*‘DE ALUGUNA MANERA, LLEGAS’*:

A GEOGRAPHIC INFORMATION SYSTEMS STUDY OF

PUBLIC TRANSIT ACCESSIBILITY FOR

PRECARIOUS SETTLEMENTS IN

BUENOS AIRES, ARGENTINA

By:

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# Acknowledgements

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# Abstract

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# Chapter 1: Introduction

Because of their quotidian nature, urban transportation systems have an indisputably vital role in contemporary human society. Without transportation, it would be impossible for people to reach essential daily sites of employment, education, public services, healthcare, and family (Cervero, 2011; Guzman, et al., 2017). In fact, transport’s role as a facilitator of accessibility is perhaps its most important function. Transportation services, modes, and infrastructures are the means for people traverse distances and reach strategic activity sites and, in an ideal setting, they would fulfill this role equitably, ensuring that all people—regardless of their socioeconomic background or location—can access any other destination within a metro area within a reasonable amount of time or cost.

Equitable transportation service in a metropolitan area are rarely found because accessibility levels vary throughout the territory of a city or region. The transportation system—and its many components, public and private—prevents, or even impedes, some members of the public from affordably making trips across the landscape while sanctioning, and even promoting, mobility for others. For those belonging to the former group, poor accessibility can have deleterious consequences: social isolation, underemployment, poverty, worsened health, and poor education. When transportation links are suboptimal—whether measured by financial cost, time, discomfort, or insecurity—people are at risk of exclusion from full participation in urban life.

Concerns about the negative impacts of a substandard transportation system on accessibility are most acute when those burdens overwhelmingly disadvantage marginalized groups of people, like the poor, women, racial minorities, and the disabled. For some of the most mobility-limited people in a society, publicly-available transportation services are often the only link between these groups and the benefits that come with participation in city-life. Oftentimes these links are ignored or neglected by authorities, especially when marginalized groups lack proper representation needed to shape transit policy in the face of stronger, more politically-influential mobility interests. . Such concerns have been noted, as evidenced by their inclusion as a United Nations sustainable development goal for the provision of “access to safe, affordable, accessible, and sustainable transport systems for all … notably by expanding public transport, with special attention to the needs of those in vulnerable situations (11.2).”[[1]](#footnote-1) Studying public transport inequalities can help produce policies and planning strategies that contribute to such a goal.

Buenos Aires, Argentina—the focus of this study—is one of many cities where concerns about transportation, accessibility, and inequality are omnipresent. As with many other cities in the Global South, where transport “conditions remain highly inadequate for most of the population … [with] low accessibility, poor public transport supply, accidents, discomfort, pollution, and congestion,” metropolitan Buenos Aires’ territorial landscape is marked by inequalities related to income, housing, education, transportation, and *access* (Vasconcellos 2001). Perhaps no better illustration of this characteristic are the hundreds of informal, precarious settlements found in its urban periphery. Known as *asentamientos*, they are illegal communities settled by low-income families, situated in isolated, environmentally-precarious locations, and lacking access to most common services, like plumbing, electricity, sewerage, and—as is widely suspected but not as visibly evident—transportation.

Emblematic of structural inequalities that plague Latin American cities, the *asentamientos* represent the struggles for access to the city faced by marginalized peoples, especially in the face of a substandard offering of transportation services. Originally founded as communal refuges for families forcibly evicted from the shantytowns of Buenos Aires’ urban center, they exist on whatever land their residents found available. Oftentimes they are situated along riverbanks or other undesirable tracts of land in the city’s suburban fringes: peripheral locations inherently isolated from the region’s established core. Public transportation services, deteriorated by decades of mismanagement and characterized by services inefficiencies, have not followed the movements of the marginalized out to the *asentamientos*, leading many to speculate that the *accessibility* of Buenos Aires’ *asentados* is being inhibited by a dearth of effective mobility options. That the wealthier, “motorized” classes of metropolitan Buenos Aires have seen great improvements in the speed and cost of their mobility conditions during the same time period only exacerbates concerns about suspected inequalities.

No existing study specifically attempts to document the existence of inequalities of access between the *asentamientos* and their surroundings. The purpose of this paper, therefore, is to quantify the *accessibility* levels of these communities—vis-à-vis the regional public transportation network—and illustrate the degree to which these inequalities exist. As such, I seek to answer the following questions:

* **Within metropolitan Buenos Aires, do the *asentamientos* enjoy worse public transit-facilitated access to important activity sites (e.g., employment sites, public health care, public schools), measured in travel time, than other parts of the conurbation?**
  + **Does accessibility vary across the conurbation and those departments characterized by different degrees of urbanization (e.g., totally urban, mostly urban, and partially urban)?**
  + **What explains the variability (or lack thereof) of accessibility (a) between the *asentamientos* and traditional neighborhoods, and (b) between these formal and informal communities across differently-urbanized parts of the metro area?**

This study is a direct answer to a series of calls made by geographer David Keeling, an expert on transportation systems in Latin American and Buenos Aires, who believes that, “Latin America should offer fertile ground for studies of **accessibilit**y, mobility, infrastructure, and transport policies... [and] more research is needed on accessibility and mobility in megacities like... Mexico City, Sao Paulo, and **Buenos Aires** (2008, pg. 103-104).” He also beseeches researchers to consider similar questions about the region’s spatial mismatches in the supply and demand for infrastructure and accessibility services, the socio-economic and political origins and impacts of projects, the spatial impacts of transportation infrastructure, and the livelihoods of people living in the precarious informal communities on the peripheries of all major Latin American cities (2002, 2008, 2013).

In this study I also answer another, methodological call of Keeling’s (2008): for a greater incorporation of GIS and mixed-methods approaches into Latin American-based transit research. Among this paper’s primary contributions is its incorporation of new travel time data into a GIS study. I used Google’s Distance Matrix API (Application Programming Interface) web tool to query its servers and obtain estimates of transit-travel times within Buenos Aires. This novel approach relies on Google’s recently-digitized archive of transit schedules from across the metro area.

Using the Google data, realistic estimations of travel times for trips made using public transportation allows an unprecedented operationalization of *accessibility* in the Buenos Aires context Rather than considering access as simply a factor of distance, the role of **time**, which is far more impactful on individual access to destinations, can be studied. The adoption of such methods can help fulfill one other plea: that results are provided to governments and planning agencies, making them aware of the problems of suboptimal accessibility in their communities. By selecting a simplistic, easily-understood accessibility metric (i.e., the minimum time between each community and its nearest opportunity sites), I am hopeful I can provide useful information to policy-makers and community members.

In the subsequent chapters, I present the background, literature review, methods, results, and findings of my study. I begin in Chapter 2 with an overview of the study area, which includes Buenos Aires’ metropolitan region, its transportation system, and its *asentamientos*. I take a geographical and historical perspective, highlighting how the current territorial configuration isthe result of decades of political decisions (and indecisions) regarding housing, transportation, and urban growth/land use management. Then, in Chapter 3, I review the literature on *accessibilit*y, focusing on its definition, policy relevance, and prior applications, especially in Latin America. Next, in Chapter 4, I overview my methodology, which includes the application of the Google Distance Matrix API web tool for calculating travel times. After discussing the statistical tests that I performed on these data, in Chapter 5 I summarize and analyze my results, contextualizing within Buenos Aires’ urban geography. In Chapter 6 I conclude the thesis with a few concluding remarks on the state of transit-facilitated accessibility in the *asentamientos* of Buenos Aires and suggest some directions for future investigation.

# Chapter 2: Political Geography of Buenos Aires

Buenos Aires is the capital and largest city of the Republic of Argentina, a country of over thirty-three million people at the bottom of South America. The original port site of Buenos Aires lies on the shores of the Rio de la Plata, a large estuary on the country’s eastern coast. Now one of the largest urban areas in Latin America, over a third of Argentina’s total national population—ca. 13 million people--live within the Buenos Aires conurbation (Blanco and Apaolaza 2018). Sprawling outward from the city’s historic center and port, five-hundred years of development has produced a massive, dynamic metropolitan region that extends for more than fifty kilometers in each direction away across the flat topography of littoral Argentina.

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| **Figure 2.1:** Map of the Republic of Argentina highlighting the Province of Buenos Aires and the Autonomous City of Buenos Aires |

Originally a coastal mercantile town built on the processing and export of crops and minerals from the country’s interior, Buenos Aires is now a major global city linking the southern region of Latin America to the world economy and accounts for half of Argentina’s national GDP (**Figure 2.1**). While its fortunes and economic well-being have waxed and waned over the centuries, it has attracted a continuous flow of migrants, whether from the Argentine hinterland or its South American neighbors, seeking employment and an increased quality of life (Keeling 1996). Many who have come to the region have been forced to settle in Greater Buenos Aires’ informal suburban neighborhoods—known as *asentamientos*—and it is these residents’ search for a better life that motivates this thesis, with its focus on how the peripheral locations of such settlements may be under-served by the region’s massive public transit system.

Before delving into the history and geography of Buenos Aires’ informal housing communities and its public transportation network, I will begin by defining the spatial unit of analysis for this project: “Agglomerated Buenos Aires.” Agglomerated Buenos Aires, or the *Aglomerado de Buenos Aires (hereafter AGBA),* as it is known in Spanish, is the technical name for the geographic area occupied by each of the administrative districts that the Argentine census authority (*Instituto Nacional de Estadistica y Censos—*National Statistics and Census Institute or *INDEC*) has deemed part of the metropolitan area surrounding the centrally-located City of Buenos Aires (Gemini 2003). AGBA is designated to include the Autonomous City of Buenos Aires (*Ciudad Autonoma de Buenos Aires*---hereafter CABA or the Federal Capital), which anchors the entire conurbation, and thirty-two adjoining departments of the adjacent *Province of Buenos Aires*. Together these departments form a large ring to the northwest, west, southwest and southeast of the City.

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| **Figure 2.2**: Buenos Aires Province | **Figure 2.3:** Agglomerated Buenos Aires |
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While CABA is fairly small and bears the formal title of “City,” it operates politically as a province (the first-level administrative level in Argentina). It is an independent entity, having its own mayor and legislature, the similarly-named *Province of Buenos Aires* does not actually govern its namesake city and, furthermore, has its own capital and legislature in the city of La Plata, sixty-kilometers southeast of CABA. As with any other province in Argentina, the Province of Buenos Aires is divided into a series of second-level administrative areas known as *departamentos* (hereafter departments), several dozen of which are located within CABA’s suburban sphere. While many of these departments are similar in size to CABA when seen on the map (**Figure 2.3**), they are governed by the provincial legislature in La Plata and possess little political autonomy. Lastly, it must also be noted that the federal government of Argentina (including the presidential palace, the legislature, and all bureaucratic headquarters) is based within CABA. As discussed later regarding transport planning and housing policy, these political distinctions, especially between province and department, are highly relevant.

To manage the confusion regarding administrative areas, INDEC devised a classification scheme to determine which departments belong to the metro area as well as dictating an official name for this collection of political units. They started by noting that the historic way to define those provincial departments that encompassed Buenos Aires’ suburban sprawl is Greater Buenos Aires (*Gran Buenos Aires* or GABA)—an area that includes CABA and the adjacent twenty-four departments within the province: Almirante Brown, Avellaneda, Berazategui, Esteban Echeverría, Ezeiza, Florencio Varela, General San Martín, Hurlingham, Ituzaingó, José C. Paz, La Matanza, Lanús, Lomas de Zamora, Malvinas Argentinas, Merlo, Moreno, Morón, Quilmes, San Fernando, San Isidro, San Miguel, Tigre, Tres de Febrero, and Vicente López. Greater Buenos Aires, however, is only a descriptive term; there has never been a formal administrative unit or governmental body encompassing all these districts together. As will be shown, GABA contains those departments with the strongest historic and commercial ties to the City.

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| **Figure 2.4:** Agglomerated Buenos Aires |
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| *Source: Gemini 2003* |

Further adding to the morphological complexity, INDEC’s statisticians also note that the continuous urbanized surface of the conurbation (referred to as the metropolitan area’s “urban sprawl” or “population envelope”) is larger than these districts alone and that an alternative definition of the region is required. Shown in blue on **Figure 2.4**, INDEC classifies this area—termed *Agglomerated Buenos Aires (AGBA)*—as the full spatial extent of all urban housing and development emanating outward from CABA, a boundary that is continuously shifting as new land is developed on its outskirts. It is likely more extensive now than when this definition was set down in 2003. As will be discussed, most of these outlying areas were incorporated into the larger economic sphere of CABA through the expansion of its railroads and, eventually, highways; these allowed goods and, increasingly, people to move into and out of Buenos Aires’ core. Over time, suburban developments filled in vacant land in the departments immediately adjacent to CABA and then sprawled outward as people continued to migrate into and within the region (Gemini 2003).

As is apparent on **Figure 2.4**, AGBA does not spatially cohere to any existing administrative boundaries; it overlaps fourteen districts, entirely, and eighteen partially (although two of these—Cañuelas and La Plata—have only a very minor intersection). In turn, INDEC decided to use the extent of individual districts’ overlap with AGBA—alongside their historical status as part of greater Buenos Aires—to devise a classification scheme to differentiate them from one another. These categories are shown on **Figure 2.5**.

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| **Figure 2.5** |
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The three grand categories are: (a) those considered part of GABA and totally agglomerated, (b) those part of GABA but only partially agglomerated, and (c) those outside of GABA but overlapping substantially with the total agglomerated surface of urbanized Buenos Aires. Summary statistics from Argentina’s most recent (2010) census are provided for these three rings and their individual constituent districts in **Table 2.6** below. Differentiating between these administrative units, and their degree of “urbanization” or “agglomeration”, is relevant to the histories of transport and housing in AGBA, the project methodology, and, eventually, this study’s results.

