041) | (0.039) |
| Panama City (Panama) | 0.375*** | -0.532*** | -0.939*** | -1.121*** |
| | (0.036) | (0.117) | (0.074) | (0.154) |

| | | | | |
|---|---|---|---|---|
| Mexico City (Mexico) | 1.383*** | 1.145*** | 1.060*** | 0.847*** |
| | (0.040) | (0.043) | (0.064) | (0.068) |
| Santiago (Chile) | 0.414*** | -0.016 | -0.463*** | -0.170*** |
| | (0.034) | (0.057) | (0.060) | (0.036) |
| Constant | 4.839*** | 5.580*** | 3.656*** | 1.455 |
| | (1.453) | (0.690) | (0.583) | (1.028) |
| R-squared | 0.148 | 0.131 | 0.117 | 0.077 |
| Number of individuals | 2,529 | 1,609 | 2,529 | 1,609 |

Note: Sample consists of working individuals aged 20 to 60 years old travelling to work, from the CAF Survey 2017. Composition of the sample by city is detailed in Table A.1 of Appendix. Estimates from OLS regressions by gender in all panels. Dependent variables: indicate how many days per week the person commutes by public or active transport, respectively. Self-reported levels of satisfaction are scaled from 1 (“not at all satisfied”) to 10 (“completely satisfied”). Regressions are weighted using individual survey weights. Robust standard errors clustered at the city level in parentheses.
* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

**Table 5.** Linear Regression of the Time of Green Commuting in Latin American Cities by Gender

| | Public | | Active | |
|---|---|---|---|---|
| | **Men** | **Women** | **Men** | **Women** |
| ***satisfaction with*** | | | | |
| security | 0.049** | 0.005 | -0.016 | -0.016 |
| | (0.016) | (0.022) | (0.015) | (0.012) |
| proximity to transport | -0.170*** | -0.224*** | 0.061* | 0.074** |
| | (0.018) | (0.027) | (0.028) | (0.029) |
| life | -0.015 | 0.007 | -0.024 | -0.075*** |
| | (0.028) | (0.027) | (0.020) | (0.022) |
| ***socio-demographics*** | | | | |
| age | -0.053 | -0.041 | -0.041*** | 0.025 |
| | (0.032) | (0.053) | (0.011) | (0.028) |
| age squared | 0.001 | 0.000 | 0.001*** | -0.000 |
| | (0.000) | (0.001) | (0.000) | (0.000) |
| male | 0.104 | 0.216 | -0.148** | -0.119 |
| | (0.232) | (0.221) | (0.062) | (0.107) |
| secondary education | 0.335* | 0.186 | -0.202*** | -0.272 |
| | (0.168) | (0.226) | (0.046) | (0.164) |
| higher education | 0.015 | 0.006 | 0.010 | -0.014 |
| | (0.019) | (0.015) | (0.021) | (0.017) |
| daily hours of work | -0.053 | -0.041 | -0.041*** | 0.025 |
| | (0.032) | (0.053) | (0.011) | (0.028) |
| ***household characteristics*** | | | | |
| in couple | 0.155 | 0.185 | -0.311** | -0.070 |
| | (0.137) | (0.136) | (0.113) | (0.078) |
| household size | 0.093** | 0.076* | -0.022 | 0.004 |
| | (0.035) | (0.040) | (0.013) | (0.038) |
| number of children | -0.078* | -0.142** | 0.009 | -0.025 |
| | (0.042) | (0.059) | (0.038) | (0.065) |
| total household income | -0.000* | -0.000 | -0.000 | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) |
| owner of a motorized vehicle | -1.000*** | -0.468*** | -0.416*** | -0.254* |
| | (0.120) | (0.142) | (0.110) | (0.122) |
| owner of a bicycle | -0.069 | -0.068 | 0.210 | 0.159*** |
| | (0.059) | (0.079) | (0.120) | (0.042) |
| ***city (ref.: Buenos Aires, Arg.)*** | | | | |
| La Paz (Bolivia) | -1.561*** | -2.171*** | -0.090 | -0.144 |
| | (0.057) | (0.110) | (0.057) | (0.082) |
| Sao Paulo (Brazil) | 0.072 | 0.129*** | -0.087 | -0.307*** |
| | (0.063) | (0.040) | (0.052) | (0.055) |
| Bogotá (Colombia) | 0.199*** | 0.099* | 0.309*** | 0.200*** |
| | (0.020) | (0.054) | (0.020) | (0.057) |
| Quito (Ecuador) | 0.418*** | 0.287** | -0.119*** | -0.326*** |
| | (0.019) | (0.091) | (0.036) | (0.032) |
| Lima (Peru) | -0.383*** | -0.707*** | -0.032 | -0.055 |
| | (0.055) | (0.083) | (0.034) | (0.062) |
| Montevideo (Uruguay) | 0.012 | 0.256*** | -0.053** | -0.307*** |
| | (0.032) | (0.039) | (0.020) | (0.021) |
| Panama City (Panama) | 0.188*** | -0.384*** | -0.393*** | -0.665*** |
| | (0.024) | (0.064) | (0.052) | (0.076) |

