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# The COVID-19 Mark on Urban Mobility

## A Tale of Two Cities' Journey to Recovery

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## Abstract

The COVID-19 pandemic significantly changed mobility patterns in the Bogotá and Buenos Aires metropolitan areas, as shown by the differences between the October 2019, 2020, and 2021 indicator values derived from call detail record–based origin-destination matrices. The differences between 2019 and 2020 were more notable than between 2019 and 2021 on most mobility indicators, demonstrating a reversal of the pre-pandemic mobility habits. However, by late 2021, the return to pre-pandemic levels was still very partial in the case of public transport use (especially so in Buenos Aires), while in Bogotá the pandemic appeared to have induced a permanent—and increasing—shift to non-motorized modes. Other mobility indicators that appear to have changed more permanently in Bogotá include the lower average distances traveled and the relatively higher importance of non-home-based mobility. In the Buenos Aires Metropolitan Area, the key persistent changes include the lower overall trip generation rates and specifically peak-hour travel, and the higher relative weight of travel to work and school compared to other travel purposes. These findings are partly explained by the underlying policy and regulatory context in the two cities and are relevant for designing transport policy in the post-pandemic context, including in terms of public transport route and schedule planning, cycleway network expansion, and, more broadly, the leveraging of big data as a complement to traditional mobility surveys.

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# The COVID-19 Mark on Urban Mobility: A Tale of Two Cities' Journey to Recovery

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## 1. Introduction

In cities around the world, the COVID-19 pandemic introduced changes in travel patterns and disruptions in urban mobility, such as reduction in trips by public transport and changes in work and study-related trips, as well as increase in e-commerce related trips. While some of these changes were driven by specific regulatory measures, such as capacity limits to public transport use, others were related to changes in personal preferences that may or may not be limited to the specific time period retrospectively referred to as "the pandemic". The traditional transport planning data sources and methods – such as periodic and time-consuming household travel surveys – were no longer sufficient to understand and act on the new dynamics associated with the pandemic, such as decrease in public transport use and changes in travel during the hours commonly thought of as "peak". The pandemic introduced new preferences, restrictions, and incentives for travel that could no longer be explained solely by population and economic growth.

The *Big Bang* of so-called "big data", advanced analytics and new technologies are transforming not only mobility but also the ability of transport planners to identify important mobility patterns at new scales and resolutions and to act on these findings in real time. Telecommunications and digital technology provide an opportunity to measure mobility; especially in data poor settings with low smartphone penetration, call detail records (CDR) have the highest coverage. In Argentina, there were over 56.3 million cellular subscriptions registered in 2019,[2] and smartphone adoption is expected to increase from 59 percent in 2019 to 82 percent by 2025, while in Colombia the respective figures are 65 percent and 77 percent.

The current study took advantage of the very high mobile phone penetration rates in Bogota and the Buenos Aires Metropolitan Area (AMBA) and the associated availability of high frequency and spatial resolution mobility data to understand how mobility evolved during the pandemic. While the pandemic impacted numerous mobility indicators that matter for the system's environmental and financial sustainability, only a subset of these can be considered to have persisted beyond the immediate lockdown period and thus not only represent more permanent changes in preferences and behaviors but are also more relevant for transport policy and planning going forward. The analysis distinguishes between short-term changes in mobility, as observed over the period between October 2019 and October 2020, and changes that also more or less persisted a full year later despite the removal of formal restrictions to mobility in both cities. The four categories of indicators tracked for the three time points are: trip generation, temporal distribution of trips, spatial distribution of trips, and modal split. In turn, indicators under each of these categories are segmented according to traveler (e.g., socioeconomic/ income group) and trip characteristics (e.g., travel purpose), in order to identify variations in their value according to different demand segments.

## 2. Review of the literature

Since the outbreak of the pandemic, several studies have analyzed mobility changes in cities in the context of the pandemic, including in Latin America. Focusing on Colombia and India, Vallejo-Borda et al. (2023) model the travel choices to understand the changes in mode-choice preference and the frequency of trips, comparing pre-COVID with during-COVID scenarios. They find that in both countries the utility related to active modes (more used) and public transportation (less used) changed during the pandemic, and that perceptions toward government responses had a significant impact on the choices in Colombia, though this was not the case in India. Mejia-Dorantes et al. (2021) analyzed mobility trends and patterns in the metropolitan area of Barcelona before and after the COVID-19 pandemic outbreak using a combination of traditional travel surveys and smartphone data. They found that after the pandemic outbreak, highly educated population groups and those with higher income were more likely to change their mobility patterns compared to others and that, while remote work and studies may shape new mobility patterns for some population segments, not all mobility

[2] World Bank World Development Indicators.

types can be replaced by information technologies. Shaer and Haghshenas (2021) identified the factors affecting older adults' travel mode choices specifically, focusing on the case of Isfahan, Islamic Republic of Iran. Because older adults are more vulnerable to bacteria and viruses, restrictions on using modes such as a private vehicle and public transportation to prevent the spread of COVID-19 led to a significant reduction in their mobility. The main purpose of the study was to understand how older adults' travel had changed since the COVID-19 outbreak. The results show that, despite the decrease in the average frequency of travel, there was an increase in the share of walking and cycling modes, shopping and recreational travel on foot, and cycling, indicating the resilience of walking and cycling in critical situations.

Several studies have proposed forward-looking mobility scenarios. These include a post-pandemic scenario analysis of lifestyle changes in developed and developing country societies (Echegaray 2021) which identifies four scenarios depending on whether social relationships tend to be more virtual or not and whether quality of life remains closely related to consumption or not; analyses of sustainable development scenarios of the LAC region in the post-pandemic environment (Morea 2020; Zhang and Engelke 2021) that identify possible evolutions of the socioeconomic context of the region, depending on whether pre-pandemic patterns continue, whether the pandemic generates controlled transformations in the economy and society, or whether the pandemic generates rapid paradigm shifts. In the European context, a similar analysis was conducted by Cuhls et al. (2022), while Trivers et al. (2021) implemented a smaller spatial scale analysis focused on the city of London.

Most studies consider that some changes in habits brought about by the pandemic may persist over time. In general, they agree that the pandemic has led to an acceleration of the virtualization of some activities (e.g. telecommuting, e-commerce, etc.), but also that there is a possibility that some of this adoption may be reversed. In addition, studies with longer-term scenarios tend to associate this virtualization with a societal reliance on technology to solve the challenge of natural resource scarcity and climate change (Cuhls et al. 2022). Reflecting this trend in mobility would be an increased adoption of new transportation technologies and services (e.g., electric vehicles, shared mobility, etc.) (Echegaray 2021). On the other hand, the pandemic may also have awakened a greater awareness of vulnerability, both at the social level (greater sensitivity to socioeconomic inequality) and at the ecosystem level (greater sensitivity to the ecosystem deterioration). If this awareness were to persist, it could lead to a search for community and proximity values, reflected in concepts such as "the 15-minute city". Scenarios in which concerns about social inequality and climate change are more evident would lead to greater efforts to improve accessibility and reduce emissions from urban mobility. A recent comprehensive study covering several countries of different income levels concludes that future travel habits remain uncertain, with several other crises coinciding with recovery from the pandemic (see ITF 2023); it also points out the possible trade-offs involved in the mobility changes introduced by the pandemic, such as less work travel at the expense of more non-work travel. The studies on the topic tend to agree that changes in habits and the socio-economic context will influence the city and mobility. The study of post-pandemic scenarios in the city of London (Travers et al. 2021) reflects well how lifestyle and socioeconomic context constraints impact mobility. This study includes a scenario in which proximity urbanism concepts are prioritized, in line with a greater awareness of vulnerability in cities; as well as a scenario in which the virtualization of work leads to a decline of the urban center and of the attractor areas of forced mobility.