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| Table 2.6 | | | | | | |
| Department | Population (2010) | % of AGBA Population | Area  (sq. km) | % of AGBA Area | Pop. Density (people/  sq. km.) | Agglom.,  Classification (2003) |
| C.A. Buenos Aires | 2,890,151 | 21.55% | 204.08 | 3.87% | 14,050.67 | CABA |
| Lomas de Zamora | 616,279 | 4.58% | 88.63 | 1.68% | 7,037.23 | GABA,  Totally  Agglom. |
| Quilmes | 582,943 | 4.33% | 91.91 | 1.74% | 6,365.45 |
| Lanús | 459,263 | 3.41% | 50.20 | 0.95% | 8,961.91 |
| General San Martín | 414,196 | 3.08% | 56.27 | 1.07% | 7,354.78 |
| Avellaneda | 324,677 | 2.55% | 56.99 | 1.08% | 6,088.92 |
| Tres de Febrero | 340,071 | 2.53% | 45.39 | 0.86% | 7,444.32 |
| Malvinas Argentinas | 322,375 | 2.40% | 63.00 | 1.20% | 5,113.58 |
| Morón | 321,109 | 2.39% | 55.29 | 1.05% | 5,804.90 |
| San Isidro | 292,878 | 2.18% | 52.23 | 0.99% | 5,603.50 |
| San Miguel | 276,190 | 2.05% | 83.51 | 1.58% | 3,336.80 |
| Vicente López | 269,420 | 2.00% | 34.47 | 0.65% | 7,793.95 |
| José C. Paz | 265,981 | 1.98% | 50.16 | 0.95% | 5,305.54 |
| Hurlingham | 181,241 | 1.35% | 34.87 | 0.66% | 5,122.64 |
| Ituzaingó | 167,824 | 1.25% | 38.06 | 0.72% | 4,407.30 |
| Ring 1 |  |  |  |  |  |
| Ring 1+ CABA | 7,742,598 | 57.62% | 800.98 | 19.07% | 9,666.41 |
| La Matanza | 1,775,816 | 13.20% | 327.91 | 6.22% | 5,432.18 | GABA. Partially Agglom. |
| Almirante Brown | 552,902 | 4.11% | 129.04 | 2.45% | 4,273.19 |
| Merlo | 528,494 | 3.93% | 174.53 | 3.31% | 3,039.10 |
| Moreno | 452,505 | 3.36% | 185.48 | 3.52% | 2,432.17 |
| Florencio Varela | 426,005 | 3.17% | 189.71 | 3.60% | 2,244.50 |
| Tigre | 376,381 | 2.80% | 396.17 | 7.52% | 953.55 |
| Berazategui | 324,344 | 2.41% | 220.11 | 4.18% | 1,474.05 |
| Esteban Echeverría | 300,959 | 2.24% | 121.40 | 2.30% | 2,481.45 |
| Ezeiza | 163,722 | 1.22% | 237.09 | 4.50% | 689.06 |
| San Fernando | 163,240 | 1.21% | 24.41 | 0.46% | 6,687.00 |
| Ring 2 | 5,064,368 | 37.64% | 2,005.85 | 38.06% | 2,524.80 |
| Greater Buenos Aires | 12,806,966 | 95.26% | 3,010.91 | 57.13% | 4,253.52 |
| Pilar | 232,463 | 1.73 | 385.57 | 7.32% | 602.908 | Non-GABA,  Partially Agglom. |
| Escobar | 178,155 | 1.32 | 301.97 | 5.73% | 589.98 |
| General Rodríguez | 87,491 | 0.65 | 367.36 | 6.97% | 238.16 |
| Presidente Perón | 60,191 | 0.45 | 120.48 | 2.29% | 499.58 |
| San Vicente | 44,529 | 0.33 | 658.69 | 12.50% | 67.60 |
| Marcos Paz | 43,400 | 0.32 | 425.831 | 8.08% | 101.92 |
| Ring 3 | 616,229 | 4.80% | 2,259.90 | 42.88% | 272.68 |
| Agglomerated Buenos Aires | 13,453,195 | 100.0% | 5,270.81 | 100.0% | 2,552.40 |  |
| *Sources: Instituto Nacional de Estadísticas y Censos (2010); Gemini (2003)* | | | | | | |

Additional datasets published by the Argentine federal government, including the *2010 National Census of Population, Households, and Housing*, carried out by INDEC, and commuting data produced by the Ministry of Transport, disclose some additional pertinent information about the departments that comprise AGBA (Instituto Nacional de Estadísticas y Censos (INDEC) 2010). Looking first at population totals, the departments with the largest populations are those immediately surrounding CABA (itself with 3.2 million): four of the largest are La Matanza (1.4 million), Lomas de Zamora (0.7 million), Almirante Brown (0.5 million), and Quilmes (0.5 million). These are all departments classified as “entirely” or “mostly” urban; many of the least-populated are those located in AMBA’s suburban periphery: Presidente Peron (70,000) and San Fernando (200,000).

**Figure 2.7** gives a substantially finer-grained perspective on the region’s settlement geography, showing patterns of population density across AGBA’s thirty departments. The highest densities are almost entirely within CABA’s boundaries, with axes of higher densities spreading out in all directions. This illustrates something that has historically characterized metropolitan Buenos Aires: high central densities that gradually decrease as one travels outward into the periphery and along the coastline of the Rio de la Plata. Any pockets of density outside of CABA are found along the city’s commuter railway lines (Van Gelder, et al. 2016). As will be explained below, the proliferation of the automobile during recent decades is changing this once-iconic pattern.

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| **Figure 2.7 –** Population Density in Agglomerated Buenos Aires |
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The spatial distribution of income and socio-economic development patterns is quite similar to that of population density. According to Blanco and Apaolaza (2018), “throughout its history, and in line with its Iberian colonial past, the central area of the city has maintained high material and symbolic value evidenced in the residential predominance of the wealthier and more prestigious classes (pg. 3).” The inhabitants of the present-day federal district have long been wealthier than their suburban counterparts; the neighborhoods on CABA’s *northern* side are some of its most luxurious. Looking beyond the boundaries of the federal capital, however, reveals a continuation of this north-south wealth gradient. Since the nineteenth century, the region’s upper classes have lived on its northern side—both within the city and within the adjoining departments—while working and middle class *porteños* (the colloquial nickname for people from the City of Buenos Aires) have called the southern and western neighborhoods (traditional centers of shipping and manufacturing) home (Van Gelder et al. 2016). Consequently, housing informality patterns follow this trend.

Unfortunately, neither INDEC nor any other Argentine public agency publishes any spatial data on income to directly illustrate these trends. However, it does publish a wide variety of other datasets (acquired via the 2010 census) concerning population and demographics, household characteristics, and housing quality which serve as mappable proxies for income (INDEC 2010). For instance, **Figures 2.8a-b** show illiteracy (inversely-related to income) and university-education (positively related), respectively. While there are certainly pockets of “poverty” in just about every department, we can clearly see how illiteracy rates are much higher in the periphery than in the core; furthermore, many of the lowest rates are along the conurbation’s northern flank and immediately along transportation corridors (including those districts in the far north found along the motorways leading into the city). Some of the worst values for both metrics are in those zones farthest from the central business district and in the spaces between railroad lines, the very places we observe the *asentamientos* and other slum settlements in the periphery (Blanco and Apaolaza, 2018; Guerra, et al. 2018). The splotches of university-educated people in the suburbs are linked to the growth of upper- and middle-class gated suburbs in those zones during recent decades.

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| **Figure 2.8a**: Illiteracy in AGBA | **Figure 2.8b:** University education in AGBA |
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In 2009, the Ministry of Transportation carried out a survey—known as the Metropolitan Mobility Survey (hereafter referred to by its Spanish initialism, *ENMODO)* that surveyed 22,170 households from across AGBA, which, alongside its main goal of providing data on mobility, origins/destinations, and modal preference within the conurbation, gives a snapshot of regionwide socioeconomic trends (Secretaría de Transporte 2011). For instance, 44% of all people are employed, with the majority (87%) in the private sector); 27% are students (two-third of whom are in public schools); and 12% are retired. In terms of schooling, more than half of all AGBA residents have, at most, a secondary-level education; 25.8% have either no education or have only partially completed primary school; and only 5.7% have anything above university-level.

Because ENMODO data will be heavily relied upon for the statistical analyses in this study, some further notes about its origin are pertinent. The sample size, while large and inclusive of people from across the study area, is only a fraction of the total population: The approximately 70,000 people surveyed from the study households represent just 0.5% of AGBA’s total population. While the survey made a concerted effort to survey riders of different backgrounds and travel mode proclivities, its representativeness, especially of underserved or marginalized groups, should be taken with some caution.

Now that the settlement pattern and political geography of the AGBA study area have been explained, the next two chapters focus on substantive issues related to two of metropolitan Buenos Aires’ characteristics: its informal housing communities (i.e., the *asentamientos*) and its public transportation system. While these two topics may appear distinct, neither can be fully described or explained without the other; understanding the history of the transportation system is necessary for understanding the perceived lack of services within the *asentamientos*. At the same time, the specific locations of AGBA’s informal housing is a clear reflection of its mobility landscape, making it difficult to tell the story of either feature in isolation of the other. I will begin in Chapter 3 by briefly overviewing the current transportation system because it is responsible, directly or indirectly, for shaping many aspects of Buenos Aires’ contemporary urban geography—including its housing and mobility patterns.

# Chapter 3: Transportation Infrastructure and Spatial Mobility in Buenos Aires

While volumes can be written on the various facets of metropolitan Buenos Aires’ public transportation system, I will profile two components critical to understanding the region’s informal housing crisis: (a) the spatial expanse of the system and its individual modes and (b) the variation in mobility trends and modal splits between socioeconomic groups.

Showcased in **Figure 2.9**, agglomerated Buenos Aires has a massive transportation system. Emanating outward from CABA and its central business district, the entire network features thousands of kilometers of commuter railways, subways, highways, and bus lines, as well as countless other forms of informal transit and non-motorized travel, all of which crisscross the territories of CABA and all the departments in AGBA. The totals are summarized in **Table 2.10**. The suburban railway network—consisting of seven radial commuter lines (shown in **brown** on **Figure 2.9**) and 259 stations—consists of 800 kilometers of track alone! At the same time, there are over 340 bus lines (with a total length of 11,000 kilometers), serviced by 170 individual companies that operate 17,000 total units (CAF 2011). While there is a subway, it is entirely within CABA’s boundaries. Filling in the rest of the territory are motorways and national/provincial highway routes.

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| **Figure 2.9** |
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| Table 2.10 | | | | | | |
| Geographic Area | Railroad trackage (km) | Railroad Stations | Bus Route Length  (km) | Subway trackage (km) | Motorways (km) | National/  Provincial Routes (km) |
| C.A. Buenos Aires | 84.97 km  (12.62%) | 43  (17.92%) | 2,916.34 km  (25.59%) | 62.14 km  (100.0%) | 56.35 km  (16.2%) | 69.45 km  (5.51%) |
| GABA,  Totally-agglom. | 190.21 km  (28.23%) | 93  (38.75%) | 4,074.57 km (35.76%) | 0.00 km  (0.0%) | 108.41 km  (31.2%) | 313.48 km  (24.88%) |
| GABA,  Partially-agglom. | 231.06 km  (34.30%) | 73  (30.42%) | 3,520.47 km  (30.90%) | 0.00 km  (0.0%) | 114.90 km  (33.0%) | 441.15 km  (35.01%) |
| GABA | 506.24 km  (75.14%) | 209  (91.67%) | 10,511.38 km  (92.24%) | 62.14 km  (100.0%) | 279.65 km  (80.44%) | 824.08 km  (65.41%) |
| Non-GABA,  Partially-agglomerated | 167.48 km  (24.85%) | 19  (7.92%) | 883.76 km  (7.76%) | 0.00 km  (0.0%) | 68.00 km  (19.56%) | 435.86 km  (34.59%) |
| AGBA | 673.72 km | 228 | 11,395.14 km | 62.14 km | 347.66 km | 1,259.94 km |
| *Sources: National Geographic Institute (IGN) and Ministry of the Interior, Public Works, and Housing (2018)* | | | | | | |

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| **Figure 2.11a –** Constitución, a major rail terminal | **Figure 2.11b –** Retiro, the second major rail terminal |
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| **Figure 2.11c –** typical CABA subway platform | **Figure 2.11d –** typical CABA subway car, Line B |
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| **Figure 2.11e –** suburban rail station under renovation | **Figure 2.11f –** typical suburban rail station |
|  |  |
| **Figure 2.11g –** typical city bus (a *colectivo*) | **Figure 2.11h –** street-car line/tram in CABA |
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An assortment of photos from Buenos Aires’ transportation system (Source: taken by the author).

When looking at the spatial extent of the network, there are some striking trends. For one, the areas of densest transit coverage are in CABA and the districts immediately surrounding the federal district; coverage is substantially more dispersed in suburban departments. Second, the roadways and highways display a radial pattern, with nearly every line terminating somewhere within CABA. There is a near total lack of circumferential beltways (in contrast, as will be seen, to actual commuting trends in recent years). Buses, meanwhile, have the most extensive coverage, facilitating access within interstitial spaces between rail lines. The region’s flat topography has allowed each mode—albeit at different times in history—to easily sprawl in all directions away from the city’s center and port, with few barriers to growth other than each other (Lascano-Kezic and Durango-Cohen 2012). The recent boom in highway construction has, unsurprisingly, followed suit.

Considering these route networks vis-à-vis population density patterns (**Figure 2.12**) showcases the important relationship between housing and mobility in Buenos Aires. While the history is explored in depth below, this population pattern is a direct consequence of the temporal evolution in the transportation technologies available for workers to commute towards their jobs in the city center: the initial railroads produced high densities around their fixed routes and stations, while the buses subsequently allowed housing developments to sprawl across the remaining landscape, shuttling passengers to either the nearest station or directly into the city center via an expanding network of roads.

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| **Figure 2.12 – REMOVE CENSUS RADIOS** |
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As a result, formal neighborhoods were built anywhere within manageable travel times of the federal district, which has largely remained the core of employment throughout AGBA. As the conurbation grew outward, the innermost departments of the metro area have become entirely urbanized (some possessing miniature central business districts of their own). Any land in AGBA that remains unoccupied and beyond the reach of developers either presents some kind of environmental hazard (e.g. riverbanks prone to flooding, dumps, polluted industrial land, etc.) or is too far away from employment centers to permit reasonable commuting.