| | | | | |
|---|---|---|---|---|
| Mexico City (Mexico) | 1.042*** | 0.813*** | 0.948*** | 0.733*** |
| | (0.036) | (0.033) | (0.042) | (0.046) |
| Santiago (Chile) | 0.343*** | -0.035 | -0.165*** | -0.172*** |
| | (0.019) | (0.044) | (0.029) | (0.021) |
| Constant | 3.616*** | 4.384*** | 1.753*** | 1.070* |
| | (0.810) | (0.760) | (0.296) | (0.557) |
| R-squared | 0.159 | 0.154 | 0.091 | 0.077 |
| Number of individuals | 2,529 | 1,609 | 2,529 | 1,609 |

Note: Sample consists of working individuals aged 20 to 60 years old travelling to work, from the CAF Survey 2017. Composition of the sample by city is detailed in Table A.1 of Appendix. Estimates from OLS regressions by gender in all panels. Dependent variables: indicate the amount of time (in log of minutes) spent by the individual in daily commuting by public or active transport, respectively. Self-reported levels of satisfaction are scaled from 1 ("not at all satisfied") to 10 ("completely satisfied"). Regressions are weighted using individual survey weights. Robust standard errors clustered at the city level in parentheses.

* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

## Appendix

**Table A.1.** Sample Composition

| city (country) | number of individuals | % |
|---|---|---|
| Buenos Aires (Argentina) | 503 | 12.16 |
| La Paz (Bolivia) | 461 | 11.14 |
| Sao Paulo (Brazil) | 378 | 9.13 |
| Bogotá (Colombia) | 480 | 11.6 |
| Quito (Ecuador) | 362 | 8.75 |
| Lima (Peru) | 417 | 10.08 |
| Montevideo (Uruguay) | 477 | 11.53 |
| Panama City (Panama) | 224 | 5.41 |
| Mexico City (Mexico) | 353 | 8.53 |
| Santiago (Chile) | 483 | 11.67 |
| All cities | 4,138 | 100 |

Note: Sample consists of working individuals aged 20 to 60 years old travelling to work, from the CAF Survey 2017.

