Insights from Leveraging Big Data to Track the Impact of the COVID-19 Pandemic on Mobility in Buenos Aires

The COVID-19 pandemic and the lockdown measures implemented in 2020 disrupted mobility in cities around the globe, by adding new constraints to the travel behaviors of the residents and businesses and by at least temporarily changing personal mobility preferences. However, while various policy responses followed over the subsequent months, including by the authorities governing the Buenos Aires Metropolitan Area (AMBA for its Spanish acronym), these were implemented in the absence of adequate data that would allow understanding exactly how travel patterns had changed, their drivers, and the likely persistence of the pandemic-induced changes going forward. Conducted at a time that could already be called the “new normal,” the study discussed in this article aimed to fill this knowledge gap by drawing on mobile phone, mobility app, and public transport smart card based “big data” and by surveying over 20,000 private motorized mode users on the ground.
Since the Steep Decline in March 2020, Overall Mobility Appears to Be Recovering

Using millions of observations of mobile phone call detail records (CDRs) covering the Metropolitan Area, the study team analyzed several key mobility indicators at the scale of AMBA for the prepandemic (October 2019), pandemic (October 2020), and “new normal” (October 2021) periods. Overall, the total number of trips made in AMBA on an average weekday was more than 11 percent lower in 2021 than in 2019. Trip generation rates per person in 2021 were still below the 2019 level in the central part of the Metropolitan Area (Autonomous City of Buenos Aires, or CABA) and the first ring of Greater Buenos Aires (GBA), while in the peripheral parts of AMBA they had recovered more.

As shown in figure 1, the overall hourly trip pattern in the prepandemic and the “new normal” periods appears to be similar, with the highest peak at around 5:00 to 6:00 p.m. (P017 to P018) and a second one at 7:00 to 8:00 a.m. (P07 to P08) However, while the overall hourly trip distribution did not change much, the intensity of the highs and the lows did. Namely, the morning, mid-day, and evening rush hour peaks in 2021 were lower than in 2019, which can be explained by the lower share of people commuting to in-person jobs, among other factors.

Figure 1. Hourly Trip Distribution in AMBA on a Weekday in October in 2019 vs. 2021

Interestingly, as revealed by complementary analysis conducted by the team using data tracked by Waze for Cities for the same type periods (see figure 2), even though total traffic intensity measured across the entire day was 11 percent lower, consistent with the overall figure obtained from the CDR analysis, the amount of “high” congestion in October 2021 (panel c) appears to have exceeded the October 2019 (panel a) level during the highest activity hours. Moreover, there was a particular increase in the “high” level of congestion in CABA specifically.

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1 In the Waze for Cities data, the congestion level is classified as either low (levels 1 and 2) or high (levels 3 and 4).
What Explains a Drop in the Overall Number of Trips, but an Increase in Congestion?

Already on a decline since a peak in 2012, public transport ridership was hit heavily by the pandemic and the associated lockdowns and changes in passenger preferences. Public transport ridership in AMBA declined sharply in March 2020 and by May 2022 it had not yet recovered despite picking up after the end of the lockdown measures (figure 3). As inferred from the Sistema Único de Boleto Electrónico (SUBE) smart card transaction data, in mid-May 2022, public transport ridership still stood at only 79 percent of the level of the same month of 2019, ranging from just 61 percent of the 2019 level in the case of the subway (called Subte by locals) to 79 percent in the case of rail to 93 percent in the case of buses. These figures can be explained not only by lower overall mobility, but also a significant shift to private motorized modes. According to the survey implemented as part of the current study of over 20,000 current car and motorcycle users, roughly 12 percent of them had shifted to the motorized mode only since the start of the pandemic, and the vast majority of them had previously relied on public transport.

Private motorized mobility saw an immediate drop of about 90 percent at the very beginning of the pandemic due to a government mandated lockdown; however, within a year it had more or less fully recovered. As of mid-May 2022, the volume of private vehicle flows recorded on AMBA’s highways stood at 107 percent the level of an average work week in 2019 (see figure 3). Also, according to the CDR-based analysis, while most neighborhoods in AMBA in October 2021 were still seeing significantly fewer trips by public transport compared to October 2019, trip generation rates by private motorized transport had already exceeded the pre-pandemic level in many areas (figure 4).
Figure 3. Change in SUBE Transactions and Private Vehicle Flows on AMBA's Motorways, 2020 to 2022

Source: Buenos Aires Government.