What has begun to change the landscape, however, is the growth in automobile ownership. Cars, the newest major player on the mobility scene, are pushing the limits of low-density growth, with its newest suburbs closely resembling the auto-centric neighborhoods found around North American cities (at similarly long distances from downtown). With this increase in individual mobility for some (car ownership is strongest among the wealthy), housing locations have changed and, as a result, so have employment centers, with service-type jobs scattered across the departments of AGBA as compared to the pre-auto era when work was primarily in CABA’s governmental, financial, or industrial areas. More people live and work outside of the federal district than ever before (see Table 2.13) although, as is seen on the map, the transport system has yet to catch up to this trend, i.e., the lack of transversal links and persistent density of transit in the core (Keeling, 1996; ST 2011). These territorial dynamics are echoed in Blanco and Apaolaza’s statement that “due to the unequal distribution of infrastructures and the severe social fragmentation between different areas of [AGBA], differential mobility is also closely associated with … territorial structure (2018, p. 5).

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| Table 2.13 – Distribution of trips, by origin and destination | | | | | | | | | |
| Origin ↔ Destination | All Trips | Mode | | | | | Purpose | | |
| Bus | Rail | Subway | Car | Non-Motor. | Work | Study | Health |
| CABA ↔ CABA | 24.6% | 22% | 5% | 60% | 22% | 23% | 27% | 25% | 25% |
| CABA ↔ GABA | 14.1% | 23% | 56% | 40% | 18% | 0% | 20% | 8% | 14% |
| GABA ↔ GABA | 61.3% | 54% | 39% | 0% | 60% | 76% | 53% | 66% | 61% |
| Source: ST 2011 | | | | | | | | | |

Alongside its physical expanse, the other aspect of AGBA’s transportation system meriting discussion is the modal split and how it varies by income. Looking first at the entire region, according to ENMODO most trips are made on public transport (43%); only 26% are made privately (primarily in personal autos but also including taxi rides) and a remarkable 31% are non-motorized (i.e., walking and biking). As for specific modes, buses (or *colectivos*, as they are known locally) are most common, taken for 39% of trips. Walking trips are next (24%), followed by private car (12%) and train/subway (10%). The relative prominence of public transit and walking, at least in comparison with driving, contrasts starkly with the automobile-centric cities of the United States and the Global North (in fact, only 64.9% of *porteños* own a car). Lastly, mode is also related to trip length; most walking, bus, private car, or subway trips begin and end within the same or adjoining departments, whereas rail trips overwhelmingly begin in CABA and end in the provincial departments of AGBA (or vis-versa) (ST 2011).

Income data provide further insights into mode splits. ENMODO statistics permit the study of mobility trends vis-à-vis socioeconomics. Using households’ self-reported monthly incomes, users were classified into five quintiles (see **Table 2.13**). While these values are estimations extrapolated from the sample of households surveyed and may not be fully representative of actual values, they exhibit some important trends. For instance, lower quintile families are typically less educated (most with nothing more than a primary education) and have larger households. Even more importantly, they spend proportionately far more of their income on travel than wealthier households.

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| Table 2.14 | | | | | |
| Income Quintile | Quintile population (est.) | Average people per household | Average monthly income (pesos) | % of income spent on travel | Education Level, Mode |
| 1st (lowest) | 3.7 million | 4.63 | $1,321 | 17% | Primary |
| 2nd | 2.8 million | 3.41 | $2,193 | 13% | Primary |
| 3rd | 2.4 million | 2.94 | $2,987 | 11% | Secondary |
| 4th | 2.1 million | 2.62 | $4,116 | 9% | Secondary |
| 5th (highest) | 1.9 million | 2.36 | $7,424 | 6% | Secondary |
| *ST, 2011* | | | | | |

When considering the mobility trends of the different quintiles (summarized in **Table 2.14** below), lower-income groups overwhelmingly take public modes: 84% of the lowest-quintile versus 59% of the highest. Meanwhile, private modes are taken by over 40% of the two highest quintiles as compared to a mere 15% of the lowest income earners. Nearly a quarter of all trips taken on public transit, or on the bus, were taken by the lowest quintile while the opposite can be said for private modes and trips made with private automobile. This latter trend is emblematic of motorization trends in other cities in the Global South, where members of the higher classes gravitate increasingly towards private car travel as their incomes rise (Vasconcellos 2001). This contrasts with perhaps one of the more striking income-based findings: that more than a third of walking trips are made by the lowest income bracket. Given that lower-income groups are primarily found in Buenos Aires’ periphery, where transit networks are sparse, this perhaps suggests that these people are having to walk to activity sites rather than taking transit.

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| Table 2.14 | | | | | | | |
| Income Quantile | Trip generation rate | Modal breakdown,  people within an income quintile | | | | | |
| Public Transit | Bus | Rail | Private | Auto | Non-Motor. |
| 1st | 1.36 | 23.3% | 24.2% | 22.4% | 15.6% | 13.9% | 36.4% |
| 2nd | 1.46 | 20.5% | 20.9% | 20.0% | 19.3% | 19.2% | 21.3% |
| 3rd | 1.53 | 18.9% | 19.1% | 19.3% | 21.4% | 21.2% | 16.6% |
| 4th | 1.64 | 18.5% | 18.2% | 19.4% | 21.4% | 22.3% | 14.0% |
| 5th | 1.78 | 18.9% | 17.6% | 19.0% | 22.3% | 23.4% | 11.7% |
| *ST, 2011* | | | | | | | |

The AGBA transportation statistics were the subject of a recent paper on income, travel expenditures, and mobility in AGBA. Guerra et al. (2018) modeled whether certain variables affected regional household travel expenditures. They found, unsurprisingly, that household income is a strong predictor of transport expenditures, especially when that household owned a car. While other variables—like distance from the center and households living in lower density neighborhoods—were found to be positive predictors of expenditures. The paper has limited application to this study because there is no way of differentiating the mode-specific spending habits of each household. Given that automobile ownership and upkeep is inherently more expensive than transit, these results are biased—for instance, they claim that job and transit accessibility increase expenditures—towards those who own cars, something few low-income Argentines will possess. Nevertheless, it is still striking—and an indication of the importance of this study—that three-times as many jobs are accessible to car-owning porteños than transit-takers.

# Chapter 4: Asentamientos and their History

While Metropolitan Buenos Aires’ public transportation system is an important component of this project, the main subject of interest is transit accessibility vis-à-vis another unique element—related, in this case, to housing—of the region: its *asentamientos*. *Asentamientos*, a Spanish term that roughly translates as “settlements,” are a type of informal housing community found exclusively *outside* of CABA. They were initially founded as illegal, if well-organized, occupations of vacant land that, over time, are slowly transitioning towards becoming formal neighborhoods. Aided by state action, they have theoretically benefited from the division and regularization of residential lots, provision of public services (e.g., plumbing, electricity, paved streets), and the ability of occupiers to eventually own the land upon which they settled and constructed their homes. Their inhabitants (called *asentados*), meanwhile, are primarily migrants from Argentina’s interior provinces, but also include immigrants from the countries that neighbor Argentina in South America and locals unable to afford housing in Buenos Aires’ formalized neighborhoods.

While all of these characteristics go into the definition of *asentamiento*, perhaps the most important attribute of *asentamientos* is that they are all located in the suburban periphery of the agglomeration beyond the borders of CABA (Van Gelder et al., 2013). This is important because it sets the *asentamientos* apart from the other primary type of informal housing in metro Buenos Aires, the *villa*. *Villas* are similarly illegal and home to destitute migrants, but they are located exclusively in the city’s core. *Villas* exhibit higher population densities (with very little vacant land in CABA, they are crammed onto miniscule plots of land). In contrast with asentamientos they contain no formal street grids or urban form, provide residents with no path to land ownership, and see no formal services from the state or private utility companies.

Most *asentamientos* got their start when a group of homeless families—commonly people who were previously living in *villas* but unable to afford their own housing—collectively invaded an unoccupied tract of land in one of the conurbation’s suburban departments. Given that progressive urbanization has already taken over most of the premium locations within these districts—i.e., those with the greatest accessibility to opportunity sites, most available vacant land is along riverbanks or near dumps, pollution-emitting factories, or dangerous infrastructure like railroads or high-voltage electricity lines (Keeling, 1996). In other words, land that would have already been developed if it had any commercial value.

Once settled in place, the *asentados*—depending on their neighborhood solidarity—began to formally take-over the territory by laying a rudimentary street grid connected with the adjacent local street pattern, dividing up the land into individual parcels, and pressuring the authorities to provide essential services and award land ownership titles (Cravino et al. 2007). Essentially a form of institutionalized illegitimacy, the *asentamientos* are both a means for families to illegally access land in the city while also putting themselves on a path to legal ownership of that land and, therefore, hoping to make amends with the same land titleship laws they broke in the first place. A paradox in and of themselves, they are a unique product of Buenos Aires’ history and have not been well-studied outside of Argentina.

Some photos of an *asentamiento* in the Pilar district are shown below.

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| **Figure 2.15a –** Dirt streets are common, which are often impassible after a heavy rain | **Figure 2.15b –** The wall and gate of a self-constructed structure; some wires present |
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| **Figure 2.15c –** Another self-constructed shelter, with some electricity wires present | **Figure 2.15d –** While uncommon in most settlements, some *asentado*s can afford used automobiles |
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| **Figure 2.15e** – a cement wall separating the *asentamiento* from a neighboring gated community | **Figure 2.15f** – a small convenience store/grocer within the neighborhood, a sign of permanence |
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The *asentamientos*’ locations, seen on **Figure 2.16** below, constitute their definitional characteristics. For instance, they are often comprised of young families who need the additional space in these parts of AGBA to build home structures that accommodate greater numbers of people, whether children, grandparents, or siblings (the residents of Villas, called *villeros*, meanwhile, often have little more than one room at their disposal). In fact, many of the families moving into the *asentamientos* come directly from a *villa*, the first place most migrants to Buenos Aires move when arriving from an interior province on neighboring country. After establishing themselves in the city (and accruing some amount of money), *villeros* will then relocate outward to one of the more spacious *asentamientos*. This move can be an individual effort—if the family is moving to preexisting *asentamiento—*or collective, if a group of families establishes a new *asentamiento*. The process of starting anew requires social organizing and the pre-identification of vacant, invadable land in the suburbs). A difficult and risky process, *asentandos* are motivated by the prospect of eventually owning a piece of land that will provide them with greater residential security, an asset with economic value that can be passed on to future generations, and general stability for their new city lives (Cravino, et al. 2008, pg. 175-179; Van Gelder, et al. 2013).

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| **Figure 2.16** |
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It must be noted, however, that living in the *asentamientos* comes with many risks and challenges.Perhaps the most pressing, public services have been slow to manifest. In most areas, residents lack access to clean drinking water, electricity, sewage removal, trash disposal, and transportation. Residents have either had to fight local authorities to provide these services —as has been the case with schools and health centers—or work together to provide their own (i.e., public spaces, communal eating hall). Few have gained full ownership of any land and others have struggled to obtain credit or financial assistance, a consequence of banks refusing to lend to people whose home addresses are within a known *asentamiento*. Such funds are especially crucial for families who need to respond and rebuild after emergencies like floods, which often plague the low-lying *asentamientos*.

The education levels of asentamiento residents are low, restricting employment to low-skill positions. Further exacerbating already tenuous employment prospects, many of these types of jobs are found in Buenos Aires’ center or the central business districts of AGBA’s other departments. Given the *asentamientos’* suburban locations and the metro area’s poor-quality transit system, difficult access exacerbates unemployment. Families who elect to live in an *asentamiento* over a *villa* must trade the job access of the centrally-located, albeit crowded *villas* for the more spacious but distant *asentamientos*. Additionally, *asentados* often face discrimination by employers, service-providers, and even emergency services personnel who refuse to help people with home addresses in known *asentamientos*. Residents of these communities are popularly perceived as illegals, even in cases where they are well-organized or have acquired land ownership (Cravino et al. 2008, pp. 132–133, 188–190).

Arce and Mino (2017): This was explained by taxi drivers who feared venturing into neighborhoods with poor quality streets. Since this is a common characteristic of many *asentamientos*, it could explain their inadequate supply of transport services (representative of the public stigma that *asentamientos* are unsafe and crime-ridden).

Examining the history of the *asentamientos* shows that they are nothing more than a collective response to unfavorable government policies—at the local and national level—and incompetent planning, with their locations inextricably linked to the region’s transportation system. Their continuous growth over the past four decades—through periods of economic boom and bust—contrasts with the inadequate provision of infrastructure and services (like transportation) to their residents, who number over a million (Keeling, 1996; Van Gelder, et al. 2016). While they exist in direct opposition to state oppression, as expressed through poverty, exclusionary housing policies, and the economic inequalities produced by neoliberal restructuring, these same forces also explain why the *asentados* nevertheless remain deprived of critical services, like transportation, that could greatly improve quality of life.

The roots of the *asentamientos* lie in the early history of metropolitan Buenos Aires. For much of the city’s history the predominant form of illegal housing was the urban *villa*. As European immigrants and domestic migrants arrived in the city during its boom period at the end of the nineteenth century and the decades prior to World War I, they would often settle in informal tenements (called *conventillos* or *villas miseria*) near the port facilities and factories along the southern edge of what is now the federal district. Overcrowded and nestled onto whatever open land was available, they were usually only the temporary home of migrants as they first got settled and found jobs in Argentina. Conditions, nevertheless, were still poor—dense with irregular construction materials (usually waste materials from factories) and tight alleys instead of streets.

Around the same time, however, the region’s transportation network was beginning to take shape—the subway through the central business district, tramways throughout the city’s innermost neighborhoods and departments, and a vast network of railways, with a half-dozen lines headed in each direction out from terminals in the city center were all built during the first decades of the twentieth century (Keeling, 1996). With much of the land along these routes—especially the trams and railways—largely unoccupied (aside from agriculture), it was cheaply sold and developed into suburban neighborhoods for working class people previously stuck in crowded tenements. This growth would not have been possible without these railways and tramways, the former of which was originally built for exporting agricultural goods during the 1870s before eventually gaining the capacity to carry passengers. When faster locomotives arrived in the early 1900s, people could commute into Buenos Aires daily, living in settlements that sprang up within walking distance of the individual lines’ stations. Train fares, moreover, were inexpensive. Initial growth came to many of the departments (e.g., Tigre, Moreno, Merlo, and Moron) that now comprise GABA (Keeling, 1996; Pirez, 2002).