## 3. Methodology

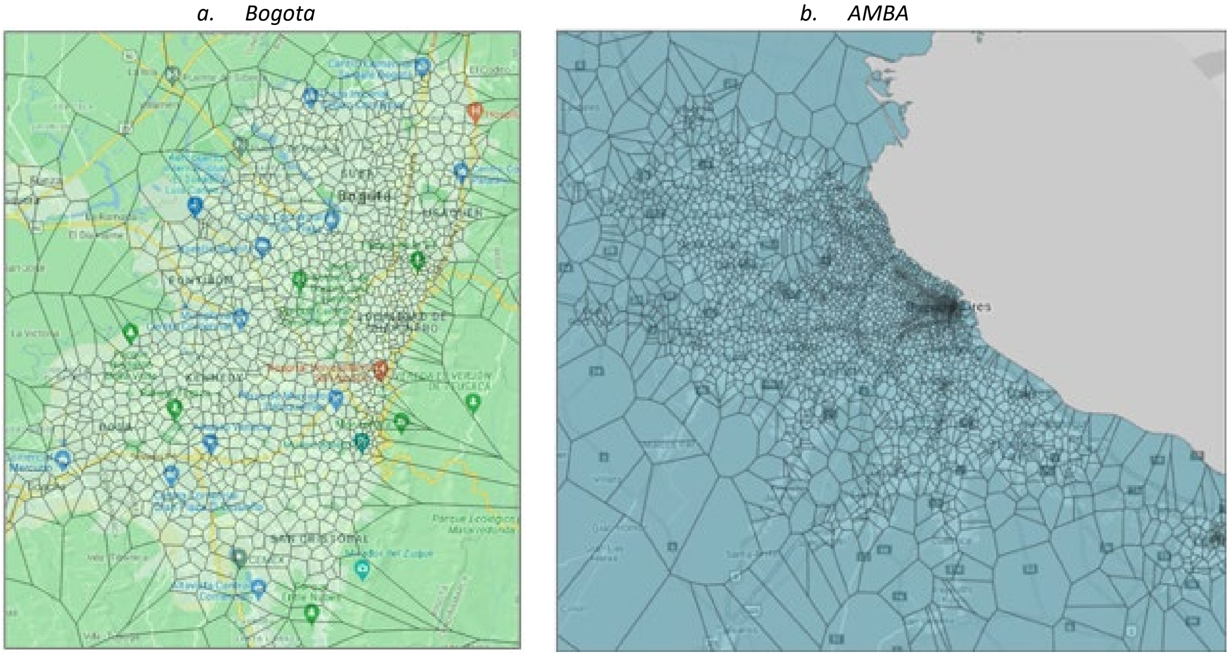
Mobile phone data refers to anonymized Call Detail Record (CDR) data (metadata), observed for every call/text made or received with timestamp, with GPS coordinates of the tower from where the call is made. Such data allows measuring mobility across entire cities or even countries at very fine spatial and temporal levels. Example outputs from mobile data that are relevant for understanding the changes in urban mobility introduced by the COVID-19 pandemic include: (i) dynamic population mapping – *How many people are at* *location X, at time T?*; (ii) individual mobility data – *How far are people traveling?;* and (iii) aggregated mobility data – *Origin-Destination (OD) matrices at the scale of cities and beyond.*

The analysis in the current paper was based on CDR data obtained from major mobile phone service operators in Argentina and Colombia, representing 37 percent and 20 percent of the respective national markets, each with 8 million to 9 million unique subscribers. The methodology combined CDR data, the primary source, with data from public transport validations (provided by Transmilenio in the case of Bogota and from the SUBTE smart card in Buenos Aires) and comprehensive household mobility surveys (from 2019 and 2010/2018 in Bogota and Buenos Aires, respectively). Unless otherwise indicated, the analysis and the individual indicators reported cover the entire Bogota metropolitan area (departments of Cundinamarca and Bogotá) and AMBA. Individual indicators of interest are separately reported for the core cities of the two metropolitan areas, namely the Bogota Capital District (Bogota D.C.) and the Autonomous City of Buenos Aires (CABA).

The mobility indicators are calculated by taking as total trips those identified as personal mobility, filtering out from the OD matrices those associated with professional mobility. The methodology for identifying professional mobility and overall methodology for calculating OD matrices generally follows other studies that have leveraged CDR data for mobility analysis (e.g., (Alexander 2015, Bachir et al. 2019, Bayir et al. 2010, Huang et al. 2019). In the case of Bogotá, the analysis was based on a total of 1,143 travel zones across the metropolitan area, of which 923 are located in Bogotá D.C. In AMBA, the analysis was based on a total of 2,010 travel zones across the metropolitan area, of which 534 are in CABA and 1,476 in PBA.

***Figure 1:*** *Zones corresponding to the cell phone towers in the two metropolitan areas*

*a. Bogota* *b. AMBA*



The CDR data sourced from mobile phone operators is processed into OD matrices by following a verification process and developing algorithms that disaggregate the matrices into different modes (i.e., non-motorized, public transport and motorized) and segment them into trip purposes (i.e., home-based work, home-based other, non-home based). Mobile phone data 'events' are generated by mobile phones as they communicate with the national cell network, and these events are collected by the mobile phone operator. Each event is tied to an anonymized user id and cell id, and this allows estimation of users' positions to be traced throughout time. The team developed algorithms to define 'stays' or 'journeys';

disaggregated the overall OD matrices by transport mode using complementary data (e.g., in the case of Buenos Aires, public transport smartcard data from SUBE); identified the trip purposes based on rules of thumb related to where the trips start, end, and their duration as well as complementary land use data; and lastly, expanded the anonymous observed sample to represent the total population of the region.

The assessment of the evolution of mobility indicators by income group was based on the spatial association of the identified travelers' home locations and the socioeconomic indicators available for the specific neighborhood blocs. In Bogota, this is based on the socioeconomic "strata" designation at the bloc level estimated by the National Administrative Department of Statistics (DANE), while in AMBA the indicator of percentage of households with unsatisfied basic needs is used, available from the National Institute of Statistics and Census of Argentina (INDEC) at the census radius level for most of the study area.

The principles followed for the construction of the indicator framework and the selection of indicators are adapted from international recommendations (e.g., Litman 2021; Olofsson and Brundell Freij 2017). These recommendations emphasize that indicators should be relevant to understanding a specific dimension of the transport phenomenon, easy to understand, reliable and measurable. While the proposed indicator framework is a powerful tool for decision making in mobility planning and management, it does not pretend to cover all the analysis needs of the transport system, as there are additional aspects to transport demand that need to be monitored (e.g., road safety or user satisfaction with the transport system). Thus, for the purposes of longer-run planning, the indicator framework complements the transport demand analysis capabilities provided by other, broader transport indicator frameworks.

## 4. The economic, transport, and regulatory context of the pandemic

### *4.1. The economic and transport sector context*

Public transport in Bogotá, the capital of Colombia of about 8 million people, is organized around the Integrated Public Transportation System (SITP), which brings together the collective public transport services and has components:

- Trunk system, consisting of the trunk and feeder services of the Transmilenio system, implemented since 2000, as well as cable services (TransMiCable). The trunk services run along the city's main roads and have segregated infrastructure, being one of the best known examples of Bus Rapid Transit (BRT) in the world. Feeder services connect the system's main stops with neighborhoods near the trunk lines. Cable services connect elevated areas of the city with Transmilenio's trunk system stops via cable cars.
- Zonal system, consisting of urban, complementary and special services. Urban services are usually transversal services, complementary services are associated with trunk services, and special services serve rural areas of Bogotá D.C.

In addition, Bogota's intermunicipal bus system connects Bogota D.C. with the municipalities of Cundinamarca that make up its metropolitan area. Finally, there are non-collective public transport services, which complement the collective public transport offer. In addition, there are three projects aimed at developing rail transportation in Bogotá: (i) the Bogotá metro, whose first line is scheduled to start operating in 2028 and second line expected in 2032; (ii) the Regiotram de Occidente, a train-tram infrastructure that is part of the commuter rail planning in metropolitan Bogotá, scheduled to start service in 2026, (iii) the expansion of the TransMilenio BRT network in four key corridors, among others.

AMBA is home to around 15 million people and consists of CABA and 40 municipalities of the Province of Buenos Aires (PBA). AMBA has fourteen Metrobus infrastructure corridors, a metropolitan bus network made up of over 300 lines,[3] nearly 300 km of protected cycle lanes within CABA, a surface and underground rail network, and a river transport system. The urban and suburban bus system in AMBA has typically accounted for approximately 80 percent of the almost 4 billion annual journeys made in the different modes of public transport which, in turn, account for half of all trips. Historically, about 12 percent of the total number of people entering CABA throughout the day come from the suburbs, and of these, 75 percent use public transport (Anapolsky 2013).

In October 2019, the total number of trips with origin and destination in the Bogota Metropolitan Area (departments of Bogotá and Cundinamarca) amounted to 24.5 million on weekdays. Of these, 19.6 million had origin and destination within Bogotá D.C. Weekend mobility was somewhat lower, with 22.3 million trips on Saturdays and 18.2 million trips on Sundays. Depending on the day of the week, Bogotá D.C. concentrated between 72 percent and 76 percent of the metropolitan area trips. In the metropolitan area as a whole, 35 percent of weekday trips were made by public transport, and 28 percent by private vehicle. "Compulsory mobility" (work commutes and study related trips) recorded the highest modal share of public transport in 2019: 42.5 percent of trips to places of study and 40.5 percent of trips to places of work on weekdays. The municipalities surrounding Bogotá have a strong link with the city, accounting for 5 percent of trips made within Bogotá D.C. in 2019.

In the same year, an average of 42.2 million trips were recorded on weekdays in AMBA, while the number of trips on Saturdays and Sundays was lower, at 37.1 million and 33.3 million, respectively. In 2019, CABA concentrated between 19 and 21 percent of the overall AMBA trips – in other words, its weight was much lower than that of Bogota D.C. in the overall Bogota Metropolitan Area. The modal shares in AMBA in 2019 were significantly different from Bogota's, with private motorized vehicles accounting for more than half (56.7 percent) of all trips on weekdays, compared to 24.8 percent in public transport, albeit with a significantly higher share of public transport (35 percent) and lower share of private vehicles (37.5 percent) in CABA specifically.