**Table A.2.** Robustness: Regression of Green Commuting in Latin American Cities accounting for Survey Design

| | Panel (A) | | Panel (B) | | Panel (C) | |
|---|---|---|---|---|---|---|
| | **(1) Public** | **(2) Active** | **(1) Public** | **(2) Active** | **(1) Public** | **(2) Active** |
| ***satisfaction with*** | | | | | | |
| security | 0.008** | -0.007* | 0.033 | -0.053** | 0.032** | -0.016 |
| | (0.004) | (0.004) | (0.022) | (0.023) | (0.014) | (0.013) |
| proximity to transport | -0.044*** | 0.040*** | -0.221*** | 0.228*** | -0.194*** | 0.066*** |
| | (0.004) | (0.005) | (0.024) | (0.024) | (0.018) | (0.013) |
| life | -0.002 | -0.020*** | -0.002 | -0.109*** | -0.009 | -0.043** |
| | (0.006) | (0.007) | (0.034) | (0.038) | (0.023) | (0.019) |
| ***socio-demographics*** | | | | | | |
| age | -0.012* | -0.009 | -0.061* | -0.058 | -0.051** | -0.016 |
| | (0.006) | (0.007) | (0.035) | (0.037) | (0.024) | (0.020) |
| age squared | 0.000 | 0.000 | 0.001 | 0.001 | 0.001* | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| male | -0.102*** | -0.040* | -0.323*** | -0.069 | -0.341*** | -0.094 |
| | (0.021) | (0.021) | (0.110) | (0.114) | (0.077) | (0.061) |
| secondary education | 0.037 | -0.080** | 0.468** | -0.367* | 0.180 | -0.131 |
| | (0.034) | (0.036) | (0.182) | (0.202) | (0.129) | (0.097) |
| higher education | 0.062* | -0.145*** | 0.446** | -0.812*** | 0.321** | -0.228** |
| | (0.037) | (0.037) | (0.195) | (0.202) | (0.142) | (0.103) |
| daily hours of work | -0.000 | -0.001 | -0.002 | 0.002 | 0.011 | -0.001 |
| | (0.004) | (0.004) | (0.020) | (0.021) | (0.015) | (0.014) |
| ***household characteristics*** | | | | | | |
| in couple | 0.052*** | -0.076*** | 0.267** | -0.403*** | 0.207*** | -0.208*** |
| | (0.020) | (0.021) | (0.110) | (0.115) | (0.076) | (0.066) |
| household size | 0.026*** | 0.002 | 0.134*** | 0.033 | 0.088*** | -0.011 |
| | (0.007) | (0.008) | (0.040) | (0.044) | (0.027) | (0.023) |
| number of children | -0.040*** | -0.002 | -0.205*** | -0.002 | -0.106** | -0.012 |
| | (0.012) | (0.012) | (0.063) | (0.065) | (0.044) | (0.033) |
| total household income | -0.000* | -0.000 | -0.000* | -0.000 | -0.000* | -0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| owner of a motorized vehicle | -0.224*** | -0.102*** | -1.248*** | -0.550*** | -0.820*** | -0.352*** |
| | (0.022) | (0.022) | (0.117) | (0.118) | (0.082) | (0.065) |
| owner of a bicycle | -0.013 | 0.064*** | -0.092 | 0.357*** | -0.060 | 0.192*** |
| | (0.021) | (0.020) | (0.111) | (0.110) | (0.078) | (0.063) |
| ***city (ref.: Buenos Aires, Arg.)*** | | | | | | |
| La Paz (Bolivia) | -0.499*** | -0.038 | -2.500*** | -0.232 | -1.832*** | -0.098 |
| | (0.032) | (0.036) | (0.171) | (0.193) | (0.118) | (0.107) |
| Sao Paulo (Brazil) | 0.058 | -0.059 | 0.461** | -0.185 | 0.131 | -0.173* |
| | (0.035) | (0.038) | (0.194) | (0.208) | (0.128) | (0.102) |
| Bogotá (Colombia) | 0.014 | 0.048 | 0.266 | 0.436** | 0.170 | 0.275*** |
| | (0.035) | (0.035) | (0.193) | (0.186) | (0.126) | (0.105) |
| Quito (Ecuador) | 0.096*** | -0.049 | 0.654*** | -0.044 | 0.367*** | -0.194* |
| | (0.037) | (0.037) | (0.204) | (0.206) | (0.135) | (0.103) |

| | | | | | | |
|---|---|---|---|---|---|---|
| Lima (Peru) | -0.130*** | -0.031 | -0.526** | -0.028 | -0.478*** | -0.048 |
| | (0.038) | (0.040) | (0.217) | (0.216) | (0.140) | (0.124) |
| Montevideo (Uruguay) | 0.051 | -0.058* | 0.420** | -0.202 | 0.156 | -0.161* |
| | (0.031) | (0.032) | (0.174) | (0.166) | (0.111) | (0.086) |
| Panama City (Panama) | -0.025 | -0.210*** | 0.081 | -0.998*** | 0.009 | -0.495*** |
| | (0.045) | (0.034) | (0.248) | (0.188) | (0.176) | (0.104) |
| Mexico City (Mexico) | 0.187*** | 0.132*** | 1.287*** | 0.937*** | 0.960*** | 0.853*** |
| | (0.039) | (0.040) | (0.216) | (0.217) | (0.156) | (0.150) |
| Santiago (Chile) | 0.028 | -0.087*** | 0.277 | -0.358** | 0.224* | -0.167* |
| | (0.034) | (0.033) | (0.182) | (0.171) | (0.128) | (0.100) |
| Constant | 1.105*** | 0.601*** | 5.358*** | 2.973*** | 4.133*** | 1.567*** |
| | (0.136) | (0.141) | (0.740) | (0.796) | (0.509) | (0.414) |
| | -0.499*** | -0.038 | -2.500*** | -0.232 | -1.832*** | -0.098 |
| Pseudo R-squared | 0.136 | 0.094 | 0.134 | 0.095 | 0.154 | 0.082 |
| Number of individuals | 4,138 | 4,138 | 4,138 | 4,138 | 4,138 | 4,138 |