Figure 4. Change in the Trip Generation Rates per Person, a Workday in October 2019 vs. October 2021

a. By public transport

b. By private motorized transport

Source: Analysis by study team, based on call detail record (CDR) data from Claro Argentina.
Accordingly, private motorized transport increased its modal share during the pandemic, from 51 percent of trips on weekdays in 2019 to 60 percent in 2020, at the expense of public transport which lost 14 percentage points (figure 5), according to the CDR-based analysis. By end-2021, the modal share of private vehicles still remained above the prepandemic level. Meanwhile, while nonmotorized transport had gained a significant modal share during the first year of the pandemic, by end-2021 the gain had dissipated. It is important to highlight that the modal share for private motorized transport from the CDR-based analysis is higher than from household surveys; for example, the ENMODO 2009/2010 results showed a 32-percent modal share.

The Pandemic Accelerated eCommerce and Telework, Although They Tapered Off in 2021...

Teleworking grew significantly during the pandemic, with the number of people working from home tripling from prepandemic levels, from 6 percent to 17 percent; an estimated 18 to 29 percent of the jobs in Argentina could conducted remotely, albeit concentrated in high-wage sectors. As revealed by high frequency data tracked by Google, in the last week of March 2022, the volume of trips to workplaces in AMBA overall was still 8 to 9 percent below the prepandemic level, with the remaining gap at least in part due to a continuation of remote or hybrid work arrangements, especially in CABA (figure 6).

Having already grown significantly in the last few years, eshopping and food delivery boomed even more during the pandemic, more than doubling in electronic sales in Argentina overall in the first half of 2020 compared to the first half of 2019. The share of online shoppers who selected the goods to be delivered to their home increased to 80 percent, up from 62 percent in 2018. That said, by late 2021, the overall boom in online shopping had slowed somewhat compared to 2020, as people returned to eating out...
more and shopping in person. Accordingly, by late March 2022, trips to retail and recreation destinations were already 10 percent or more above the March 2020 level in many parts of the metropolitan area.

Figure 6. Trips to Workplaces and Retail or Recreation in AMBA, March 21–28, 2022 vs. March 7, 2020

<table>
<thead>
<tr>
<th>percent change</th>
<th>a. To workplaces</th>
<th>b. To retail/recreation</th>
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<tbody>
<tr>
<td>-29.8 to -20.0</td>
<td>-23.0 to -20.0</td>
<td>-29.8 to -20.0</td>
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<td>20.1 to 36.5</td>
<td>20.1 to 38.0</td>
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Source: Original figure produced for this publication, based on analysis by study team, using data from Google COVID-19 Community Mobility Reports.

How Will Urban Mobility in AMBA Evolve in the Coming Years, in the Context of the Past and Recent Trends?

The “new normal” mobility environment in AMBA appears characterized by less public transport ridership than prior to the pandemic, which could persist for some time. The pandemic has also strengthened some previous trends already taking shape over the past decade and likely to further consolidate—such as increased use of nonmotorized transport (NMT).

As of late spring 2022, the effects of the pandemic and the lockdowns on transit ridership had tapered significantly, though not fully. Having seen the most consistent growth in the decade before the pandemic, the Subte subway system in Buenos Aires was hit the hardest by the pandemic and has recovered the least, while the opposite has been the case for the city’s bus system. Among other factors, the ability of the bus system to attract new users and increase its share of public transport trips will depend on whether the public perceives the suburban rail system as a convenient mode for shorter commutes—as the trend toward trips between GBA’s municipalities, which accelerated during the pandemic, strengthens.
Despite considerable investment in efficient bus systems over the past decades and associated reductions in travel times, for the foreseeable future, plans for bus rapid transit (BRT) expansion are limited to CABA. Given the congestion already above the pre-pandemic levels during certain times of the day (as captured by data from Waze for Cities), commercial speeds for buses in GBA could start to decline on the nonsegregated bus corridors, thus impacting service quality and the ability to attract the passengers lost over the past two years.

During the pandemic, the city saw a significant population relocation to gated communities in GBA, as telecommuting allowed workers to stay at home without the need to spend time commuting. Families that already had a house in a gated community opted for staying there as restrictive measures on personal movement were enforced, which in turn spurred a surge in property prices as more people decided to move to these communities. As a result, plans for new housing developments continued to consolidate through GBA, and new gated communities are currently being built, especially in the western and southern areas.