### *4.2. Mobility and other restrictions in response to the pandemic*

In Bogota, there were two distinct periods in the management of the pandemic, as reflected in the actions taken by the national, departmental, and municipal authorities: (1) mandatory isolation phase, between March 2020 and August 2020, in which most of the measures were adopted by the national government; and (2) selective isolation phase, starting in September 2020, in which municipalities have greater flexibility to manage the measures in their territory. Three types of measures were implemented that altogether reduced transport supply and/or ease of personal mobility:

- ***Direct mobility restriction measures*:** total or partial confinement and nighttime curfews to limit social contact; the so-called *pico y cédula* applied during the mandatory isolation phase in September 2020, December 2020 to February 2021 and April to May 2021, allowing certain activities such as shopping or banking to be carried out on a given day only by persons whose personal identification number ends with a certain number. These measures drastically reduce the generation of non-essential trips among those affected by the measures. It is important to note that *pico y placa*, Bogota's license-plate-based private vehicle circulation restriction policy, was temporarily lifted only during the mandatory isolation phase but was reinstated in September 2020.
- ***Distancing measures in public transport***, which reduced the capacity of public transport and therefore overall transport supply. The national Ministry of Transport in March 2020 established a minimum safety distance between passengers in public transport of 1 meter and a maximum occupancy of 35 percent of the vehicle capacity in mass transit systems. The maximum occupancy allowed was gradually raised,

[3] Includes 138 national jurisdiction lines serving inter-municipal and within-CABA trips, 106 provincial jurisdiction lines serving trips between districts in the Province of Buenos Aires, and 57 municipal jurisdiction lines serving trips within districts in the province.

reaching 50 percent by August 2020, 70 percent by December 2020, and by June 2021, those cities with ICU bed occupancies below 85 percent were allowed to use 100 percent of capacity.

- ***Other distancing measures***: Non-essential activities involving crowds, especially in enclosed spaces, were banned in Bogota from the beginning of the pandemic until June 2021. The permitted capacity of large events was not 100 percent until November 2021. Only in January 2022 were students allowed to fully return to face-to-face classes after almost 2 years.

In response to the pandemic, the Government of Argentina implemented several measures to manage the pandemic, in several phases: (1) strict confinement throughout the national territory through the application of "social, preventive and compulsory isolation" (ASPO), between mid-March 2020 and the end of April 2020; (2) de-escalation of strict containment, depending on the area, through a phased regime that relaxed some restrictions set by the ASPO, between the end of April 2020 and early June 2020, although during this period AMBA remained in strict containment; (3) selective confinement, through the application of ASPO in the areas with the highest virus transmission and "social, preventive and mandatory distancing" (DISPO) in the rest of the country, between the beginning of June 2020 and the beginning of April 2021; however, during this period AMBA remained under ASPO until early November 2020, and then switched to DISPO; and (4) period of restrictions determined based on epidemiological risk levels, from the beginning of April 2021; during this period, AMBA oscillated between periods of greater restriction (such as the end of May 2021, with a period of strict confinement) and others of more targeted restrictions such as nighttime curfews and capacity limitations.

As in Bogota, several types of restrictions relevant for mobility were implemented in AMBA:

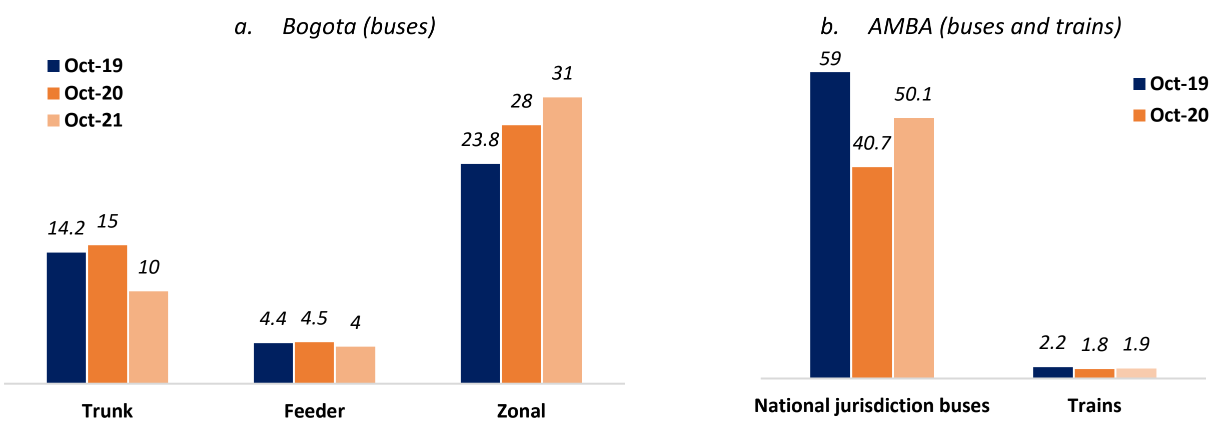
- ***Direct mobility restriction measures:*** Argentina maintained strict confinement throughout its territory between March 19, 2020 and April 26, 2020. During this period, leaving home was allowed only to stock up on food, medicine, and cleaning products. Face-to-face work was only allowed for essential workers. Between late April 2020 and early November 2020, AMBA followed a regime differentiated from the rest of the country by remaining under quarantine. During this time, local authorities were allowed to establish regulations for recreational outings – for example, in CABA, permits for weekend trips for minors began to be issued in May 2020. On November 9, 2020, AMBA moved to the DISPO regime, which marks the end of quarantine, with social gatherings and team sports of limited size allowed, as well as the possibility of unauthorized movement. CABA began the process of returning to face-to-face classes at all educational levels. In response to a new wave of infections, night curfews were implemented between early April and July 2021 in addition to a new strict confinement during the last week of May 2021. The improvement of the epidemiological situation as of the end of July 2021 allowed the removal of direct mobility restrictions.
- ***Restrictions on public transport use***: The ASPO decree of March 19, 2020, established that public transport in AMBA would only be usable by essential workers. Despite the relaxation of other measures during the period in which the DISPO applied, this limits on the use of public transport remained in force until the end of August 2021, although the list of essential workers had undergone changes. On March 17, 2020, it was decreed that only seated passengers could travel in buses and trains, although these restrictions were progressively lifted in the second half of 2020.
- ***Other distancing measures***: Some activities continued to be limited for longer periods of time, which also had an impact on transport demand. Non-essential activities involving crowds, especially in enclosed spaces, were banned from the beginning of the pandemic until the end of 2021, and even in the case of large outdoor events the permitted capacity did not reach 100 percent until November 2021. The suspension of face-to-face classes in schools and universities remained in effect between March and November 2020, as well as between April and June 2021. The State encouraged the adoption of teleworking among public sector workers beyond periods of strict isolation, particularly for those in charge of children under 13 years of age.

The restriction measures described above were implemented in different times and combinations in the two urban areas and therefore had different degrees of impact on the mobility indicators calculated based on CDR data for the three study periods (October 2019, 2020, and 2021). In Bogota, none of the study periods were affected by direct mobility restriction measures: there were no direct restrictions on all trips (peak and license plate), although there were peak and license plate restrictions on private vehicle trips between Monday and Friday. The hours of application of the measure are from 6:00 to 8:30 in the morning and from 15:00 to 19:30 in the afternoon. The maximum allowed occupancy in public transport vehicles was still only 70 percent in October 2020 but already 100 percent in October 2021, and there were some restrictions on non-essential gatherings, capacity of large events, and in-person studies in both October 2020 and 2021. In AMBA, the October 2020 study period was still affected by both travel restriction measures (last weeks of enforced social, preventive and mandatory isolation (ASPO)) and restriction on the use of public transport, which was only allowed for essential workers. The October 2021 study period was no longer affected by these constraints.

### *4.3. Planning and transport supply adjustments*

Bogota's public transport system significantly reduced its supply during the periods of mandatory isolation. The first weeks of confinement saw the greatest reductions, with Transmilenio's programmed fleet values reaching 20-25 percent of the usual levels. However, supply did not fall as much as demand, with the objective of maintaining the occupancy conditions established by the public transport distancing measures mentioned above. Public transport supply grew in the second half of 2020, and by October 2020, the number of bus-kilometers traveled on the zonal, feeder, and trunk lines were already higher than in October 2019. In 2021, the supply of the zonal component continued to grow (in October 2021 being 20 percent above the October 2019 levels in terms of the number of dispatches and 30 percent above in terms of vehicle-km traveled), while the trunk and feeder supply was adjusted downwards (by 30 percent and 10 percent, respectively, compared to 2019) (Figure 2).

***Figure 2:*** *Change in the number of kilometers traveled in the months of October 2019, 2020 and 2021 (million)*




Source: Transmilenio, Ministry of Transport of the Government of the City of Buenos Aires

Similarly, in AMBA, the public transport system significantly reduced its offer during the periods of strict confinement (ASPO). The first weeks of confinement saw the greatest reductions, with limited occupancy and limited train and bus dispatches. However, supply did not fall as much as demand, in order to maintain the occupancy conditions established by the public transport distancing measures. The supply of national jurisdiction bus services – serving within-CABA and CABA-Province routes – was reduced by 31 percent of vehicle-km, while train service was cut by 18 percent. The subway (Subte) service, which is important for mobility within CABA although it represents a fraction of the vehicle-kilometers of service offered by the bus and train lines, was reduced by nearly 44 percent. In addition to the drop in the number of seats offered, some

Subte stations were closed: initially, only 39 of 106 stations were kept open, extended to 50 stations in April 2020 and remained at this number during the October 2020 analysis period. By October 2021, all the stations of the network were operating, while the available supply on the rail riles measured in train-kilometers was still 15 to 20 percent below October 2019 levels.