Aiding this growth were relatively lax housing regulations. A system of *loteos populares* emerged whereby developers could lay out “subdivisions” of empty lots, each with minimal services and infrastructure, and sell them cheaply to willing buyers. Customers, often low-income workers, took on the burden of constructing the house or providing basic services and the land was **legally** their own. (Van Gelder et al. 2016; Borthagaray and Natale, 2017; Blanco and Apaolaza, 2018). This meant that people often only lived in the *villas* temporarily before being able to afford their own housing in the up-and-coming railway suburbs. The *loteos* ensured a consistent means of legal housing for low-income Argentines throughout the first half of the twentieth century, even as the number of migrants grew spectacularly. Between 1930 and 1970, the people living in CABA, and the departments of would-be AGBA, increased from 3 million and 1.8 million, respectively, to 3.5 million and 5.5 million. During the 1940s, import substitution policies pushed over 200,000 rural migrants into the city each year alone.

Up through the mid-1970s, the continuous stream of people into Buenos Aires, albeit comprised increasingly less by Europeans and more by neighboring South Americans, was so great that the *villas* continued to house a substantial share of the population. The *loteo popular* and other government-support housing programs were scuttled by political and economic turmoil in the post-war decades and hundreds of thousands of people were still living in the same crowded, unregulated, self-constructed communities wedged onto vacant land in the city’s center (Van Gelder et al. 2013; Van Gelder et al. 2016).

At the same time, the railway network—which had peaked in ridership during the 1940s—fell into a long decline thanks to a botched program to nationalize the railroads, previously owned by the private British interests who constructed them. With a lack of public investment, the system was marked with inefficient services, frequent labor issues, poor management, deteriorating infrastructure, and, most importantly, greater competition from buses and automobiles (Keeling, 1996). Buses captured much of the lost market with cheap fares and flexible routes. Initially routes were run that fed passengers to rail stations, but gradually bus service expanded into new areas and even began to compete directly with rail. Their relative affordability was buoyed by domestic oil production, which deflated gasoline prices. Of key importance to this paper, the buses greatly expanded the territory available to commuters; the spaces between adjacent railways quickly filled in with new roads and developments and, as stated before, brought near-complete urbanization—except for river banks and polluted spaces—to those departments bordering upon the main city (CAF 2011).

Major changes, especially to housing, came suddenly after the ascension of Argentina’s military dictatorship in 1976. First and foremost, the military passed the Eradication Law in 1977, banning all *villas* from the federal district. Supposedly to curb overpopulation in the city, improve the city’s image ahead to the 1978 World Cup, and to construct new urban highways, the *villas* and their 280,000 residents were evicted, with many of their homes demolished. According to Van Gelder, et al. (2016), seventeen of thirty-one *villas* were destroyed. At the same time, the military also oversaw a new national housing policy that revoked the *loteo popular*, instead mandating that all new developments be fully stocked with requisite urban infrastructure. Apparently attempting to curb urban sprawl, the new regime essentially killed the preeminent legal avenue for low-income Argentines to own land. The costs of new lots, with the price of services built-in, was immediately prohibitive. To make matters worse, the military also halted rent controls in the city, hoping to spur private housing developments. Rising rents, coupled with continued economic disarray, meant that many low- and middle-income *porteños* were essentially excluded from legal residences.

Out of this policy triad emerged the *asentamiento:* the thousands of people fleeing the urban center, without an affordable, legal recourse to secure housing, collectively settled on whatever vacant land they could find. These spaces were either undesirable or undevelopable lands in those departments immediately bordering CABA or, in the outer municipalities, lands too distant to feasibly commute on the existing transit system. By 1981, only 30,000 people were still living in Buenos Aires’ *villas,* whereas 287,000 people were living in informal settlements in the periphery. Keeling (1996) states that 46% of them were within 30 kilometers of the center, 35% were between 30 and 40 kilometers from the center, and 19% had to live in settlements beyond 45 kilometers.

Compared with the *villas* that many were fleeing, these *asentamientos* “came into existence as a consequence of an instantaneous and organized land invasion” (p. 1965), often with help from outside organizations like churches, NGOs, or lawyers (Van Gelder et al. 2016). The decision to divide these spaces into lots and lay out a street grid contiguous with the surrounding neighborhoods was a legacy of the recently-abolished *loteo*. As alluded towards before, these spaces were “in the urban periphery and generally in locations where there is less of an incentive to react for a landowner (whether the state or private) in comparison with the central areas” (Van Gelder, et al. 2016, p. 1965). Since the land was often not of value to its previous owner, there was generally less resistance from the state (but not always). Keeling (1996) tells the story of one *asentamiento* that was settled by exiled *villeros* along a riverbank in the Quilmes department in 1981, met with resistance by the dictatorship (who tried to bulldoze the complex but were halted by mass protests), and then succeeded in establishing a formal neighborhood after the territory’s previous owners agreed to sell the land (unprofitable otherwise) to the state to be regularized (p. 106-7). As is clear from this anecdote, well-organized *asentados* were more likely to prevail and have their settlements persist (Van Gelder et al. 2013; Van Gelder et al. 2016).

While the military dictatorship collapsed by 1983 and was replaced by a democratic government, the issues facing the *asentamientos* did not much improve. This was especially the case with regard to the provision of services. For instance, even though the new government stopped the crack-down on illegal settlements and reversed the ban on *villas* within the city, neither the *loteo* nor rent controls returned; most families chose to remain in in the new *asentamientos* rather than return to the city (although some *villas* did reappear in the city in some of the same places where they had been previously destroyed) even as economic malaise affected the country throughout the 1980s and early 1990s and kept many in poverty.

In an attempt to resuscitate the economy, the national government turned to neoliberal policies in the 1990s, Many public services, including gas, water, electricity, telecommunications, and some transport services were privatized, and land development opened to international actors. The implications for marginalized Argentines were deleterious: private utility companies stopped or reduced services for low-income groups, local governments lacked the authority or power to counteract private interests, and land values increased in an unregulated, speculative real estate market. Meanwhile, federal legislation to officially regularize illegal land tenure and property rights in the *asentamientos* failed to materialize. When the Argentine economy collapsed in 2001–2002 as a result of the country defaulting on its enormous national debt, earlier advances made in housing and service provision were wiped away . Estimates are that by 2002 over half of all Argentines were in poverty (Van Gelder et al. 2013; Van Gelder et al. 2016).

The period from 1990 to 2002 was particularly tumultuous for public transportation services, which continued their decline. The railways, bleeding money and passengers, were privatized. Buses continued their ascendance while the government turned its spending and sanctioning priorities towards roadways and highways; privately-operated suburban motorways were constructed, linking the formerly-isolated and largely-agricultural northern departments (most notably Pilar) with the urban center. Little was invested into railroad infrastructure or management as metropolitan Buenos Aires grew to exceed 12 million people by the end of the 1990s (CAF 2011). Pirez (2002) explores the effect of privatization on public services: “in the absence of any democratic decision making at the metropolitan level, key decisions are left to market forces … including developers and private companies now controlling privatized public services” (p. 145). Without a state presence, utility and transport companies concentrated their services in wealthier areas, where they could get the best return on their investments; poorer areas, including the *asentamientos*, saw fewer services and higher prices. As for transit, Pirez notes, “the metropolitan transport system is the best example of [post-neoliberal] fragmentation. Different modes of transport co-exist with no coordination other than that provided by the users themselves … [the result of] three regulatory systems in juxtaposition (municipal, provincial, and federal)” (p. 153).

One of the more well-documented consequences of this deregulation was the appearance of gated communities and auto-oriented suburbs in AGBA’s peripheral departments. After the construction of the tolled motorways during the 1990s, upper- and middle-class *porteños* could live in suburban enclaves in distant departments, such as Pilar, and then commute, one-way, into the city center in just 45 minutes. Subdivisions were constructed on agricultural lands in these far-off municipalities, where officials relaxed land use regulations to attract developers. These homes, in turn, were attractive to well-to-do families who previously lived in the dense, albeit wealthy, neighborhoods on the northern side of the City. Seeking larger homes, safer housing, and country club amenities, many families relocated to the suburbs. By the end of the 1990s, gated communities in the region’s periphery comprised a surface area 1.5 times the size of CABA yet with just 17% of its population (Pirez 2002). This dispersion of population is another example of the regionwide trend away from Buenos Aires’ traditional mono-concentricity, except the wealthy are the ones now fleeing to the periphery.

Many of the remote departments conveniently located along the region’s upgraded motorways were cash-strapped. Filled with cheap, underutilized land and desperately in need of tax revenue, they modified or waived planning regulations to lure real estate developers. Aided by provincial legislation that gave municipalities leeway over land development, these outer departments relaxed regulations to attract residents. Rural outposts along a railway line or roadway, with nothing more than one or two small towns (the only places within those departments that had any kind of public services) quickly filled with the homes of upper-class commuters. De Duren (2006) notes that constructions booms immediately followed the completion of roadway projects in 1993 and 1996. Nevertheless, the services provided to these developments, as private constructions, were limited to just their residents; many of the people who had previously lived in these municipalities—some in *asentamientos*—saw no benefit. In Pilar, for example, “spatial changes were led by investors and did not correspond to a development of local government institutions, or to a local municipal plan on how to guide local growth … 80% of people still lacked piped water [by 2001] and sewerage” (De Duren 2006, p. 322).

Two trends have predominated since the 1990s: (1) the *asentamientos* have continued to grow and have continued to lack of access to requisite services, and (2) public transportation, still poor in many areas, has shown signs of a rebound. In terms of the first, the resurgent Argentine economy, which saw the government’s debt paid off and dropping unemployment, led to another real-estate boom, increasing land prices and rents, once again pushing at-risk citizens into informality. The victims of better times joined those that had been shoved out to the illegal *asentamientos* during the crash, when more than half of Argentines were in poverty.

Recently, the government has made some inroads providing low-income citizens with housing. The Federal Social Housing Program was launched in 2004 with the goal of building 38,000 units in AGBA. It, however, has failed to produce widespread results. The FSHP lacked funds to purchase land for housing, meaning that many homes had to be constructed in inaccessible locations where land was cheap. Government reinvolvement in utility provision, a reversal of trends from the 1990s, has led to some improvements in services; the census in 2010 showed fewer homes in poor condition, even as the number of people living in informal communities exceeded one million. Like transportation, the responsibility for housing and land use policy also spans multiple levels of government, complicating the comprehensive planning needed to improve the situation in the *asentamientos* (Van Gelder et al. 2016).

Two primary sources, both from Argentina, provide ethnographic and qualitative information on the contemporary *asentamientos*: a 2013 report produced by an NGO working on housing and a 2007 study by an Argentine sociologist. The Argentine government does not officially recognize or define the physical boundaries of the *asentamientos* and *villas;* this task has been left to academics and non-profit organizations. These studies serve to (1) provide hard data and survey results to confirm the dire conditions of inequality in the *asentamientos*, (2) highlight the need for further studies of their transit services and mobility options, and (3) foreshadow some of the parameters that I included in my methodology.

The best source for contemporary information and socio-economic data on the *asentamientos* and *villas* in Argentina is the non-profit organization “TECHO,” or “Un techo para mi pais.”[[2]](#footnote-2)Specializing in housing policy, TECHO is active throughout Latin America and often works in conjunction with local universities, government agencies, and civil society organizations. Among their many activities in Argentina, they and their partners have carried out extensive surveys of the country’s informal housing settlements and produced an online map of their locations. Carried out by TECHO’s Center for Social Investigation, the most recent survey, from 2013, provides details on the quantity, location, and principle characteristics of the country’s informal settlements. The overarching goal of the surveys was to collect dynamic housing information that could be provided to authorities and community organizers working to improve the services and housing rights guaranteed to all of Argentina’s inhabitants.

Carried out across Argentina during April 2013, a coordinated team of volunteers interviewed—using a series of pre-determined, standardized questionnaires—residents of 1,834 settlements nationwide (*villas* and *asentamientos*). Data were collected on attributes commonly associated with the settlements: their geographic coordinates, status as *villa* or *asentamiento;* access to water, sewage, electricity, and gas; quality of roads; provision of street lighting; flood frequency; emergency service response rates; and distance to services. These data were cross-checked with existing surveys, government reports, and university studies, and entered into an online database, with the location of each settlement geo-referenced. The last of these steps, new to TECHO’s 2013 survey, was done to specifically diagnose the accessibility of informal settlements to city services and infrastructure.