Note: Sample consists of working individuals aged 20 to 60 years old travelling to work, from the CAF Survey 2017. Composition of the sample by city is detailed in Table A.1 of Appendix. Estimates from OLS regressions in all panels. Dependent variables in Panel (A) are indicator variables that take the value of 1 if the person commutes using public or active transport, respectively. Dependent variables in Panel (B) indicate how many days per week the person commutes by public or active transport, respectively. Dependent variables in Panel (C) indicate the amount of time (in log of minutes) spent by the individual in daily commuting by public or active transport, respectively. Self-reported levels of satisfaction are scaled from 1 (“not at all satisfied”) to 10 (“completely satisfied”). Regressions account for survey design (i.e. sampling weights, clustered sampling, and stratification). Robust standard errors clustered at the city level in parentheses.

* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.

**Table A.3.** Robustness: Different Estimation Methods of Green Commuting in Latin American Cities

| | **Panel (A)** | | **Panel (B)** | | **Panel (C)** | |
|---|---|---|---|---|---|---|
| | **(1) Public** | **(2) Active** | **(1) Public** | **(2) Active** | **(1) Public** | **(2) Active** |
| ***satisfaction with*** | | | | | | |
| security | 0.009*** | -0.008* | 0.024** | -0.040* | 0.038*** | -0.020 |
| | (0.003) | (0.004) | (0.012) | (0.024) | (0.008) | (0.013) |
| proximity to transport | -0.051*** | 0.045*** | -0.161*** | 0.191*** | -0.197*** | 0.103*** |
| | (0.007) | (0.013) | (0.018) | (0.057) | (0.019) | (0.034) |
| life | -0.002 | -0.021*** | 0.007 | -0.079*** | -0.005 | -0.054*** |
| | (0.008) | (0.007) | (0.017) | (0.030) | (0.028) | (0.015) |
| ***socio-demographics*** | | | | | | |
| age | -0.013 | -0.009*** | -0.035 | -0.038*** | -0.051* | -0.019*** |
| | (0.008) | (0.002) | (0.035) | (0.013) | (0.027) | (0.006) |
| age squared | 0.000 | 0.000*** | 0.000 | 0.000*** | 0.000* | 0.000*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| male | -0.116*** | -0.040** | -0.208* | -0.058 | -0.397*** | -0.120** |
| | (0.032) | (0.018) | (0.109) | (0.077) | (0.115) | (0.047) |
| secondary education | 0.045 | -0.076*** | 0.361* | -0.281* | 0.194 | -0.181*** |
| | (0.039) | (0.023) | (0.214) | (0.147) | (0.216) | (0.061) |
| higher education | 0.076* | -0.142*** | 0.265 | -0.661*** | 0.351** | -0.342*** |
| | (0.044) | (0.019) | (0.188) | (0.100) | (0.171) | (0.059) |
| daily hours of work | -0.001 | -0.002 | 0.000 | 0.008 | 0.005 | -0.002 |
| | (0.003) | (0.004) | (0.009) | (0.016) | (0.012) | (0.013) |
| ***household characteristics*** | | | | | | |
| in couple | 0.062* | -0.079*** | 0.178 | -0.304** | 0.226 | -0.223*** |
| | (0.036) | (0.027) | (0.141) | (0.131) | (0.141) | (0.076) |
| household size | 0.030*** | 0.002 | 0.095*** | 0.035 | 0.103*** | -0.000 |
| | (0.009) | (0.006) | (0.026) | (0.027) | (0.036) | (0.013) |
| number of children | -0.047*** | -0.003 | -0.145*** | -0.016 | -0.139*** | -0.017 |
| | (0.009) | (0.015) | (0.029) | (0.066) | (0.040) | (0.045) |
| total household income | -0.000*** | -0.000 | 0.000*** | 0.000 | 0.000*** | 0.000 |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| owner of a motorized vehicle | -0.247*** | -0.109*** | -0.909*** | -0.474*** | -0.903*** | -0.351*** |
| | (0.029) | (0.027) | (0.095) | (0.133) | (0.107) | (0.088) |
| owner of a bicycle | -0.015 | 0.071*** | -0.098 | 0.290* | -0.066 | 0.210** |
| | (0.017) | (0.027) | (0.064) | (0.112) | (0.055) | (0.081) |
| ***city (ref.: Buenos Aires, Arg.)*** | | | | | | |
| La Paz (Bolivia) | -0.458*** | -0.034 | -2.615*** | -0.130 | -2.773*** | -0.083 |
| | (0.005) | (0.023) | (0.079) | (0.114) | (0.082) | (0.070) |
| Sao Paulo (Brazil) | 0.066*** | -0.060*** | 0.368*** | -0.168** | 0.187*** | -0.178*** |
| | (0.009) | (0.014) | (0.045) | (0.066) | (0.037) | (0.042) |
| Bogotá (Colombia) | 0.021*** | 0.055*** | 0.267*** | 0.336*** | 0.160*** | 0.228*** |
| | (0.005) | (0.006) | (0.029) | (0.033) | (0.014) | (0.021) |
| Quito (Ecuador) | 0.108*** | -0.048*** | 0.432*** | -0.047 | 0.392*** | -0.171*** |
| | (0.008) | (0.012) | (0.028) | (0.060) | (0.036) | (0.038) |
| Lima (Peru) | -0.146*** | -0.028* | -0.289*** | 0.016 | -0.512*** | -0.040 |