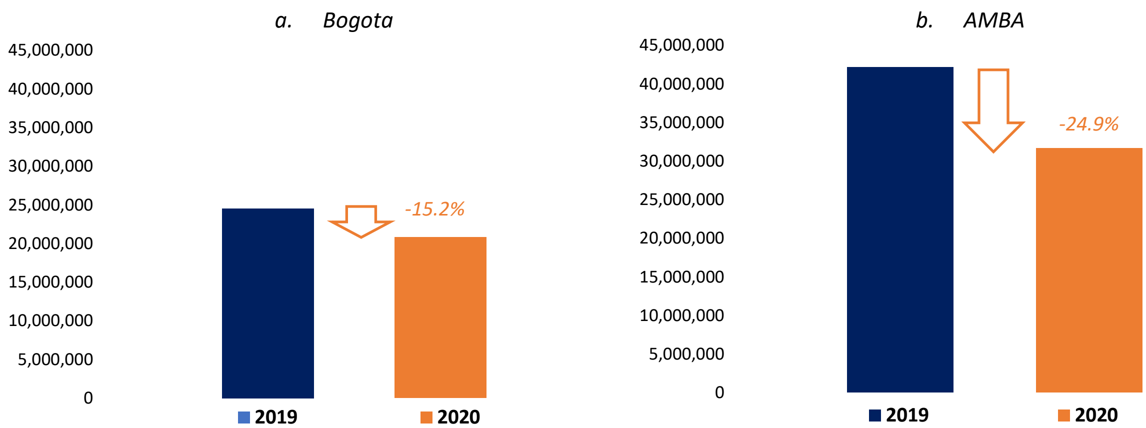
The pandemic led to an increased urgency to implement policies that benefit and protect active travelers (World Bank 2021). Also in the case of the Bogota and Buenos Aires metropolitan areas, albeit in the latter case concentrated in CABA, aggressive measures were taken to facilitate active mobility. Bogota implemented 84 km of temporary bike lanes. Buenos Aires built 17 km of new bicycle lanes on two of the city's main avenues, Córdoba and Corrientes.

## 5. The impacts of the pandemic on mobility in Buenos Aires and Bogota: Comparative results

### *5.1. Initial changes (2020): Decline in public transport use, non-home based, and peak-hour travel*

The initial reduction in total trips was much more significant in AMBA (25 percent) than in Bogotá (15 percent) (Figure 3). The fall was stronger in the central cities of both metropolitan areas, at 18 percent in Bogota D.C. and 33 percent in CABA on weekdays. The decline in travel was somewhat lower on Saturdays compared to weekdays although the trends on Sundays differed between the two metropolitan areas. Total trips in Bogota fell by 7.4 percent on Saturdays and by 2.7 percent on Sundays, while the corresponding reductions in AMBA were 14.0 percent and 24.8 percent.

***Figure 3:*** *Change in the number of daily trips on weekdays in October 2020 vs. 2019*



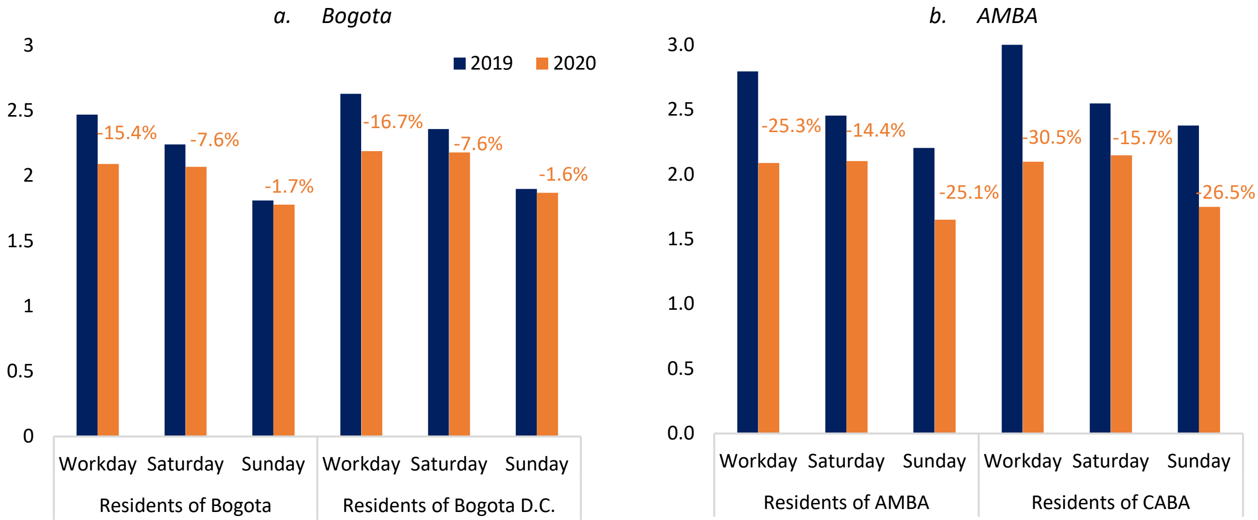

Source: Authors based on CDR data

The overall fall in the number of trips was driven mostly by falling trip generation rates (TGRs) per person, although population out-movement also played a role. In October 2019, Bogota's residents made on average 2.5 trips per day on weekdays and 2.2 trips and 1.8 trips on Saturdays and Sundays, respectively. In contrast, by October 2020, the TGRs had fallen by 15 percent on weekdays although only by 7 percent on Saturdays and 1-2 percent on Sundays. In AMBA, the TGRs on weekdays, Saturdays, and Sundays in 2019 were, respectively, 2.8, 2.46, and 2.21. By October 2020, they had declined by about 25 percent on weekdays and Sundays and by 14 percent on Saturdays.

As with total trips, TGRs per person fell disproportionately more in Bogota D.C. and CABA than in the overall metropolitan areas, from an initially higher level. The reduction in weekday TGRs was greater in Bogota's northern localities – from an initially higher level – and smaller in the western ones. Trip generation on weekdays fell by more than 25 percent in Usaquén, Chapinero, and Teusaquillo, compared to just 2 percent in

Bosa. In AMBA, the drop in trip generation was greater in the northern and coastal districts of CABA as well as in the coastal municipalities of Vicente López and San Isidro.

***Figure 4:*** *Change in number of trips per person per day (trip generation rates) on weekdays in October 2020 vs. 2019*




Source: Authors based on CDR data

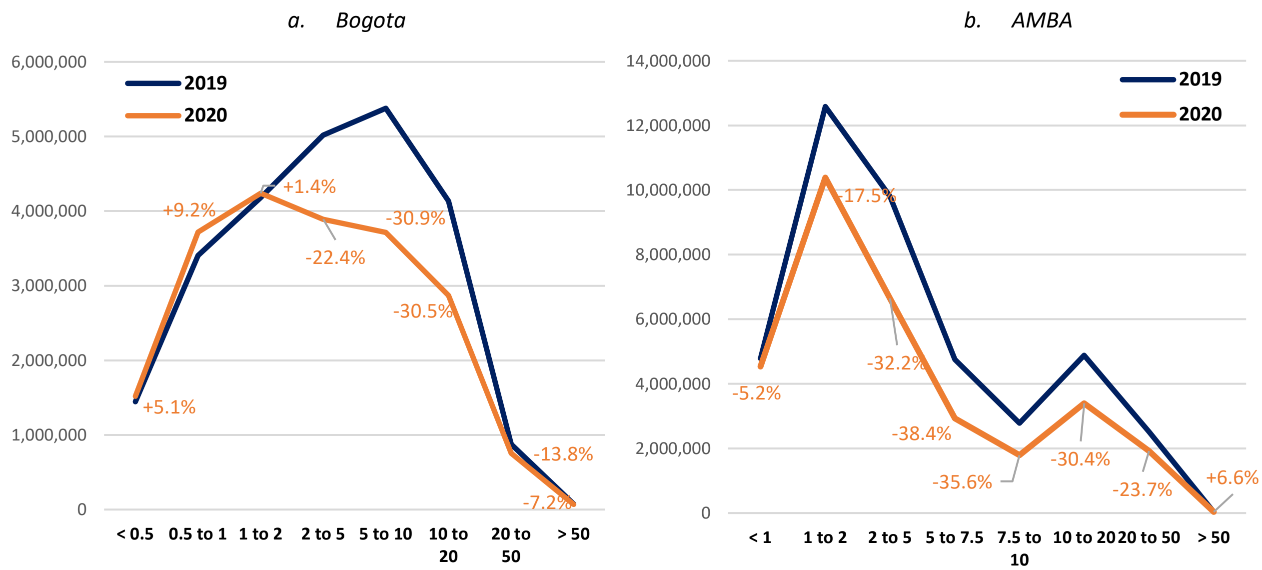
The drop in TGRs in 2020 was associated with a significant increase in the share of residents not traveling at all. In Bogota, the share of such residents on weekdays increased from 24 percent in 2019 to 35 percent in 2020. The pandemic reversed the geographic distribution of non-travelers, with peaks in 2020 in the northern localities and markedly increasing differences between localities. In Usaquén, Chapinero and Teusaquillo, the share non-travelers doubled with respect to 2019, likely due to having more possibilities to adopt teleworking and other virtual activities (given the higher socioeconomic level of these localities). In contrast, this share grew by only 25-30 percent in Bosa and Ciudad Bolivar. In AMBA, the share of residents not traveling increased from 19 percent to 32 percent on weekdays.