That being said, the level of service of private motorized transport connecting these communities to central Buenos Aires will likely see a decline as limited room exists for expanding access roads, either from a fiscal or land availability perspective. Therefore, travel times are expected to grow for the fraction of commuters living in gated communities in the second and third ring of GBA, but also for poorer commuters living in GBA using motorized modes. The increasing congestion in AMBA over time, driven by the continuing rise in motorization and the limits to road expansion, is likely to impact the modal split to at least some extent. As suggested by the results of the survey implemented for the current study, if private motorized travel times were to increase by at least 15 minutes for a typical trip, nearly 31 percent of the current car and motorcycle users said they would switch to public transport, and another 5.5 percent and 4.5 percent would switch to NMT modes and taxi respectively.

How Can Policy and Planning Tools Shape Future Trends?

The transport planning authorities in AMBA can influence which transport behaviors remain more permanent in the post-pandemic world. Infrastructure investments can be crucial for building trust in public and active transport. On the other hand, pricing and regulatory policies can help—at least to some extent—incentivize travel behaviors that are more environmentally friendly. Finally, as demonstrated by CABA’s experience with cycling, public behavior change campaigns can work under the right conditions.
Public transport and NMT expansion and reorganization

During the past decade, price signals favored public transport. To be successful, however, price-based incentives have to be combined with infrastructure supply and improvement. As shown by the results of the demand elasticity analysis, ridership in most public transport subsystems and routes in AMBA has historically responded significantly to changes in the vehicle-kilometers of service supplied and improvements in punctuality. Similarly, the stated preferences of the surveyed current car and motorcycle users indicate that improvements in the public transport performance could incentivize a significant modal shift from private to public transport. In fact, the results of the survey suggest that if using public transport allowed saving even just 5 minutes of travel time compared to the current times by private modes, 56 percent of the current private mode users were willing to shift from private to public transport (figure 7). In other words, public transport would have to offer travel times that are on par with or slightly better than those offered by private motorized modes to be able to attract significantly more riders.

Figure 7. Share of Current Car or Motorcycle Users Willing to Switch to Public Transport at Different Levels of Possible Time Savings Offered for a Typical Trip

The patterns of private versus public transport use appear to be relatively set in the most well-off localities in AMBA, where nearly half of households own a vehicle. Increasing these residents’ use of buses or trains will likely require changing their perception of these modes by improving the safety and security, comfort, and the objective aspects of journey time and frequency. As suggested by the results of the stated preference survey, 36 percent of those current private motorized vehicle users are not sensitive to price signals—that is, those who would not switch to another mode, even if gas prices doubled.
Opportunities for mode shift toward public transport are likely the greatest in AMBA’s middle-income localities, located along the axes formed by motorways and public transport lines, where in the past improvements in public transport supply have led to increased public transport use and decreased private car use. Thus, in considering which rail improvement works should be prioritized in order to encourage sustainable mode shift or at least prevent a shift to private mobility, it is likely that investments in the Belgrano Norte or San Martin lines serving middle-income neighborhoods would have a bigger impact. On the other hand, considering rail improvements that will increase accessibility to jobs and services for low-income populations and encourage mode shift from bus transport, rail investments in the Belgrano Sur line would likely have a larger impact. Furthermore, given that GBA in particular has seen a shift toward more local trips, investments in rail connections between localities in GBA could be an effective policy response, especially if well-integrated with the NMT infrastructure.

The city administration and transit operators will need to work together in implementing regulations to create a safe public transport environment. As shown by the study’s car and motorcycle user surveys, safety concerns and fear of contracting COVID-19 ranked highly among the mode choice factors among those who became users of private motorized modes only since the start of the pandemic, although the fear of contracting COVID-19 will subside over time.