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| **Figure 2.17** |
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While the project was carried out nationwide, the survey revealed there to be 786 precarious settlements in AGBA: 550 *asentamientos* and 236 *villas*. Nevertheless, as TECHO itself acknowledges, it is key to remember these data are from 2013 and that conditions and quantities may have changed since (Gregorini 2013). TECHO’s statistics on these *asentamientos* are contained in **Table 2.18**; listed by department, I tabulated the number of communities and the number of resident families, together with the communities’ total areas, densities, and populations relative to the rest of AGBA.

|  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 2.18 | | | | | | | | | |
| SDepartment | % of AGBA Population | No. of Asent. | % of all Asent. in AGBA. | No. of fam. in Asent.  (est.) | % of AGBA fam. in Asent. | Families per Asent. | Area of Asent. (sq. km.) | % of Dept. Pop. in Asent. | % of Dept. Area with Asent. |
| C.A. Buenos Aires | 21.55% | 0 | 0.00% | 0 | 0.00% | 0.0 | 0 | 0.00% | 0.00% |
| Quilmes | 4.33% | 43 | 7.40% | 19,995 | 8.55% | 465.0 | 5.44 | 15.78% | 5.92% |
| José C. Paz | 1.98% | 26 | 4.48% | 6,575 | 2.81% | 252.9 | 4.10 | 11.37% | 8.18% |
| Malvinas Argentinas | 2.40% | 20 | 3.44% | 3,495 | 1.49% | 174.8 | 1.10 | 4.99% | 1.75% |
| Lomas de Zamora | 4.58% | 17 | 2.93% | 11,440 | 4.89% | 672.9 | 2.98 | 8.54% | 3.40% |
| San Miguel | 2.05% | 17 | 2.93% | 7,642 | 3.28% | 449.5 | 2.74 | 12.73% | 3.32% |
| Ituzaingó | 1.25% | 12 | 2.07% | 819 | 0.35% | 68.3 | 0.29 | 2.24% | 0.76% |
| Hurlingham | 1.35% | 11 | 1.89% | 3,011 | 1.29% | 273.7 | 0.68 | 7.64% | 1.92% |
| Avellaneda | 2.55% | 7 | 1.20% | 2,305 | 0.99% | 329.3 | 0.24 | 3.09% | 0.43% |
| General San Martín | 3.08% | 6 | 1.03% | 6,245 | 2.67% | 1,040.8 | 0.83 | 6.94% | 1.47% |
| Lanús | 3.41% | 5 | 0.86% | 2,200 | 0.94% | 440.0 | 0.36 | 2.20% | 0.70% |
| Morón | 2.39% | 3 | 0.52% | 125 | 0.05% | 41.7 | 0.02 | 0.18% | 0.04% |
| San Isidro | 2.18% | 3 | 0.52% | 320 | 0.14% | 106.7 | 0.06 | 0.50% | 0.11% |
| Tres de Febrero | 2.53% | 2 | 0.34% | 315 | 0.13% | 157.5 | 0.05 | 0.43% | 0.10% |
| Vicente López | 2.00% | 0 | 0.00% | 0 | 0.00% | 0.0 | 0.00 | 0.00% | 0.00% |
| GABA, total agglom. | 57.62% | 172 | 29.60% | 64,487 | 27.57% | 374.9 | 18.89 |  |  |
| La Matanza | 13.20% | 69 | 11.88% | 34,681 | 14.83% | 502.6 | 13.69 | 8.98% | 4.19% |
| Moreno | 3.36% | 66 | 11.36% | 18,423 | 7.88% | 279.1 | 9.20 | 18.73% | 4.94% |
| Florencio Varela | 3.17% | 48 | 8.26% | 17,925 | 7.66% | 373.4 | 7.69 | 19.36% | 4.05% |
| Merlo | 3.93% | 46 | 7.92% | 19,490 | 8.33% | 423.7 | 10.26 | 16.96% | 5.90% |
| Almirante Brown | 4.11% | 22 | 3.79% | 11,040 | 4.72% | 501.8 | 4.33 | 9.18% | 3.35% |
| Esteban Echeverría | 2.24% | 19 | 3.27% | 13,800 | 5.90% | 726.3 | 3.95 | 21.09% | 3.26% |
| Tigre | 2.80% | 16 | 2.75% | 2,920 | 1.25% | 182.5 | 0.83 | 3.57% | 0.21% |
| Ezeiza | 1.22% | 12 | 2.07% | 10,020 | 4.28% | 835.0 | 3.87 | 28.15% | 1.63% |
| Berazategui | 2.41% | 3 | 0.52% | 460 | 0.20% | 153.3 | 0.60 | 0.65% | 0.27% |
| San Fernando | 1.21% | 2 | 0.34% | 520 | 0.22% | 260.0 | 0.04 | 1.47% | 0.01% |
| GABA, partial agglom. | 37.64% | 303 | 52.15% | 129,279 | 55.27% | 426.7 | 54.47 |  |  |
| Greater Buenos Aires | 95.26% | 475 | 81.75% | 193,766 | 82.84% | 407.9 | 73.36 |  |  |
| Pilar | 1.73 | 35 | 6.02% | 13,170 | 5.63% | 376.3 | 7.54 | 26.06% | 1.96% |
| Escobar | 1.32 | 22 | 3.79% | 7,980 | 3.41% | 362.7 | 2.66 | 20.60% | 0.88% |
| General Rodríguez | 0.65 | 21 | 3.61% | 5,178 | 2.21% | 246.6 | 3.99 | 27.22% | 1.09% |
| San Vicente | 0.33 | 15 | 2.58% | 4,685 | 2.00% | 312.3 | 4.05 | 48.40% | 0.62% |
| Presidente Perón | 0.45 | 9 | 1.55% | 6,780 | 2.90% | 753.3 | 4.30 | 51.82% | 3.56% |
| Marcos Paz | 0.32 | 4 | 0.69% | 2,340 | 1.00% | 585.0 | 2.75 | 24.80% | 0.65% |
| Non-GABA, part. agglom. | 4.80% | 106 | 18.24% | 40,133 | 17.16% | 378.6 | 25.28 |  |  |
| AGBA | 100.0% | 587 | 100.0% | 233,899 | 100.0% | 398.5 | 98.64 |  |  |
| *Source: TECHO 2013* | | | | | | | | | |

The survey’s results within Buenos Aires suggest substantial inequalities. Starting with electricity, only 31.1% have metered electricity, 6.1% have community units, and 62.4% have either irregular or no service. Statistics are not much better for sewerage; over a third reported having no more than a cesspool for waste disposal and a mere 3.3% are hooked up to the public network. In fact, the state is responsible for sewage in only 16.4% of the surveyed *asentamientos*, forcing neighbors to find their own solutions. Similar results appeared for drinking water, where just 4.8% reported regular access to the public network, while more than 40.8%, the largest share, got their water through an illegal connection to that same grid. A majority of AGBA’s *asentamientos* also lack asphalted roads (52%) and residents painted a tenuous picture of emergency services. Nearly a quarter felt that firefighters and the police sometimes, or even never, attended to issues in the community, with nearly a third saying the same about ambulance services.

Not all results were bad: residents of most of the settlements reported having state-sponsored trash collection and lighted streets (even if the community had to install the illumination. Somewhat similarly, environmental hazards were not as prevalent as popularly perceived. Large majorities (70%) of the communities did not have a dump, high tension power lines, train lines, industrial waste sites, large inclines, agricultural plantations, or landfills within even 100 meters of their land. Riverbanks, however, were the feature most commonly within the confines, or within 50 meters, of an *asentamiento* (35%), followed by high-traffic roads (20%) and dumps (15%). Curiously, this is the same percentage of communities that also reported rampant flooding after any rain event (a commonality with the climate of coastal Argentina).

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| Table 2.19 | | | | | |
| Service | Inside the neighborhood | Less than 10 blocks | 11-30 blocks  (1-3km) | 31-50 blocks  (3-5km) | Beyond 50 blocks  (5+ km) |
| Kindergartens | 11.5% | 49.3% | 24.9% | 3.3% | 10.9% |
| Primary school | 10.9% | 48.9% | 25.6% | 3.2% | 11.4% |
| Secondary school | 8.3% | 42.8% | 29.4% | 5.7% | 13.8% |
| Hospital | 0.0% | 2.6% | 19.9% | 23.4% | 54.0% |
| Medical center | 10.3% | 39.2% | 30.7% | 6.7% | 13.1% |
| Police station | 1.2% | 15.9% | 38.6% | 20.1% | 24.3% |
| Public transit | 19.8% | 60.1% | 8.9% | 0.6% | 10.6% |
| Plaza | 23.3% | 37.1% | 18.0% | 4.5% | 17.0% |
| Recreation center | 10.8% | 26.2% | 19.5% | 5.1% | 38.4% |
| Source: TBD | | | | | |

Lastly, TECHO also inquired into the distances between each settlement and the nearest location where a range of services are offered. Shown in Table 2.19, the results are mixed. Schools, generic medical centers, and public transit centers all seem to be close, whereas hospitals and recreation centers were much further away. Since these are low-order and high-order services, respectively, it is hard to immediately prognosticate on *accessibility* since we do not know how long it takes to get to these places (or how much it costs). The proximity of schools and health centers is likely a good sign for service access, although poor quality streets or unreliable transit could make these journeys more difficult. Conversely, if good public transit to hospitals is available the longer (more than five-kilometer average distance) may not be of as much concern as they might seem. This shows the importance of incorporating travel time.

Altogether, TECHO’s report showcases that some services are clearly lacking within or proximate to AGBA’ *asentamientos*. This sentiment is captured in perhaps the most interesting of TECHO’s interview questions which asked residents about the greatest threat to their individual neighborhoods. While insecurity was a common answer, the largest cohort felt the lack of services was most grave. Using travel time data to quantify the provision of one of these services, public transportation and its accessibility-inducing mobility services, can help strengthen the argument to policymakers that inequalities exist and must be fixed.

The other primary source for information on the *asentamientos* is the quantitative-ethnographic work of Argentine sociologist Cravino et al. (2008). Just one part of a larger project entitled INHABITAT, the author and her collaborators carried out a survey in four different *asentamientos* in metropolitan Buenos Aires—one each from the departments of Moreno, San Miguel, Quilmes, and La Matanza—during July and August 2006. While there was some variability between the communities selected in terms of degree of organization, ability to mobilize, location relative environment hazards, outside help, and service provision, there were other commonalities; all were far from their municipal centers and hospitals, roads were of poor quality, and public spaces were lacking. All in all, 480 people were interviewed. Their responses comprise the only direct documentation of living conditions and of residents’ personal observations on life in the *asentamientos*. Unfortunately, the interviews were conducted more than a dozen years ago and the respondents represent a tiny fraction of the million-plus *asentados* and *villeros* in metropolitan Buenos Aires. While I used their opinions and observations to shape parts of my methodology, I understand the risk that they are biased and out-of-date.

INHABITAT’s findings, at least for 2006, corroborate many of the prior descriptions of the *asentamientos*. Those in the sample were young (a majority of residents under age 40), most had migrated from the interior of Argentina, and a large number were poorly-educated. The sample included relatively few foreigners (only 22%, with most from Bolivia and Paraguay) and a near-majority (47.5%) have only a primary-level education. Just 0.2% made it to the university level and many were illiterate. A sizeable share of those in the sample—around 40%--were employed, with most in low-skill, temporary jobs. While few were fully unemployed, substantial numbers were on state-sponsored employment plans or reported being housewives; almost none were retired. For those who worked, nearly all were in typical working-class positions: construction and carpentry (25%), domestic workers (17%), street vendors (13.7%), service sector workers (11%), and mechanics (4.2%) (pp. 92–144).

Their households, meanwhile, were crowded and lacked some of the same services highlighted earlier. While running water and electricity were commonplace in the four study areas, sewage disposal was uncommon, creating unhygienic conditions that promoted the spread of disease. Less than a quarter of households had either a television or landline phone, something the authors attributed to the reticence of utility companies to extend services into the *asentamientos*. Even when these services were formally provided (and not merely clandestine connections to the grid), outages were still common. Lastly, these four settlements were all flood prone, with residents (the majority of whom either had self-constructed their home or purchased one from a prior owner) often at risk of losing property—primarily furniture. Relatively few people owned their property; approximately 20% had proof of purchase or ownership of their land, whereas over 60% were merely occupiers. This, respondents felt, made it difficult to replace lost property or receive help from public authorities (pp. 169–175, 182).

Much like the TECHO report, INHABITAT also collected important information on mobility preferences and the geographic location of common activities. For instance, employed *asentados* primarily worked in their same department (48.1%) or within the neighborhood (28.8%), while 17.7% traveled to jobs in a separate AGBA department and 8.7% went into the federal district. In **Table 2.20**, some of the other common trip types—and their destinations—are summarized. Few activities took *asentados* far beyond their neighborhoods; everyday shopping (e.g., for groceries), the purchase of construction goods, schooling, socialization, and religious practices all took place nearby. Only shopping for luxury goods (e.g., furniture, appliances) required lengthy trips, if purchased at all. In terms of familial trips, many respondents either had no family in the area to visit or, if they did, their extended members often lived with them or in the same *asentamiento* (pp. 185–188).

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| Table 2.20 | | | | | |
| Activity | Inside Asentamiento | Immediately Around Asentamiento | Outside Asentamiento, Same Department | Outside Asentamiento, Another Department | Not Applicable |
| Everyday Shopping | 79.8% | 21.9% | 2.1% | 3.8% |  |
| Luxury Goods | 4.6% | 22.7% | 22.1% | 23.0% | 28.3% |
| Construction Goods | 4.6% | 41.0% | 9.2% | 4.8% | 40.0% |
| Study | 24.0% | 32.3% | 6.7% | 12.0% | 22.1% |
| Socialized with Friends | 53.3% | 7.9% | 6.3% | 3.1% | 29.0% |
| Practiced Religion | 56.9% | 24.6% | 11.2% | 7.3% |  |
| Cravino, et al. 2008, pg. 117, 119-120, 122 | | | | | |

As for the modal breakdown of these trips, most people reported taking the bus, followed closely by those who traveled on foot and those who biked. Merely 5% rode the train (although, as the authors mention, the four surveyed sites were all far from the nearest stations), and only 1.5% reported owning their own car. While data on the *quality* of these transit services was not collected, some respondents’ answers alluded to an apparent crisis. One person felt unable to rely on the available public transit system to reach relevant employment sites, another felt it might be worthwhile to simply move to an *asentamiento* or *villa* closer to jobs, and a third commented that her neighborhood was essentially isolated, like being in a “desert” or on an “island” given the difficulties of accessing proper services and employment (pp. 166, 175). All indicators from the survey results point toward inequitable access being a significant problem for *asentados*.

Alongside these qualitative studies, INHABITAT also performed basic geospatial analyses to tabulate the distances between the *asentamientos* of greater Buenos Aires. Centered on their own dataset of *asentamiento* locations, they determined the average distance from each settlement to its nearest health center, clinic, hospital, primary school, secondary school, middle school, kindergarten, and public transit stop. Looking at the results, public schools were, on average, the closest feature class, followed by public transit, health centers/clinics, and private schools. Interestingly, the results were disaggregated based on whether a given settlement was closer to CABA (first-ring) or further away (second-ring). The results, shown in the last two columns of Table 2.21, indicated, as might be expected, that peripheral communities must travel further distances to reach every single destination type.