In both metropolitan areas, the largest declines were recorded in non-home-based trip generation, of 35 percent on weekdays in Bogota and 37 percent in AMBA. These typically include trips associated with recreational and similar purposes. In comparison, home-based trip generation declined only by 8.5 percent in Bogota and 22 percent in AMBA. Within home-based trips, the drop was greater among trips to work and studies specifically ("compulsory mobility"), of 11 percent in Bogota and 17 percent in AMBA, which can be explained by the transition in many businesses and education institutions to remote home/studies or to hybrid modes.

Especially because of the decline in work and study related trips, there was a fall in the number of trips made in both central cities by residents of municipalities of the broader metropolitan areas. The share of trips within Bogotá D.C. made by residents living outside the city fell from 5.4 percent in 2019 weekdays to 4.9 percent in 2020. The linkage of Cundinamarca municipalities to Bogotá has declined during the pandemic, especially among non-bordering municipalities. The decrease was greater on weekdays than on weekends. In the case of weekday trips within CABA, while 12 percent of were made by out-of-city residents in 2019, this share fell to 9 percent in 2020. These declines were more intense among residents of municipalities bordering CABA, and were generally greater in the north of the AMBA than in the south.

Average travel distances declined significantly in 2020. In Bogota, average travel distances decreased by between 5 and 10 percent in the metropolitan area overall and by between 12 and 15 in Bogotá D.C., depending on the type of day (less so during weekends). The reduction in the number of trips was concentrated in the medium and long distances (greater than 2 km), with a fall of more than 30 percent on weekdays in the 5-20 km range (Figure 5). At the same time, there was an increase in the number of trips of less than 2 km and especially of less than 1 km. In AMBA, the number of trips of less than 500 meters fell by 5 percent, compared to 25 percent across all trip distances. In CABA, the number of trips between 2 and 10 km fell by more than 35 percent in the metropolitan area as a whole and by more than 50 percent.

***Figure 5:** Change in the number of trips on a weekday in 2019 vs. 2020, by trip distance (km)*

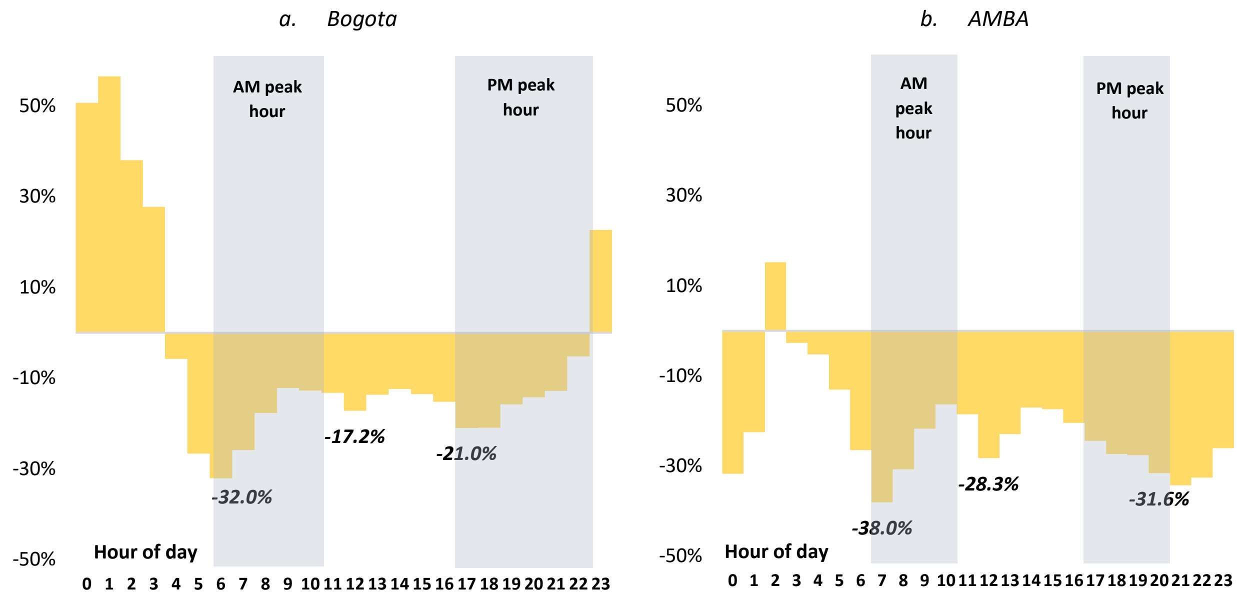



Source: Authors based on CDR data

Changes in the distribution of distances meant a greater concentration of mobility flows on a smaller number of routes in Bogota but an increased dispersion in AMBA. In 2020, the number of OD pairs in which trips were recorded fell by 28 percent in Bogota on weekdays, and the median number of trips traveled per OD pair grew (+13 percent), indicating a greater concentration of mobility flows. In contrast, in AMBA, the pandemic caused a greater spatial dispersion of mobility flows, especially on weekdays. The number of OD pairs in which trips are recorded declined less than the total number of trips, leading to a drop in the median number of trips per OD pair by 8.5 percent on weekdays.

The pandemic changed the hourly profile of weekday travel, with more intense trip reductions at peak times, reaching 32 percent in Bogota and 38 percent in AMBA in the morning peak hours (Figure 6). The reduction in the number of trips during peak hours in AMBA was concentrated in the flows between residential areas in the northern districts of CABA and Commune 1, an attractor of forced mobility due to the large number of offices located in the area. In both metropolitan areas also the decline in public transport use specifically was greatest during peak hours. This is largely explained by the significant decline in in-person employment and, thus, physical travel during the typical commute hours. However, while in AMBA the time profile of trips changed considerably, with a significant reduction in the midday peak (largely corresponding to school pick-ups and student travel) and in the evening peak hours, Bogota kept an hourly profile comparatively more similar to the pre-pandemic. In both metropolitan areas, the hourly profile of mobility changed more on weekdays than on weekends and more within the central cities (Bogota, D.C. and CABA).

***Figure 6**: Change in total number of trips per hour in the two metropolitan areas in 2020 compared to 2019 (%)*



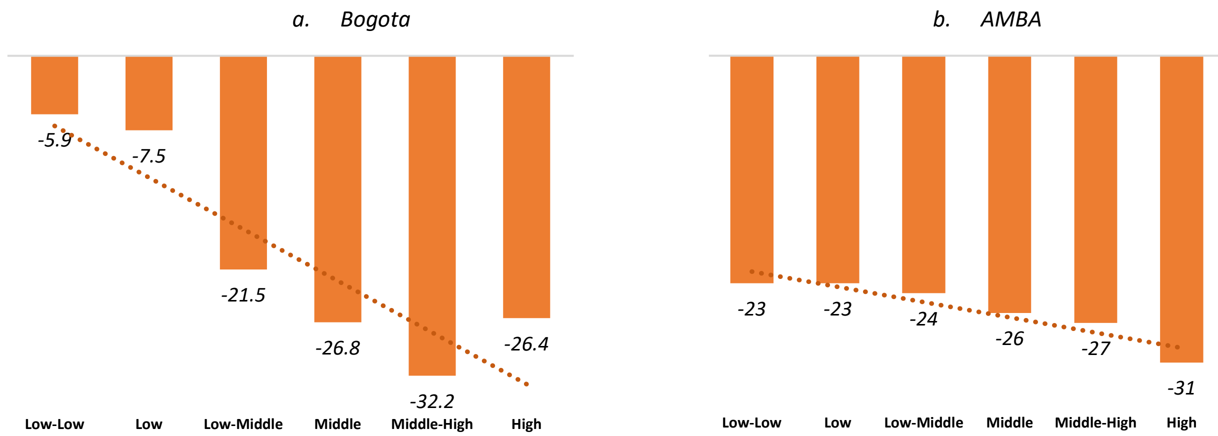

Source: Authors based on CDR data

The initial reduction of public transport was much more drastic in AMBA than in Bogotá, declining from a modal share of 24.8 percent in October 2019 to 9 percent a year later, compared to a decline from 34.7 percent to 28.2 percent in Bogota. The drop in public transport demand occurred mainly during peak hours and late in the day in Bogota while it was quite uniform throughout the day in AMBA. While the drop was less steep, also in Bogota the isolation measures imposed by the national government and the users' perception of a high probability of contagion in the public transport system drove a sharp reduction in trips (by more than 30 percent on weekdays, with the sharpest declines in Bogotá D.C.) and fare revenues. In the case of Transmilenio, while transport supply was reduced during the first weeks of mandatory isolation, in the following months the goal was to operate with the same levels of supply to ensure compliance with passenger spacing requirements. The drop in demand and the maintenance of supply caused the proportion of the cost covered by fares to halve, from 71 percent in 2019 to 35 percent in 2020 (Bogotá 2021). In AMBA, fare coverage for bus services stood at around 12 percent of total costs in 2020, representing a third of the coverage from before the pandemic, and the required subsidy to keep the operation running in 2020 was 71 percent higher than in 2019. In the case of rail, fare coverage was already extremely low before the pandemic and during it declined to just a few percent for some operations.