| | | | | | | |
|---|---|---|---|---|---|---|
| | (0.021) | (0.016) | (0.053) | (0.081) | (0.070) | (0.051) |
| Montevideo (Uruguay) | 0.060*** | -0.058*** | 0.305*** | -0.183*** | 0.192*** | -0.189*** |
| | (0.008) | (0.004) | (0.031) | (0.028) | (0.029) | (0.014) |
| Panama City (Panama) | -0.028** | -0.240*** | 0.124*** | -1.465*** | -0.023 | -0.965*** |
| | (0.014) | (0.005) | (0.042) | (0.064) | (0.038) | (0.042) |
| Mexico City (Mexico) | 0.204*** | 0.148*** | 0.971*** | 0.729*** | 0.885*** | 0.631*** |
| | (0.009) | (0.007) | (0.059) | (0.040) | (0.025) | (0.016) |
| Santiago (Chile) | 0.033*** | -0.090*** | 0.144*** | -0.368*** | 0.199*** | -0.238*** |
| | (0.006) | (0.009) | (0.024) | (0.038) | (0.020) | (0.043) |
| Pseudo R-squared | 0.108 | 0.078 | 0.051 | 0.044 | 0.049 | 0.036 |
| Number of individuals | 4,138 | 4,138 | 4,138 | 4,138 | 4,138 | 4,138 |

Note: Sample consists of working individuals aged 20 to 60 years old travelling to work, from the CAF Survey 2017. Composition of the sample by city is detailed in Table A.1 of Appendix. Panel (A) reports estimates from Logit regressions, Panel (B) reports estimates from Ordered Logit regressions, and Panel (C) reports estimates from Tobit regressions. Dependent variables in Panel (A) are indicator variables that take the value of 1 if the person commutes using public or active transport, respectively. Dependent variables in Panel (B) indicate how many days per week the person commutes by public or active transport, respectively. Dependent variables in Panel (C) indicate the amount of time (in log of minutes) spent by the individual in daily commuting by public or active transport, respectively. Self-reported levels of satisfaction are scaled from 1 ("not at all satisfied") to 10 ("completely satisfied"). Regressions are weighted using individual survey weights. Robust standard errors clustered at the city level in parentheses.
* Significant at the 10% level; ** significant at the 5% level; *** significant at the 1% level.