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| **Table 2.21** | | | |
| Destination Type | Distance to Destination Type | | |
| Across Entire Metro Area | First- Ring Departments | Second-Ring Departments |
| Health Center, Public | 0.61 km | 0.56 km | 0.68 km |
| Clinic, Public | 0.64 km | 0.61 km | 0.71 km |
| Hospital, Public | 2.52 km | 2.02 km | 3.42 km |
| School, Any | 0.33 km | 0.30 km | 0.40 km |
| School, Public | 0.39 km | 0.36 km | 0.42 km |
| School, Private | 0.60 km | 0.49 km | 0.78 km |
| School, Initial Level | 0.65 km | 0.60 km | 0.73 km |
| School, Primary Level | 0.47 km | 0.45 km | 0.51 km |
| School, Middle Level | 1.01 km | 0.92 km | 1.19 km |
| Public Transit Stop | 0.4 km | 0.3 km | 0.6 km |
| Public Transit Stop, with at least 3 lines | 6.3km | 4.1 km | 10.0 km |
| *Source: Cravino, et al. 2008* | | | |

It must be noted, however, that these calculations—from all indication—are simple Euclidean, straight-line distances and originate from those *asentamientos* identified by INFOHABITAT during 2006–2007, which are somewhat inconsistent with the more recent map created by TECHO. Furthermore, and as will be explored in the literature review on accessibility measurement in the next chapter, these are physical distances that do not necessarily reflect the actual amount of time or money that would be required to access the destinations; simple spatial proximity is not relevant if that journey is costly in time or money. Just as with the data produced by TECHO, my project builds on these existing data by adding the element of time.

While it would be nice to have data from a larger sample of households, like from a census, there is not much information on the *asentamientos* from the ENMODO travel survey. While it did record the households’ housing types, the only category that pertains are those labelled “villa de emergencia,” which could hypothetically apply to any informal or illegal housing (*villa* or *asentamiento*) across AGBA. Without knowing the degree to which such areas, which house 3.1% of the metropolitan population, correspond to *asentados*, I choose not to use data or summary statistics for them (ST 2011).

In terms of present-day transportation conditions, Lascano Kezic and Durango-Cohen (2012) provide an excellent overview of planning politics and ridership patterns, illustrating why I expect mobility conditions within the *asentamientos* to be poor. For instance, planning responsibilities remain atomized between federal, provincial, and municipal governments, a problem that persisted throughout Buenos Aires’ metropolitan history. The national government controls the commuter railways (re-nationalized in the 2000s), subways, highways, and buses that run routes between the federal district and the outlying province. It also holds ultimate authority over all funding responsible for projects that involve both the city and the province. In addition, the national government controls transit subsidies, which are a substantial expenditure, amounting to 0.7% of national GDP in 2012 (Guerra et al. 2018). Initially introduced during the 2001–2002 economic crash, these subsidies keep transit fares affordable for many low-income porteños but have diverted funds away from the maintenance and upgrade of the existing system (Guerra et al. p. 106). Meanwhile, the province sanctions all travel across municipal borders, and the municipalities supervise modes whose routes lie within their own boundaries. The city of Buenos Aires, meanwhile, controls just bus stop locations, subway extension planning, and taxicab licenses, despite operating its own planning agencies and having nearly a quarter of the metropolitan area’s total population and a substantial portion of the region-wide tax base. This is reflected by the fact that the entirety of the subway network is within CABA’s boundaries, as is the region’s more recently built bus rapid transit lines.

Alongside the disarray in planning circles, the number of people owning private automobiles has skyrocketed as the country’s economy has stabilized and produced a growing middle class. This has, in turn, siphoned away much-needed fare revenue from buses and rail lines, the latter of which see relatively low ridership. Lascano-Kezic and Durango-Cohen (2012) note that these trends have been ongoing for decades but have accelerated in the last twenty years aided by government subsidies, new highway construction, and users discontented with poor-quality transit (pp. 110-1). The modal split in 1992 (according to Vasconcellos 2001) was 60% public, 24% private/auto, 9% non-motorized, and 7% other, while twenty years later it had become 43% public, 26% private, and 31% non-motorized (ST 2011).

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| Table 2.22 | | | | |
| **Mode** | **Share** | | | |
| **1972** | **1992** | **1996** | **2007** |
| Bus | 54.3% | 49.85% | 42.7% | 31.33% |
| Subway | 5.4% | 3.62% | 4.3% | 3.74% |
| Train | 7.2% | 6.37% | 6.45% | 5.08% |
| Automobile | 15.4% | 24.29% | 31.4% | 41.94% |
| Total number of trips | 17.4m | 18m | 19.3m | 26.3m |
| *Source: CAF 2011, pg. 30* | | | | |

Public transportation, the traditional leader in Buenos Aires’ modal split, has seen some improvements in recent years despite losses relative to private automobiles. Trains, still losing traffic and revenue compared with their heyday, were initially franchised out to private operators during the 1990s, and then partially re-nationalized during the 2000s. They have seen some new investments (electrification of railway lines, for instance). Ridership levels are at approximately 250 million people, and the rail lines remain one of the easiest ways to reach the city center from the metropolitan outskirts (reflected in ENMODO data). Given the age—and their history as the initial progenitors of suburban growth in AGBA—their stations are associated with high residential densities and as centers of commerce within the departments they serve (Blanco 2014). Nevertheless, they have struggled against a negative popular image, with a now long-established legacy of poor service quality, rampant safety violations, insufficient investment in capital (e.g. tracks, stations, locomotives, and rail cars), poor on-time performance, significant fare evasion, and debates over funding.

Buses, meanwhile, have retained their spot atop the regional modal split and are still privately-operated. Companies continue to bid on routes put out by the state (the location of a given route is determined by the government body whose jurisdictions it serves) and awarded to them through concessions. While not strictly a public service, the companies are still held to federal safety and technical regulations and have received help in purchasing and maintaining new equipment. Furthermore, efforts have made to ensure intermodal connections, with buses now stopping at rail or subway stations to permit connections. In some parts of the metro area (albeit primarily within CABA), segregated bus lanes have been installed. Fares—which are distance-based—are heavily subsidized by the state, with discounted tickets available to seniors and students (Guerra et al. 2017). As seen in the ENMODO results, the bus is also the preferred mode of the lower classes: the busiest routes, as it turns out, are those serving southern and northwestern departments of AGBA, where many of the region’s poor, working-class people (including the *asentados*) are to be found (Keeling, 1996).

Recent transportation system improvements, however, have overwhelmingly favored residents of CABA and the wealthier communities in the region’s periphery. The federal government, alongside the city and provincial governments, has pushed the electrification of suburban railway lines, expanded the City’s subway system, and constructed several bus rapid transit corridors throughout the City of Buenos Aires. It has also implemented a region-wide fare card program (known as the SUBE), helped fund the purchase of newer vehicles, added a transit safety agency, and added university programs in transit engineering (CAF 2011; Borthagaray and Natale, 2017).

In AGBA’s peripheral zones, away from CABA and its wealthy residents, services are still poor, with chronic congestion, unreliable services, frequent accidents, poor management, and transit that is over-capacity (CAF 2011; Gutierrez 2014). Some scholars, like Pirez (2002), Gutierrez (2014) and Blanco (2014), attribute this imbalance to inequitable spending on automobile-based transport—which has increased air pollution and street congestion while attracting paying customers away from transit—and the lack of a proper, regional planning authority. With such a body, transportation and land use planning could be coordinated comprehensively, with departments working together with the federal, provincial, and CABA governments, to ensure that the transit system is more efficient and equitable for all porteños, not just the minority wealthy enough to drive or to afford buy or rent their own home or apartment.

While the city enjoys walkable streets and transit coverage greater than 90%, substantial mobility problems remain for those living far from the central business district. Despite the continued growth in the conurbation’s periphery, “Greater Buenos Aires concentrates residents and overall wealth in the central city. The densest neighborhoods are centrally located and emanate radially from the center … [and] the highest income households are located in central locations of Buenos Aires, where the best transportation infrastructure and urban amenities are located” (Guerra et al., 2017, p. 3). Pirez (2002 over a decade ago correctly observed that there “is no democratic decision-making process at the metropolitan level, so key decisions are left to the market ... and more powerful economic actors (such as developers and private companies providing public services) … without the necessary accountability to the citizens that represent the real city (p. 158).”

* In conclusion, there is ample evidence to support the hypothesis that the residents of metropolitan Buenos Aires’ *asentamientos* experience poorer transit-based access, to daily activity sites than those people living in the formal, legally-established neighborhoods that surrounded them. It is this hypothesis, quantified through average travel times, that I explore in the still-to-come analytical portion of this thesis. The contributing factors I have discussed thus far are, first and foremost, that *asentamientos*—by their nature—are found exclusively in peripheral spaces, both relative to their individual districts and the whole metropolitan region. If the land upon which they were settled was more transit accessible—and not already plagued by floods, pollution, and other environmental hazards—it would have been developed. While it could be argued that their peripheral locations will inherently make travel times longer, this is still not an excuse for not providing essential, accessibility-enhancing transportation services to these areas.
* Aiding this initial spatial disadvantage is the long-ongoing deterioration of transportation and other public services in the metro area; since the 1950s, rail and bus services have been poor, especially in the metropolitan periphery. Aside from the recent construction of wealthy gated communities, the periphery has always been resource-poor compared to the cosmopolitan city. With reduced fare revenue from those who now drive and the general disengagement of the state from the economy through neoliberal regulatory policies, decreases in transit-accessibility are to be expected everywhere, but the worst impacts are likely to be felt by those marginalized people living in the region’s most precarious locations.
* Lastly, with profit-minded utility companies choosing to forgo low-income areas in other spheres, it would come as no surprise to see longer travel times for *asentados* than their (relatively) wealthier neighbors, a reflection of infrequent, overcrowded, and under-supported transit services. Despite being transit-dependent, their low-incomes and stigmatized popular image likely hinder the ability to attract higher-quality transit services.

# Chapter 5: Accessibility

The primary concept underlying this analysis is *accessibility*. Seemingly simple, it has been conceptualized and operationalized in many ways and, as acknowledged in the literature, there is no singular interpretation that can always be called upon. It varies based on context, a characteristic reflected in array of definitions of *accessibility* and *access* in the literature. Nevertheless, as explained by Handy and Niemeier (1997), nearly all conceptualizations acknowledge, whether explicitly or implicitly, that it is characterized by two basic, yet highly-interconnected, components: (1) the distribution of activities (origins *and* destinations) across a territory and (2) the ease and costs of travel through a transportation system between those points. This second component is especially critical to this study because without the means to travel across a space, the actual distribution of destinations is substantially less important. Considering accessibility as just a factor of physical separation does not fully capture the realities of individual mobility. This is particularly true for low-income groups, like the *asentados*, whose time and monetary budgets are exceptionally limited thereby significantly restricting their ability to move about the landscape. In the absence of cost-effective mobility services, low-income people may well be prevented from reaching important destinations, regardless of proximity.

A definition of accessibility that emphasizes constraints on mobility is from Hansen (1959): “*accessibility* is a measurement of the spatial distribution of activities about a point, adjusted for the ability and the desire of people or firms to overcome spatial separation*”* (p. 78). In other words, it is ultimately about whether people can reach the places they need to go to carry out their daily necessities. When accessibility is high, people can reach wherever they need to go in a cost-effective manner; when it is low, people struggle or fail to reach important destinations, burdened by time- or cost-ineffective means for overcoming distance. Ideally, all people will enjoy a high degree of access, regardless of their location or socioeconomic condition. Similar definitions have been given by Guers and Van Wee (2004), “the extent to which land-use and transportation systems enable (groups of) individuals to reach activities or destinations by a means of a (combination) of transport mode(s)” (p. 128) and Handy and Niemeier (1997), “the spatial distribution of potential destinations, the ease of reaching each destination, and the magnitude, quality, and character of activities found there” (p. 1175).

These definitions provide the basis for the approach adopted to measure accessibility in the current study. To measure the cost-impedance faced by AGBA’s *asentados* as they try to travel between their homes and important activity sites (e.g., schools, health care, employment centers, train stations), I use calculated travel time by public transportation. I focus on the role of public transportation services as the mechanism for overcoming spatial separation because this is the likely mode of longer-distance travel for residents of the *asentamientos*. By considering the time-cost of travel, I am moving beyond any of the existing studies of access in the *asentamientos* (e.g. XXXXXX and XXXXXX) which looked exclusively at the physical distances separating the communities and their service providers and not whether the *asentados* could time-effectively reach those sites. If I can show that the *asentamientos’* residents require more time to reach daily activity sites than it takes those living in formal neighborhoods, I can provide an illustration of relative accessibility conditions for the residents of metropolitan Buenos Aires’ many precarious settlements.

Given that accessibility is about whether people can feasibly reach locations distributed throughout space, conceptualizing and operationalizing accessibility is of great importance to those people responsible for studying the services that help people move across space: transport geographers and planners. When accessibility levels are poor, the current transportation system, and all its constituent modes, is failing to meet the mobility needs of its users. Cervero (2011) notes, for instance, that poor accessibility makes it difficult for people to reach jobs and schools, limits economic mobility, and promulgates social isolation, unemployment, and low wages (p. 7). Garett and Taylor (1999) reached a similar conclusion, noting that planners and policymakers can create a situation where “poor or mediocre public transit service in areas with high proportions of transit dependents exacerbates problems of social and economic isolation” as a consequence of an incomplete understanding of the consequences of the spatially-uneven distribution of public investments in an urban area (p. 393).

The role of public transportation should be to promote accessibility, especially for those without private means for traveling the distances requisite for finding employment, attending school, seeking healthcare, and fulfilling other basic human needs. Jaramillo et al. (2012) contend that traditional transport planning has focused on managing demand in urban transport systems rather than studying their socio-economic impacts. Karen Lucas, an expert on the social consequences of inadequate transit, adds that traditional methods analyzing transport’s negative economic and environmental impacts has resulted in a serious lack of attention to its significant social impacts like social exclusion (Lucas and Jones, 2012). In fact, social exclusion is a process “by which, due to an insufficient or inexistence of adequate means to travel, people are prevented from participating in the economic, political, and social life of the community … a result of reduced accessibility to opportunities” (Bocarejo and Oviedo 2012, p. 144). Measuring and observing accessibility conditions would thus seem a prerequisite for policies targeted to avoid social exclusion.

With substantial implications for poverty and economic disadvantage, the same authors believe transport authorities must work to identify geographic areas of need and to prioritize strategies to spatially target and deliver mobility assets to the transport-disadvantaged. Augmenting this plea, Jaramillo et al. (2012) argue that ensuring social inclusion can only take place through “improvements and/or implementation of a high-quality network of public transport with tariffs suitable for [disadvantaged] sectors” (p. 340). Any solution, they say, must directly incorporate the needs of all people, not just those with the greatest demand. Explicit plans should be made to incorporate transport-disadvantaged groups like the poor, the carless, the disabled, those unable to speak the local language, and children. The fact that many urban poor, especially in Latin America, are forced to live in distant locations should not stop them from being able to access and enjoy the benefits of the city through its transport system.