In both metropolitan areas the use of non-motorized transport initially grew significantly, increasing from 37.2 percent to 44.2 percent of trips in Bogota and from 18.6 percent to 25.3 percent in AMBA. However, the shift to NMT in AMBA was mostly concentrated in CABA, while in AMBA, most of the shift from public transport was towards private motorized vehicles (56.7 percent to 65.7 percent), compared to almost no change in Bogota. Instead, in Bogotá, even a large share of trips as long as 10 km were replaced by non-motorized modes.

The underlying regulatory context provides some clues for the differing modal shift trends in the two metropolitan areas. While both CABA and Bogota D.C. have well developed cycleway networks, the broader Buenos Aires Metropolitan Area lacks such a network, meaning that inter-jurisdictional trips (between CABA and the Province of Buenos Aires, PBA) are not as feasible by cycling, nor are trips within PBA itself, which have increased in importance in recent years as a share of overall trips in AMBA. Moreover, part of the explanation for the much more significant shift to private vehicles in AMBA than in Bogota has to do with the underlying regulatory context. Namely, while a license plate based vehicle circulation restriction scheme (*Pico y Placa*) has been in place in Bogota for many years, with many adjustments made over time to increase its actual impact on private vehicle use, no such a scheme is yet in place in Buenos Aires although it has been contemplated for the City of Buenos Aires. In other words, while both central cities offered a "carrot" to non-motorized mobility in the form of well-developed cycleway infrastructure and public bikeshare systems, only Bogota also used a "stick" to deter private motorized vehicle use.

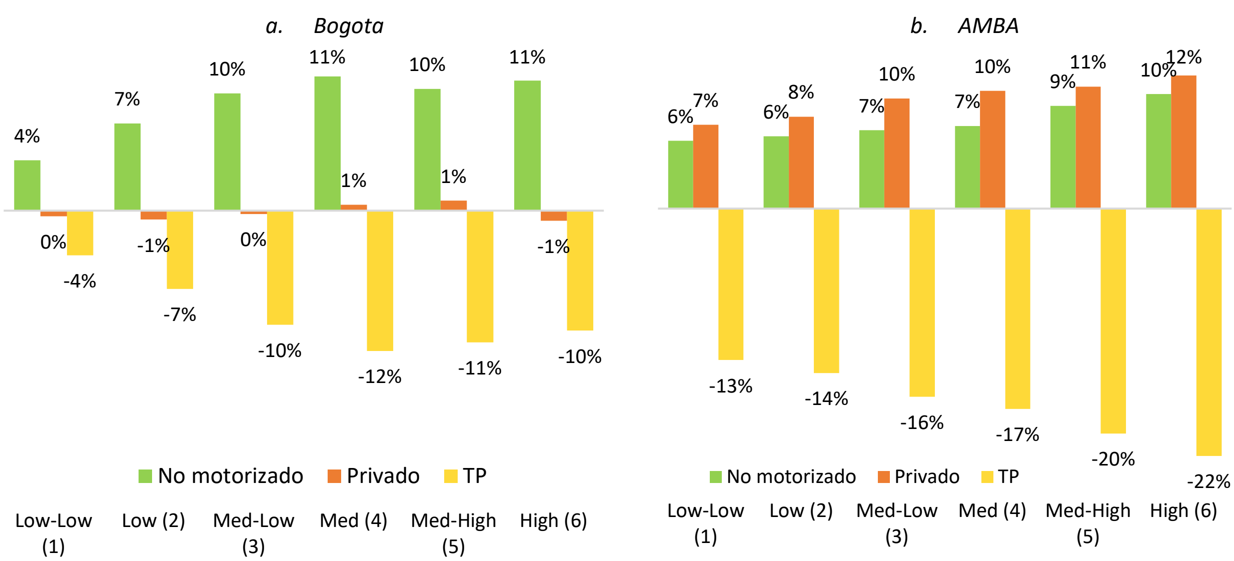
***Figure 7:*** *Change in trips per person per day in October 2020 vs. 2019 on weekdays, by travelers' income group (%)*




Source: Authors based on CDR data

Daily travel patterns and mobility behavior were significantly different for the socioeconomically vulnerable population. Especially in Bogotá, the most vulnerable population had less flexibility to change jobs, telework or modify their mobility behaviors when the mobility restrictions were introduced. While the TGR among people residing in the high socioeconomic strata neighborhoods declined by about 30 percent, it was only 6-8 percent below the 2019 level among the residents of low strata areas. The effect of socioeconomic level on the reduction in the number of trips was more intense for "compulsory mobility" specifically, likely associated with a greater propensity to adopt telework among the upper strata. In AMBA, the correlation between income and TGRs was comparatively much smaller, with all income groups reducing travel rates by between 23 and 31 percent.

***Figure 8****: Change in modal shares in October 2020 vs. October 2019, by travelers' income group (percentage points)*



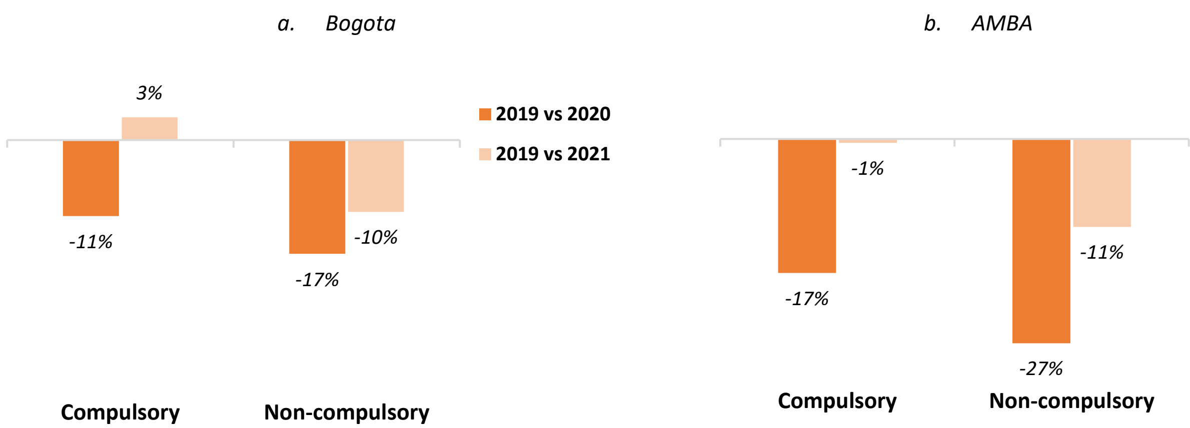

Source: Authors based on CDR data

On the other hand, the use of public transport was much more distinctly related to income in AMBA than in Bogota, with high income groups reducing their use of this mode by about 22 percentage points (and nearly proportionately increasing the use of private motorized modes), compared to about 13 percentage points among the low-income residents (Figure 8). In Bogota, in contrast, the decline in the share of public transport in overall modal split was the highest among middle-income residents (approximately 11 percentage points), and all income groups, especially the most well-off residents, significantly increased travel by walking and cycling.

### *5.2. Persistent changes (2021): Below-2019 public transport use, continued shift to NMT in Bogota, shift to private mobility in AMBA*

The initial drop in trip generation rates was partially, but not fully, reversed even by the fall of 2021. The total number of trips in 2021 was 7.5 percent lower than in 2019 on weekdays in Bogota and 9.5 percent lower in AMBA, meaning that about half of the drop recorded in 2020 had been recovered. The share of residents *not* traveling at all on a typical workday remained high – in Bogota, at 28 percent, compared to 24 percent in 2019, and in AMBA the respective figures were 25 percent (2021) and 19 percent (2019). The number of home-based trips in late 2021 had already practically recovered to 2019 levels in Bogota (-0.6 percent) although less so in AMBA (-8.2 percent), while the number of non-home-based trips were still at much lower levels (-26.5 percent in Bogota and -16.1 percent in AMBA) (Figure 9). This meant an increase in the weight of home-based mobility in both metropolitan areas. Also travel for work and education specifically ("compulsory travel") had reached (AMBA) or even exceeded (Bogota) pre-pandemic levels, while non-compulsory travel remained at 10-11 percent below the 2019 level.

***Figure 9:*** *Recovery of "compulsory" versus "non-compulsory" travel*

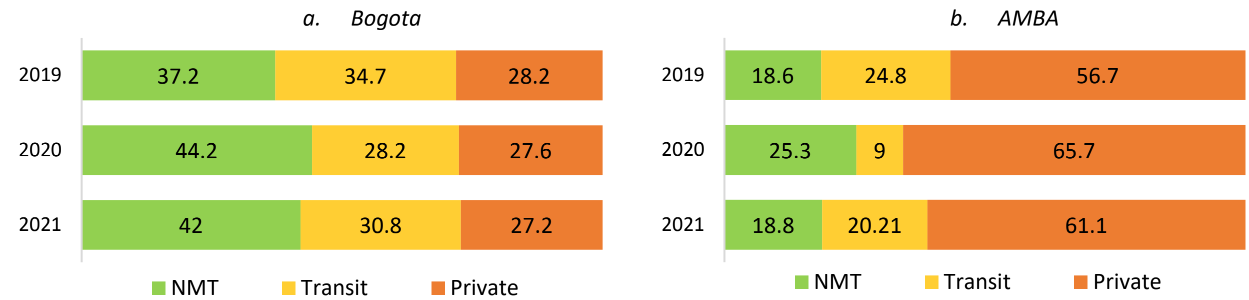



Source: Authors based on CDR data

Mobility within Bogota associated with residents in other municipalities continued to fall in 2021, so that on weekdays its share was 20 percent lower than in 2019. Relatedly, average distances traveled remained much below the 2019 level and mobility became significantly more spatially dispersed compared to both 2019 and 2020. In contrast, in AMBA, average distances traveled in 2021 were already *above* those recorded in 2019 (+3.2 percent) – in other words, the trends had more than fully reversed compared to 2020. Similarly, after an initial strong increase in spatial dispersion of travel, 2021 saw a partial reversal, with more trips recorded per OD pair compared to 2020. Also in contrast to Bogota, the trip generation of residents living in the Province of Buenos Aires traveling to CABA increased a lot compared to 2020 although it did not yet fully recover.