In addition, to prevent a shift to private motorized mobility going forward—in the post-COVID context where an increasing share of the population could be considering moving to lower density environments, but do not necessarily want to live in gated communities lacking sustainable connectivity options—public transport supply must be accompanied by a proactive land-use policy. The rail infrastructure provides a good opportunity to engage in transit-oriented development (TOD) projects to densify areas around train stations, especially in rings 1 and 2 and attract middle-income households to move into these areas and avoid the connectivity limitations associated with living in more segregated gated communities. TOD near rail could foster multimodality by expanding the effective rail coverage area, especially if rail services were better integrated with municipal bus lines and newly developed NMT infrastructure. As the expansion of gated communities in GBA continues, public policies can also be oriented toward the generation of new mixed-use centralities, thus helping avoid long commuting trips from GBA into CABA.
In the context of the accelerating trend toward shorter trips, especially within GBA, a policy aimed at promoting nonmotorized travel could attract users throughout the metropolitan area and could gain increasing traction in the post-COVID context of heightened aversion to enclosed public spaces and vehicles. Moreover, as shown by the CDR data analysis comparing the prepandemic period with the “new normal” (in October 2021), trips between 1 and 2.5 kilometers still dominate AMBA’s mobility, corresponding to trips that could feasibly be made by walking or cycling. Also as suggested by the results of the survey implemented by the study team, the share of the current private motorized mode users willing to switch to cycling for their typical trip if a bicycle lane were available to them is by far the highest (40 percent) among those whose typical trips take place within GBA. However, even among the respondents who typically commute between CABA and GBA, more than 15 percent would consider this mode. Among the current car or motorcycle users, women are much more likely than men to state they would consider biking if a safe bike route were available. Finally, while we have no current comprehensive data on how many rail, subway, or Metrobus stations are physically integrated with NMT modes, a clear untapped opportunity exists for deploying NMT infrastructure to prioritize rail and subway stations as the hubs for trip attraction in GBA. In turn, these hubs would improve public transport ridership. The Metropolitan Transport Agency can play a cross-cutting coordinating role in these efforts.

More selective road infrastructure investment

In order to reduce the incentives for private motorized mobility, to foster multimodal integration, authorities could limit further expansion of the radial access road capacity, while they increase investment in road safety and improve the connectivity between access highways and public transit infrastructure. Additional road space could also be allocated to public transport corridors, perhaps following the example of the segregated corridor set aside for the Metrobus on the 25 de Mayo highway in CABA.

Pricing tools

The decline in public transport ridership over the past two years has further worsened the financial sustainability of the transit system and poses some challenging questions for its future. Even in a context of recovering ridership in 2021 and 2022, the lag in fare increases, combined with recognition of higher public transport service operators’ costs, means that the “new normal” for the public transit system in AMBA will be characterized by low cost recovery. The longer-term response of public transport ridership to changes in real fares suggests room certainly exists for increasing fares on most bus and rail routes without jeopardizing ridership. The elasticity of demand with respect to fares is either statistically nonsignificant or marginally significant and low in magnitude on most
of the bus lines (except individual lines mostly concentrated in northern and western AMBA), and there appears to be a small demand response to fare changes on either of the rail lines.

An important aspect for the development of an integrated system is the deepening of the price signals in terms of road pricing, gas taxes, tolls, and licenses for Uber-type ride-share services. An increase in the price of gas, such as through increased taxes, would likely have at least some impacts on mode choices in AMBA, as suggested by the findings of the preference survey implemented by the study team. With a 50 percent increase in the price of gas, approximately 40 percent of the current car or motorcycle users would shift to public transport, and an additional 7 percent would shift to nonmotorized modes. Certainly, such an increase is rather large and also somewhat difficult to interpret in a high-inflation context; increases of such magnitude are much more likely to result from external factors such as logistics bottlenecks and global supply limitations.

Some level of cross-subsidization could be implemented via the city's Metropolitan Transport Agency to support public transport. For example, a small surcharge on road tolls could fund infrastructure to improve the level of service for public transport, following a similar model implemented in 2002, whereby subsidies for public transport were funded through a surcharge on diesel fuel.

Data alliances for mobility planning

The proliferation of mobile devices, the widespread adoption of geolocation technologies, and the increasing digitization of mobility have given rise to new data sources with enormous potential to complement, enrich, or even replace data sources traditionally used for mobility analysis and transport planning. Each of these data sources can provide some, if not complete, insights that will allow AMBA's transport planners to make more demand-responsive and informed decisions.

Many of these new data sources rest in the hands of private entities, heightening interest to explore the establishment of data partnerships from which cities, the private sector, and society as a whole can benefit. We see several opportunities to improve the mobility information available in Buenos Aires through access agreements to nonpublic data and better use of public data, in particular: (1) using cell phone data to periodically update AMBA's origin-destination matrices, perhaps complemented by brief and targeted household travel surveys that can provide more detailed socioeconomic data on the travelers; (2) leveraging SUBE public transport smart card data for a better characterization of public transport demand; (3) making use of Waze for Cities data for transportation planning, beyond just traffic management; and (4) partnering with the providers of different mobility services to help mitigate the existing mobility information gaps, such as on new mobility services (ride sharing, shared mobility) and freight mobility.