The impacts of improved accessibility, in turn, are many. Keeling (2008), for instance, notes that “transportation enables poorer communities to [reach] basic economic activities and social services and facilitates accessibility to opportunities … [it] reduces the friction of distance between places and regions” (p. 141). He also extolls the virtues of high-quality transport for promoting economic competitiveness, lifting people out of poverty, and reducing inequality. Without the mobility and accessibility provided by transportation infrastructures, services, and technologies, people, places, and capital would not interact, stymieing socioeconomic development (Keeling 2002). Cervero (2011) notes that “for many … the availability of good, reliable, and affordable bus and rail services can be the difference between being integrated into the economic and social life of a city or not … a lifeline to participation in society’s economic, social, cultural, and religious offerings” (p. 5). This is particularly true in market-driven societies, where the going-price for transportation is many times above what many citizens can afford; without an affordable, accessible alternative, they are shut-off from activity sites beyond their immediate surroundings.

Blanco and Apaolaza (2018) expand on the relationship between accessibility and space, emphasizing that accessibility is a consequence of both location and socioeconomic conditions. While the authors acknowledge that socio-economic disadvantage and the lack of mobility assets (e.g., fare-paying capacity, vehicle ownership, drivers’ licenses, transit-using competencies, system knowledges) go a long way to explain limitations in certain groups’ access to urban transport services, they posit that the territorial configuration of these groups is equally as important. Referencing the proximity of groups to services, activities, and transport infrastructure, itself, the authors contend that, “the same transport supply and territorial configuration could be advantageous to a particular social group and not for another, while the same [mobility resources] of households and individuals could be advantageous in a certain specific territorial context but not in others” (p. 2). In other words, the accessibility conditions of a group must always be considered vis-à-vis their socio-economic resourcesand their location; the same system can disadvantage some groups and advantage others. This echoes an earlier conclusion from Bocarejo and Oviedo (2012) that “accessibility can be related to the time and percentage of income spent on commuting [and] the type of user, [his or her] location, and [the] mode” … “showing general higher incidents of time in richer areas and the important effect of money over accessibility in low income areas*”* (p. 153). While accessibility is important in many ways, it is important to recognize that it takes different forms based on characteristics of the user.

Many have tried to operationalize and measure accessibility to evaluate whether existing systems are adequately and appropriately serving their constituents (Litman, 2002; Manaugh and El-Geneidy, 2012; Taleai, 2014; Dadashpoor et al., 2016). Talen (1998) advocates mapping as a tool to “elucidate equity variation” and analyze “the spatial incongruity between resource need and … distribution” through the mapping of disadvantaged groups alongside the “local distribution of public facilities” (p. 23). In the context of transportation, scholars have compared spatial gaps in transit coverage with socioeconomic data, determining if supply is appropriately commensurate with demand, especially in areas with marginalized peoples.

Questions of transportation and access have recently come to the forefront of a “growing scholarly interest in devising measures to assess the accessibility impacts of transport interventions.” Studies looking at accessibility impacts include those focusing on a diverse array of common activity sites like health facilities, supermarkets, social services, parks, and even the transportation system itself (Tsou et al., 2005; Chang and Liao, 2011; Delmelle and Casas, 2012; Venter et al., 2013, Taleai et al., 2014). The aims of most such studies are, as explained by Handy and Niemeir (1997, p. 1176) “providing planners and decisionmakers with [an] assessment of the implications of potential investments for the daily lives of residents” and helping them to strategically improve accessibility conditions. These measures can inform decisions like building new affordable housing units, relocating employment sites and critical services, or restructuring a transportation system outright (e.g., new routes, improved schedules, more comfortable vehicles). As noted by Delmelle and Casas (2013), “identifying population groups with limited access to opportunities” is complex, requiring highly-specific measurements of accessibility that, over the course of the years, have taken many different shapes and forms.

Handy and Niemeier (1997) outline some common methods of measuring access and provide strategies for calibrating the metric of choice. They categorized the metrics into three groups, each of which makes different assumptions and generalizations about the two main components of *access*, land use and travel system. The first of the three are *cumulative opportunities measures*, which reflect, as the name suggests, the iterations of a given category of activity sites that can be reached from an origin within a certain time, distance, or cost. All instances of a destination category within a certain threshold are counted, regardless of the specific travel time, distance, cost, or any other quality or characteristic of that activity site. Each origin point is assigned a number, with no other output. These measures are, on the one hand, the most simplistic, but that means they are also easy to understand and compute.

The second classification, *gravity-based measures*, weight the attractiveness of potential destinations as a function of the cost, distance, or time required to reach each individual instance. With measures of this type, closer locations are weighted more heavily than those more distant. An approach initially promoted by Hansen (1959), this method is more complex than the simplistic “cumulative opportunities” measures because it factors in the human tendency to travel to one of the closest acceptable opportunities. Along these lines, however, the gravity model is also useful for scenarios where people may be willing to travel to farther destinations that offer specialized goods or features not available at other, similar sites closer to the origin.

In a gravity-based measure of accessibility, the equation used to model distance-decay is typically a negative power or negative exponential function whose deterrence parameter can be altered based on the characteristics of given activities. Some activities may be able to draw people from farther distances than others, requiring a change in the exponent of that equation. While gravity-based measures may provide a more nuanced picture of accessibility than cumulative opportunities measures, they require more computation, can be harder for the layperson to understand, and, as importantly noted by Delmelle and Casas (2013), can be highly subjective, depending on how activities are weighted. In fact, it is hard to know what exactly drives people to travel, or not travel, longer distances for a good.

The third category distinguished by Handy and Niemeier (1997) are *utility-based measures*. These attempt to proxy the probability that a person will choose to make a certain trip based on selecting, from a range of choices, the alternative that maximizes his or her utility. These are the most complex and rely on mathematical and economic models; their greatest limitations are their computational complexity, steep data requirements (detailed survey data on consumer preferences are needed), and their difficult for the average person (or policymaker) to understand.

Regardless of which measure is chosen, there are some considerations that must be made. One of those is the level of spatial aggregation. Access can be measured for large areas like cities or neighborhoods and smaller areas like households or even individuals. Larger-scale units require less total data, but assumptions must be made about how to generalize the needs of the people living therein. Small-scale, household- or individual-level studies give a fine-grained understanding of individual accessibility but are less generalizable across a region and are data-intensive. Destinations must also be considered, with activity sites that represent the people under study—locations that “residences perceived to be available to them” (Handy and Neimeier, 1997, p. 1179). This furthermore requires one to consider destination attractiveness. The size or quality of certain features may draw people from further away than otherwise assumed. Some features, like public schools, draw mainly from surrounding areas while others, like hospitals, can draw people from further away if they offer a unique good or service.

Another consideration is the quantification of travel impedance. Traditionally, this was done as a distance measure, whether Euclidean, Manhattan, or network-based. However, distance alone is not enough to fully represent access—distances are meaningless if people have no means of crossing them. As such, time- and cost-based measures are better. Time-based measures, historically difficult to estimate, are now possible thanks to recent innovations in geographic information systems and travel forecasting models; it is even possible to estimate travel times on transit alone, even accounting for variations in trip-length caused by restrictive transit schedules or congestion. Similarly, a cost-function can be added to capture the monetary cost of a trip. Comparisons across modes are possible, representing the choice set available to a traveler when deciding how to reach a destination or whether the trip is feasible in the first place (i.e. transit against driving, transit against walking, or biking against walking).

Handy and Neiemer are not the only authors to categorize accessibility metrics. Geurs and van Wee (2004) offer a similar classification system. They believe a measure needs to consider four things: land-use patterns in a region, transportation systems, temporal constraints on individuals and destinations, and the various constraints and limitations that affect individual users. They provide a four-pronged categorization: (1) infrastructure-based, (2) location-based, (3) person-based, and (4) utility-based. Those in the first category deal with service quality along a network, emphasizing travel speeds, congestion, and how well an individual transportation mode facilitates access. The second looks at accessibility from a given location to an assortment of activity sites scattered across a study area, identifying the number of locations within a reasonable travel distance or cost threshold, identical to *cumulative-opportunities*. Person-based measures focus on the activity sites available to a person given individual characteristics that may affect or hinder their movement across an area (e.g., income, disability, age, employment). The last category, the same as one from Handy and Niemeier, consists of studies that take an economic approach to accessibility and consider the benefits or use-value that people derive from a given distribution of activities and how this influences mobility choices.

Lei and Church (2010) added another classification system, focusing measures that analyze transit*.* They note that transit’s unique characteristics create unique accessibility challenges: a simple shortest-path solution does not work when a network relies on fixed routes, schedules, layovers, and fares, and that people must negotiate these constraints with their own schedules and budgets. In turn, transit-specific measures are classified as measuring either (1) *system accessibility* (whether people can physically access a system and that it is proximate to everyone), (2) *system-facilitated accessibility* (whether a system takes people where they need to go in a reasonable travel time), (3) *integral accessibility* (the total number of opportunities available within a given travel distance or time), (4) *space-time accessibility* (which focuses on individual limits to movement across space vis-à-vis time budgets), (5) *utility-based accessibility* (looking at how consumers weigh travel alternatives and select the one that is most useful), or (6) *relative accessibility* (how well transit compares against rival modes in offering access to the same set of destinations).

Miller and Harvey (2001), meanwhile, provide a similar tripartite typology: measures that (1) incorporate individual space-time constraints, (2) those that focus on the characteristics of places that make them more or less attractive or accessible (like in a gravity model), or (3) those that measure the benefits and utility that different transport alternatives afford to users vis-à-vis a larger choice set. They advocate for the first category, noting that individuals’ access to locations cannot be separated from their available time. In their opinion, a well-functioning system allows all people, regardless of time budget, to feasibly reach demanded destinations. Fransen at al. (2015) alternatively find that existing accessibility metrics ultimately focus on one of four things: (1) *physical accessibility* (people’s proximity—in time or distance—to a system), (2) *frequency of transit stops* (the number of trips—or number of seats—available at the stops proximate to a person), (3) *time or cost of travel to a destination*, or (4) *the temporal variability of service* (at a location or over a route during a day, week, or year) relative to people’s demands. Each metric builds in complexity over the prior.

The literature applying measures of accessibility to Buenos Aires and other cities in Latin America is small, although growing in recent years. Even though these cities share unique geographies—e.g., massive population growth, pronounced socio-territorial inequalities, rampant poverty, sprawling informal settlements, unequal provision of services, deteriorating public transportation, rapid motorization and congestion, inept bureaucracies, and nonexistent planning—the application of advanced accessibility metrics is hindered by poor data quality (Jaramillo et al. 2012). Rather than devising novel approaches for measuring access for their unique urban environments, many papers adopt simplistic cumulative-opportunities measures that rely only on distance-based operationalizations of access. There are few that provide accurate estimates of travel times and even fewer that adopt gravity- or utility-based measurements.

Peralta Quiros and Mahndriatta (2015) are a lone exception, who estimated the number of jobs available to workers in different parts of metropolitan Buenos Aires within different travel times. They self-constructed a network-based travel time model that tabulated the number of “employment opportunities” (a vague measurement adopted by the authors, with no explanation of how they estimated employment since, as far as I am aware, these data are not made public by the Argentine government) within sixty-minutes’ travel (driving and transit). Performed at a fairly-large scale, the authors calculated access for neighborhood-sized zones across AGBA so as to get a wide-ranging picture of access, they concluded that its peripheral regions were the most transit-inaccessible. They likewise lamented that most regional growth in the previous decade had taken place in these distant, low-density areas instead of in transit-efficient areas closer to the urban core. The results do have a few limitations; they do not incorporate actual transits schedules (just estimations created by the authors that were incorporated into a geographic information system) and represent access at a more aggregate scale (we cannot see scores for individual parcels or blocks, the scale of most *asentamientos* and other precarious settlements). It also does not account for diurnal fluctuations in regional travel times brought about by congestion during peak travel times. Nonetheless, this is still one of the few studies of accessibility in Buenos Aires that attempts to incorporate travel time, a model for this paper and an improvement over previous studies of the region.

Salerno (2012), for instance, is an earlier accessibility study that measured access solely as a factor of distance. In order to diagnose the transit access of the *villas* in the City of Buenos Aires, the author calculated the number of transit lines, stops, frequencies, and seats available to CABA’s *villeros*. Attributing access to those stops and lines closest (via straight-line distance) to each of the city’s *villas*, he surmised that over 93% of the land area of city—including its precarious settlements—had reasonable access to transit services. Instead of using a traditional cumulative-opportunities metric, which looks at the total number of opportunities within a distance, he focused on just the closest iteration (in this case, stops and routes). While he did incorporate transit frequency data (albeit acquired through a personal connection at Argentina’s transit-statistical agency), the accessibility component was still based only on distance, possibly over-estimating actual conditions. All the while, the study was done at a fine scale, calculating access for disaggregated units similar in size to the *asentamientos* examined by this project. A similar study was carried out by Arce and Mino (2017) for one of Greater Buenos Aires’ outer departments, Jose C. Paz. Using publicly-available train schedules and auto-estimations of bus frequencies, the authors found that census blocks (a small unit similar in size to a neighborhood) near train stations had the greatest supply of transit across all modes. Like Salerno, they used simplistic distance-based approximations of access to transportation services while still managing to capture accessibility patterns at a disaggregate scale.

Recent papers from Guerra, et al. (2018) and Blanco and Apaolaza (2018) did little to advance the measurement of accessibility in Buenos Aires. The primary objective of the first paper was to determine predicts of household travel expenditures in AGBA, thus accessibility was only considered as a potential explanatory variable for the outcome of interest. In fact, this is illustrated by the incorporation of the same access-to-employment opportunities measure created by Peralta Quiros and Mehndiratta (2015) as one representation of *accessibility* in explaining travel spending across the conurbation. The authors also added a simplistic transit access variable to the mix, tabulating the straight-line distance separating each of metropolitan Buenos Aires’ census *radios* (the smallest census-geographic unit that exists in Argentina) and their nearest stop. While the analysis is done at a relatively fine scale, it is problematic for using a potentially-inaccurate employment-access measure and an overly-simplistic transit-access metric that relies only on distance. The second of these papers, meanwhile, barely considered access as part of its goal of evaluating the relationship between limited mobility, socio-economics, and the physical location of Buenos Aires’ inhabitants. While they do find that location to be equally as predictive of limited mobility (e.g., longer trip times, infrequent services, long distances from transit, unpaved roads) as income within the conurbation, accessibility itself is not considered beyond the travel times reported in the ENMODO origin/destination survey.