One of the more permanent imprints on mobility behaviors left by the pandemic – those still observable nearly two years later – was in terms of modal choices. Some of the changes in modal choices introduced by the "deep pandemic" were maintained or even reinforced in 2021. In both metropolitan areas, public transport in late 2021 continued to see demand below pre-pandemic levels. In Bogota, the absolute number of public transport trips in late 2021 was still 17.6 percent below the 2019 values in the metropolitan area as a whole and 20.6 percent below in Bogotá D.C. That said, daily validations data collected by Transmilenio suggest that the recovery continued thereafter until stabilizing in the first half of 2022 (in March 2022 the trunk and zonal components registered respectively 30.7 percent and 13.8 percent more ridership than in October 2021).

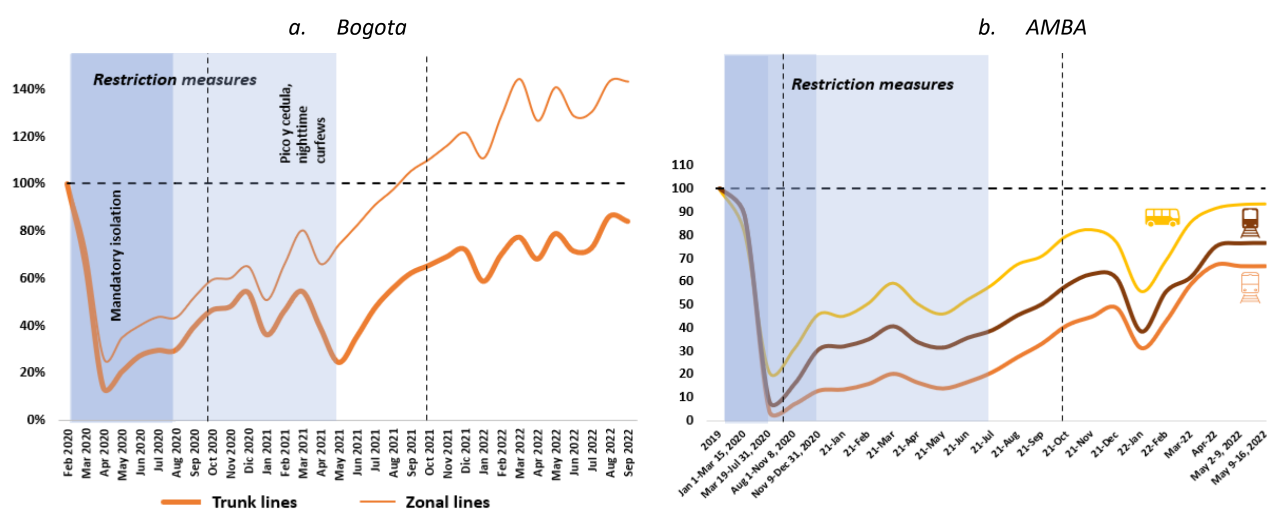
***Figure 10**: Modal shares in the two metropolitan areas in 2019 vs. 2020 vs. 2021*




Source: Authors based on CDR data

By the end of 2021, only in Bogota was the use of non-motorized transport still high, being nearly 5 percentage points above the 2019 level although declining by about 2 percentage points compared to 2020 (Figure 10). In contrast, in AMBA, the gains made in NMT share in 2019-2020 had completely evaporated by late 2021, although they remained significant specifically in CABA, where the initial increase in the modal share of walking and cycling was not only much steeper than in AMBA overall, reaching 41.2 percent in 2020 compared to 27.5 percent in 2019, but also by late 2021 these modes still maintained an elevated share (31 percent). The strong shift from public transport to private vehicles across all distance ranges observed in AMBA in 2020 still partly persisted in late 2021, while the shift from public transport to non-motorized mobility for short-distance trips had practically dissipated. Private motorized modes accounted for 61.1 percent of trips compared to 56.7 percent prior to the start of the pandemic in AMBA. As a result of the persistently higher private vehicle modal share and recovering trip numbers, there were days in AMBA in late 2021 with congestion levels higher than in 2019. In contrast, in Bogota, private modes reduced their share slightly even compared to 2020 and in late 2021 accounted for about 1 percentage point less of all trips than in late 2019.

***Figure 11:** Index of variation in public transport ticket transactions (Feb 2020 = 100)*




Source: Transmilenio (Bogota) and SUBE transaction data (AMBA)

The recovery of ridership varied by type of public transport system and the types of routes served. In Bogota, the trunk line public transport services had recovered much less so than the zonal line services, which by October 2021 were already above the pre-pandemic level (Figure 11). In AMBA, by far the least recovered public transport mode was the subway, which prior to the pandemic had experienced the most consistent growth in demand. Even as of May 2022, subway ridership was still 30-35 percent below the pre-pandemic level, while bus ridership had nearly recovered.

## 6. Policy implications

Two years after the start of the pandemic, trip generation and temporal distribution in both metropolitan areas were still far from 2019 values. Trip distances had returned to 2019 patterns in AMBA, but not in Bogotá. While in Bogota the number of NMT trips continued to increase in 2021, in AMBA it fell back to even below the 2019 level. In neither metropolitan area had public transport trips recovered. The persistence of these changes in the coming years will determine the key challenges of transport planning and the priorities for mobility studies in the two metropolitan areas.

***Implement demand management policies combined with investment in NMT***. The modal shift from public transport in Bogotá towards non-motorized modes, in contrast to the shift primarily to private vehicles in AMBA, can be at least partly attributed to the underlying regulatory context, in which only the former urban area had in place policies that strongly limit private vehicle use. For AMBA and other global cities, the example of Bogotá illustrates that appropriately targeted and calibrated transport demand management policies can help achieve a more sustainable modal shift, especially when combined with investments in infrastructure that supports alternative modes such as cycling. However, as shown by the example of CABA, significant gains in non-motorized mobility can also be achieved just through consistent, long-term NMT policies and investment in safe NMT infrastructure.

***Improve the quality of the public transport system and adjust it to the changing mobility needs.*** The decline in the use of public transport occurred to a greater extent among high-income groups. Therefore, comfort, travel time, and safety in public transport will need to be improved to recover this demand segment. At the same time, planners and decision makers should consider systemic inequalities and unequal levels of risk and exposure, and support the mobility needs of the most vulnerable residents who during the pandemic were less able to switch to modes they considered safe due to public transport “captivity”. The spatial dispersion of mobility is a relevant factor for the competitiveness of public transport systems, since they are better suited to efficiently absorb concentrated flows than dispersed flows. The spatial dispersion of mobility in Bogota increased significantly in 2020 and even more so in 2021; in other words, the density of trips per OD pair decreased. In AMBA, the initial decline in trip density per OD pair was partially reversed in 2021. At the same time, in both metropolitan areas, the hourly profile of trips changed significantly, especially so in AMBA, with a decreased peak during the usual morning and evening peak hours. With the expectation of remote and hybrid work and study arrangements persisting and possibly increasing in the future, the transport planning agencies may need to adjust the supply of public transport services during the traditional “commute” hours while possibly deploying additional services elsewhere.

***Leveraging of state-of-the-art data tools.*** The dynamics affecting transport systems require to frequently review whether the tools and procedures used to analyze mobility are still valid for capturing the transport demand information that is necessary to plan and manage transport services (ITF 2021). The pandemic posed a major disruption to people’s lives and daily activities, and, therefore, to transport demand in cities. Thanks to *big data*, urban policy makers now have more effective and agile tools at their disposal to test, evaluate, and scale new measures in a more responsive manner.

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**Annex 1:** Summary of key mobility indicators for October 2019, 2020, and 2021

**Table 1**: Evolution of mobility indicators of weekdays in Bogota and AMBA

| **Indicator** values **and** (**unit**) | *BOGOTA* | | | *AMBA* | | |
|---|---|---|---|---|---|---|
| | **2019** | **2020 (vs. 2019)** | **2021 (vs. 2019)** | **2019** | **2020 (vs. 2019)** | **2021 (vs. 2019)** |
| **Total number of trips within the study area (trips)** | 24.509.327 | 20.778.513 (-15,2%) | 22.727.827 (-7,3%) | 42.149.431 | 31.643.244 (-24,9%) | 38.125.199 (-9,5%) |
| **Trip generation rate of residents in the study area (trips/person/day)** | 2,47 | 2,09 (-15,3%) | 2,29 (-7,0%) | 2,80 | 2,09 (-25,3%) | 2,48 (-11,2%) |
| **Percentage of residents in the study area that do not travel (%)** | 23,7% | 34,5% (+10,8p.) | 28,4% (+4,6 p.) | 19,0% | 32,3% (+13,4p.) | 24,7% (+5,7 p.) |
| **Percentage of trips the central city by non-residents of central city (%)** | 5,4% | 4,9% (-0,5p.) | 4,3% (-1,1p.) | 12,1% | 9,1% (-3,0p.) | 11,0% (-1,0p.) |
| **Percentage of home-based trips in the field of study (%)** | 74,2% | 80,1% (+5,9p.) | 79,6% (+5,3p.) | 83,1% | 86,0% (+2,8p.) | 84,4% (+1,2p.) |
| **Percentage of obligatory mobility trips in the study area (%)** | 22,8% | 23,9% (+1,1p) | 25,3% (+2,6p.) | 17,0% | 18,7% (+1,7p) | 18,7% (+1,7p.) |
| **Percentage of non-home-based trips in the study area (%)** | 25,8% | 19,9% (-5,9p.) | 20,4% (-5.3p.) | 16,9% | 14,0% (-2,8p.) | 15,6% (-1,2p.) |
| **Number of trips between 6:00 and 10:00 (Bogota) or between 7:00 and 10:00 (AMBA) in the study area (trips)** | 5.854.948 | 4.518.211 (-22,8%) | 5.151.213 (-12,0%) | 7.202.197 | 4.979.065 (-30,9%) | 6.585.032 (-8,6%) |
| **Number of morning peak hour trips (7:00-8:00) in the study area (trips)** | 1.655.651 | 1.227.162 (-25,9%) | 1.447.667 (-12,6%) | 2.658.818 | 1.647.790 (-38,0%) | 2.401.805 (-9,7%) |
| **Number of trips between 16:00 and 20:00 (Bogota) or between 17:00 and 20:00 in the study area (trips)** | 6.287.914 | 5.124.949 (-18,5%) | 5.715.116 (-21,4%) | 8.333.108 | 6.131.928 (-26,4%) | 7.541.250 (-9,5%) |
| **Number of evening peak hour trips (17:00-18:00 in Bogota and 18:00-19:00 in AMBA) in the study area (trips)** | 1.737.967 | 1.373.152 (-21,0%) | 1.591.725 (-8,4%) | 2.899.975 | 2.108.417 (-27,3%) | 2.584.985 (-10,9%) |
| **Percentage of off-peak trips (10:00-16:00) in the study area (trips)** | 28,1% | 28,5% (+0,4p.) | 27,8% (-0.3p.) | 29,2% | 30,9% (+1,7p.) | 29,8% (+0,6p.) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Average distance of trips in the study area (meters)** | 6.133 | 5.493<br>(-10,4%) | 5.626<br>(-8,3%) | 6.049 | 5.795<br>(-4.2%) | 6.245<br>(+3,2%) |
| **Median size of OD pairs in the study area (trips/OD pair/day)** | 9,0 | 10,1<br>(+12,2%) | 8,7<br>(-3,3%) | 5,1 | 4,6<br>(-8,5%) | 4,8<br>(-4,5%) |
| **Trip generation from peripheral municipalities to central cities (trips/person/day)** | 0,23 | 0,17<br>(-25,0%) | 0,19<br>(-18,1%) | 0,29 | 0,19<br>(-35,4%) | 0,24<br>(-17,6%) |
| **Number of trips by non-motorized modes in the study area (trips)** | 9.115.343 | 9.182.636<br>(0,7%) | 9.556.228<br>(4,8%) | 7.825.979 | 8.001.966<br>(+2,2%) | 7.177.725<br>(-8,3%) |
| **Number of trips by public transport in the study area (trips)** | 8.493.021 | 5.851.822<br>(-31,1%) | 6.996.025<br>(-17,6%) | 10.434.109 | 2.856.340<br>(-72,6%) | 7.662.591<br>(-26,6%) |
| **Number of trips by private vehicle in the study area (trips)** | 6.900.962 | 5.744.054<br>(-16,8%) | 6.175.574<br>(-10,5%) | 23.889.343 | 20.784.938<br>(-13,0%) | 23.284.883<br>(-2,5%) |
| **Modal share of non-motorized modes in the study area (%)** | 37,2% | 44,2%<br>(+7,0p.) | 42,0%<br>(+4,8p.) | 18,6% | 25,3%<br>(+6,7p.) | 18,8%<br>(+0,2p.) |
| **Modal share of public transport in the study area (%)** | 34,7% | 28,2%<br>(-6,5p.) | 30,8%<br>(-3,9p.) | 24,8% | 9,0%<br>(-15,8p.) | 20,1%<br>(-4,7p.) |
| **Modal share of private vehicles in the study area (%)** | 28,2% | 27,6%<br>(-0,6p.) | 27,2%<br>(-1,0p.) | 56,7% | 65,7%<br>(+9,0p.) | 61,1%<br>(+4,5p.) |

**Table 2**: Evolution of mobility indicators of Saturdays in Bogota and AMBA

| **Indicator** values and (**unit**) | *BOGOTA* | | | *AMBA* | | |
|---|---|---|---|---|---|---|
| | **2019** | **2020 (vs. 2019)** | **2021 (vs. 2019)** | **2019** | **2020 (vs. 2019)** | **2021 (vs. 2019)** |
| **Total number of trips within the study area (trips)** | 22.322.318 | 20.675.856<br>(-7,4%) | 22.067.968<br>(-1,1%) | 37.073.517 | 31.884.611<br>(-14,0%) | 33.663.300<br>(-9,2%) |
| **Trip generation rate of residents in the study area (trips/person/day)** | 2,24 | 2,07<br>(-7,3%) | 2,21<br>(-1,2%) | 2,46 | 2,10<br>(-14,4%) | 2,19<br>(-10,8%) |
| **Percentage of residents in the study area that do not travel (%)** | 22,9% | 31,8%<br>(+9,0p.) | 28,5%<br>(+5,6p.) | 24,6% | 34,3%<br>(+9,7p.) | 30,0%<br>(+5,4p.) |
| **Percentage of trips the central city by non-residents of central city (%)** | 5,8% | 5,1%<br>(-0,8p.) | 5,3%<br>(-0,6p.) | 9,7% | 7,1%<br>(-2,6p.) | 9,4%<br>(-0,3p.) |

| | | | | | | |
|---|---|---|---|---|---|---|
| **Percentage of home-based trips in the field of study (%)** | 75,2% | 79,0%<br>(+3,8p.) | 78,2%<br>(+3,1p.) | 83,9% | 86,1%<br>(+2,2p.) | 84,1%<br>(+0,2p.) |
| **Percentage of obligatory mobility trips in the study area (%)** | 15,5% | 19,2%<br>(+3,7p.) | 19,2%<br>(+3,8p.) | 11,1% | 13,0%<br>(+1,9p.) | 12,7%<br>(+1,6p.) |
| **Percentage of non-home-based trips in the study area (%)** | 24,8% | 21,0%<br>(-3,8p.) | 21,8%<br>(-3,1p.) | 16,1% | 13,9%<br>(-2,2p.) | 15,9%<br>(-0,2p.) |
| **Average distance of trips in the study area (meters)** | 6.072 | 5.660<br>(-6,8%) | 5.527<br>(-9,0%) | 5.569 | 5.083<br>(-8,7%) | 5.718<br>(+2,7%) |
| **Median size of OD pairs in the study area (trips/OD pair/day)** | 11,3 | 13,1<br>(+15,9%) | 10,4<br>(-8,0%) | 6,0 | 6,0<br>(-1,0%) | 6,1<br>(+1,7%) |
| **Trip generation rate from peripheral municipalities to central cities (trips/person/day)** | 0,20 | 0,17<br>(-12,3%) | 0,18<br>(-8,0%) | 0,19 | 0,13<br>(-31,0%) | 0,16<br>(-17,7%) |
| **Number of trips by non-motorized modes in the study area (trips)** | 8.821.938 | 9.223.262<br>(+4,5%) | 9.469.106<br>(+7,3%) | 7.855.200 | 8.521.711<br>(+8,5%) | 7.026.691<br>(-10,5%) |
| **Number of trips by public transport in the study area (trips)** | 7.155.895 | 5.771.734<br>(-19,3%) | 6.577.713<br>(-8,1%) | 5.858.472 | 2.520.095<br>(-57,0%) | 4.888.767<br>(-16,6%) |
| **Number of trips by private vehicle in the study area (trips)** | 6.344.485 | 5.680.860<br>(-10,5%) | 6.021.148<br>(-5,1%) | 23.359.846 | 20.842.804<br>(-10,8%) | 21.747.842<br>(-6,9%) |
| **Modal share of non-motorized modes in the study area (%)** | 39,5% | 44,6%<br>(+5,1p.) | 42,9%<br>(+3,4p.) | 21,2% | 26,7%<br>(+5,5p.) | 20,9%<br>(-0,3p.) |
| **Modal share of public transport in the study area (%)** | 32,1% | 27,9%<br>(-4,2p.) | 29,8%<br>(-2,3p.) | 15,8% | 7,9%<br>(-7,9p.) | 14,5%<br>(-1,3p.) |
| **Modal share of private vehicles in the study area (%)** | 28,4% | 27,5%<br>(-0,9p.) | 27,3%<br>(-1,1p.) | 63,0% | 65,4%<br>(+2,4p.) | 64,6%<br>(+1,6p.) |