Looking beyond Buenos Aires to other urban areas in Latin America, there is a steadily growing body of literature on accessibility and public transportation, although data limitations remain. In fact, authors like Bocarejo and Oviedo (2012) and Gutierrez (2012) attribute some of the problems of transportation provision in the region to the lack of data on transportation systems (e.g., commuting patterns, origins/destinations, modal preferences, revenue) and the inability of policymakers to employ complex, accurate measures of accessibility and, therefore, to incorporate observations into comprehensive transportation plans. This is certainly the case for Buenos Aires, where there is little publicly-available data on critical phenomena like socioeconomics, income distributions, transit schedules, activity sites, employment locations, or geographic information systems. Accurately estimating accessibility, especially as a factor of travel time, is not possible without these data, even if the measurement is a more simplistic cumulative-opportunity estimate.

Such limitations do not exist everywhere, however, higher-quality data becoming available in more cities. For instance, Guzman, et al. (2017), Rodriguez, et al. (2017), and Hernandez, et al. (2017) were able to estimate travel times for Bogota, Colombia and Montevideo, Uruguay using their cities’ respective network-routing tools, which permit travel time estimations through their respective transit systems. Delmelle and Casas (2012) and Martinez, et al. (2017), who looked at different aspects of transit-facilitated travel in Cali, Colombia and Santiago, Chile (respectively), called upon public data on employment and income from their respective census authorities and municipal travel authorities to improve their estimates. Boisjoly, et al. (2017), who looked at employment access in Sao Paulo, Brazil, directly incorporated transit-based travel times from Google. The absence of such data for Buenos Aires helps to explain why the aforementioned studies of accessibility in AGBA presented so many limitations. Better information on land use and travel systems in other Latin American cities allowed more advanced evaluations of accessibility in those cities, whereas the absence of such data in Buenos Aires presupposes potentially-inaccurate assumptions about employment, income, transport infrastructure, and travel times in AGBA.

# Chapter 6: Methods

This project relies primarily on quantitative methods, although qualitative studies were heavily consulted to inform the analysis. To operationalize the concept of accessibility I chose based on my literature review (whose selection I will describe below), I first queried Google Maps’ shortest-path routing assignment algorithms to calculate the minimum transit-based travel times between (1) a sample of *asentamientos* from across AGBA, and (2) a series of ten important activity sites. Then, I supplemented these values with a battery of statistical tests to see whether travel times from the *asentamientos* were statistically-significantly different from those values associated with a sample of the conurbation’s formal neighborhoods.

In the following sections I will describe the Google Distance Matrix API tool and its travel-time calculation process, inputs, parameters, assumptions, outputs, and functional limitations. I will also discuss the important role that the API played in the selection of a modified cumulative-opportunities type accessibility metric. I will then discuss the steps by which I acquired and formatted the tools’ inputs (e.g., origins and destinations) and how I determined modal parameters (e.g., departure dates and times, modes, etc.) selected for my transit-based travel time queries. Lastly, I will briefly discuss formatting the API’s travel-time matrix outputs and how I implemented two different differences-of-means tests: ANOVA and independent-sample t-tests.

To calculate transit-based travel times within Greater Buenos Aires, I used Google Maps’ Distance Matrix API (Application Programming Interface) web service. This tool allows researchers to determine the shortest-path travel times between different origin-destination pairs, utilizing the same transportation network data and routing algorithm that Google Maps employs when performing on-demand route-finding requests through its popular web interface (Wang and Xu 2011, p. 200). Shortest-path routing algorithms, like the one employed by Google, try to estimate the route between a given origin and destination pair with the shortest travel impedance (time or cost) through a given network. These algorithms are associated with the trip-assignment stage of traditional travel modeling, the step where planners seek to “determine the trip-maker’s likely choice of paths between zones … along the network of each mode … and predict the resulting flows … on the individual links [of that] network,” (Papacostas and Prevedouros, 2000, p. 400).

According to Google, using an API “gives developers several ways … [for] retrieving data from Google Maps … [with] simple or extensive customization” that, in the case of the Distance Matrix API, “provides travel distance and time from a matrix of origins and destinations … based on the recommended route between start and end points, as calculated by the Google Maps API” (Google 2018).[[3]](#footnote-3) The API, in turn, produces an output that is a travel time matrix indicating the amount of time that Google Maps estimates—based on its proprietary algorithm—would be required to travel between the origins and destinations of interest to the researcher.

These estimates depend on one of the API’s integral functionalities: its parameters regarding travel mode, arrival/departure times, units, language, and day-of-the-week. When it comes to requesting these data, Google has several interfaces (or “client libraries,”) that allow the user to query its servers via well-known programming languages or software packages. I chose the client library created for the statistical programming language R.[[4]](#footnote-4) Per Wang and Xu (2011), R is good at handling large data requests and makes it easy to perform statistical tests once the time values were acquired. The specific tool within R for performing these requests is called “gmapsdistance” and requires an input value for each of the parameters listed above.[[5]](#footnote-5)

The first step required to use the Distance Matrix API tool is to acquire and prepare the data needed for the tool’s three fundamental inputs: origins, destinations, and an API key. The origins and destinations are the geographic points representing the starting and ending points for any travel-time analysis. These points can be provided in the form of latitude and longitude coordinates or full addresses. With a standard, free Google account, users are permitted to enter, at one time, no more than twenty-five origins and/or twenty-five destinations. In R, these addresses or latitude/longitude pairs must be entered as a string, or a vector of string values, each separated with a “+”.

Google’s monitoring and limitation of user activity explains the final required input: the API key. An API key is a unique identifier code that a user must enter into the program before making any requests. Each key is linked to a user’s Google account. As a result, they can track and, most importantly, limit the number of requests made to their servers. For the Distance Matrix API the daily quota is set to 2,500 free elements (where an element is one origin/destination pair), each request may have no more than 25 origins or 25 destinations per request, and requests are limited to 100 per second. Once a user reaches this total for the day, the application will stop returning results.

After the origins, destinations, and API key are set, the user then sets the remaining parameters. These are the mode of travel (driving via the road network, walking via pedestrian paths and sidewalks, bicycling via paths and preferred streets, or transit via public transit routes), the language and units (metric or imperial) of the output, the arrival and/or departure time (in UTC time), arrival and/or departure date, and the shape of the time table (long or wide). Some parameters are specific to certain modes. If driving is selected, the user can stipulate certain traffic conditions (optimistic, pessimistic, or best guess) or what types of feature to avoid (tolls, highways, or ferries). For transit-based modeling, the user can stipulate specific modes—bus, subway, train, tram/light rail, or rail (a combination of subway, train, and tram)—as well as routing preferences—selecting routes with less walking or fewer transfers (if appropriate). If not stipulated, many of these parameters have a default value: driving as the mode, English as the language, metric as the unit system, and the present day and time for the departure. In R, these parameters are included within the “gmapsdistance” tool and are all stipulated as text strings. I will explain my selection of parameters below.

Once the parameters are set, and the tool is run, the final output is a “list with the traveling time(s) and distance(s) between origin(s) and destination(s).” The output table contains a row for each origin and three columns for each destination: one for the distance (in meters), one for time (in seconds), and one that displays a “status” that indicates whether that origin/destination pair calculated correctly (“OK,” “NA,” “INVALID,” and “OVER QUERY LIMIT” are common statuses). The first row and column of the table also contains the latitude/longitude coordinate for the corresponding origin or destination, as entered into the API. Serving as unique identifiers for each row, they allowed me to join these data to other tables.

Given how recently Google Maps introduced its Distance Matrix API web tool (launched in 2006), its application within the academic literature is nascent. Nevertheless, researchers have already documented its advantages over alternate methods of estimating network-based travel times. Wang and Xu (2011) compared driving times estimated by the API with those from a network dataset self-constructed within ESRI ArcMap and its network analyst tools. Looking specifically at access to hospitals, they found Google’s estimates to be *longer* than those from ArcGIS, an indication that the former was actually accounting for traffic congestion and other possible delays that are more difficult to represent with ArcMap.

Google Maps maintains and constantly updates on their servers a massive quantity of transportation data on network configurations and characteristics including real-time traffic data, prior congestion levels, speed limits, and restricted turns on urban streets. This permits more accurate and up-to-date estimation of travel times than researchers could feasibly pull together for a custom-built network. Most alternative methods rely solely on speed limits to calculate travel times along road segments and are unable to account for diurnal variations in traffic, a key feature of the API) (Wu 2017).

Deploying the Google Distance Matrix API, the user does not have to collect huge volumes of transportation data or become familiar with complex road and transit network data structures because all the “dirty work” of modeling the network is already done. In the words, of Wang and Xu (2001, p. 202), “modeling is as good as the data get.” In the case of Buenos Aires, as I will explain below, Google appears to have the best and most comprehensive data. Nevertheless, Wang and Xu noted some of the API’s remaining limitations: the number of requests is limited for users without a paid license, there is little transparency for non-Google users related to data quality or routing algorithms, and the servers are still prone to returning seemingly-random errors for certain requests (p. 208).

Academic use of the Distance Matrix API for transit-based analysis appears to have been uncommon, thus far. I was unable to locate any papers that explicitly assess transit-based travel time queries using Google (at least in a manner similar to Wang and Xu’s evaluation of drive times), although a bit more has been written about Generalized Transit Feed Specification (GTFS) datasets, the data structure employed and developed by Google for standardizing transit schedules around the world. GTFS, first introduced by Google in 2005, consists of a series of CSV files that contain information on a transit agency’s name, routes, schedules, frequencies, stop locations, shapes, transfer points, and fare attributes. Regardless of an agency’s size or location, each of these files uses the same simple, open-source formatting; this helps to “facilitate data sharing and access to information” and to be easily operable with online applications that provide route and schedule information to transit users (Fortin et al. 2016, p. 22).

GTFS has become standard within transportation departments in the United States and, increasingly, around the globe. Recent innovations have made GTFS datasets interoperable with GIS programs like ArcGIS, permitting users to more accurately study and produce “service area calculations, … time and distance service calculations, stop location and spacing optimizations, [and] service frequencies” (Fayyaz et al. 2017, p. 5). Additionally, when looking specifically at transit, the GTFS schedule estimator is paired with calculations of the walking distances and times required for users to: (1) reach transit stops, and (2) make any in-route transfers (Wu 2017).

Two studies (Fortin et al. 2016; Wu 2017) acknowledged shortcomings of GTFS and the transit travel time estimates derived from it. The data files are susceptible to data-entry errors or network “misrepresentations” (e.g., stops or routes with incorrect coordinates) and the schedules are, in fact, schedules and not innately able to account for real-time traffic delays or service disruptions. Furthermore, since Google does not publicly disclose its routing algorithm or procedure for estimating travel times, it is difficult to verify their claims (Wu, 2017). There is a need for academic research that validates the accuracy of Google’s transit-based travel time estimates, and these limitations are acknowledged as potentially affecting my results.

In terms of applying Google Maps’ web tools to questions of transit in metropolitan areas in Latin America and the Global South, there is actually some precedent. Boisjoly et al. (2016) used the Distance Matrix API to estimate travel times between residences and employment sites in Sao Paulo, Brazil. More specifically, they queried the API for transit-based travel times that left their stipulated origins at 7am (during the metro area’s peak travel hour), all while minimizing necessary transfers. All of these were made possible by the conversion of Sao Paulo’s transit schedules into GTFS (although not all of these have been made public, according to the authors), a process that is similarly ongoing in Buenos Aires. It should be noted, however, that the authors note the risks of using a single departure date and time in their study. Greatly different outcomes could result from small shifts in departure time, but they argue that such small variations are not as important when diagnosing access at an aggregated, metro-level scale (Boisjoly et al., p. 91). Knowing that my technique was used to analyze accessibility in a similarly-sized Latin American conurbation to metropolitan Buenos Aires adds confidence to its application.

In fact, Google is perhaps the most authoritative source for travel data in agglomerated Buenos Aires. According to a 2016 article from *La Nacion*, one of Buenos Aires’ primary newspapers, Google worked extensively with the governments of CABA and the departments of AGBA to acquire all the transit schedules needed to allow local travelers to request transit-based directions (with corresponding estimates of travel time, distance, and cost) through Google Maps’ web and mobile applications. According to the article’s author, Google collected schedules from an array of government agencies: CABA’s municipal government, the federal transport ministry, Ferrovías (a private company operating one of Buenos Aires’ commuter rail lines), Metrovías (another private company operating CABA’s subway system), and the CNRT (government agency responsible for transport statistics), and other private enterprises (presumed to be the operators of major bus lines). Altogether, they collected data on 800 routes and 34,000 stop locations. Argentine public users gained access to this information—through the Google platform—in early 2016, following in the footsteps of 18,000 other cities in 70 countries from around the world (Tomovose 2016). Combined with existing roads datasets, users could now request directions for driving, walking, and using transit (bus, train, and subway) between any two points in the conurbation.

The incorporation of transit into Google Maps’ directions tools in Buenos Aires presupposes that Google converted the schedule data collected from the different local agencies and companies into GTFS format. Since these datasets have not been made public (as would be the case for transit agencies in the United States), it is impossible to know for sure or to check their quality). There is little to no publicly available official information on transit schedules for routes within the AGBA’s departments outside of the City of Buenos Aires. CABA operates its own travel-time route estimator, known as ComoLlega, for requests within its boundaries, and it publishes GTFS files for its bus and subway routes. The only exceptions are the printed time tables for the individual commuter railway lines. Given these discrepancies, it naturally forces on to ponder how exactly Google was able to cajole these data from existing operators, some of which are colloquially said to not even follow exact schedules, operate along informal schedules or headways, or that lack dedicated stops.

As it would be virtually impossible for me to self-construct a network dataset using publicly-available data in the conurbation, in pursuit of accurate travel time-estimations I am essentially forced to call upon the Google Distance Matrix API. In turn, however, using these reasonably accurate public transit travel time estimates immediately places this accessibility study ahead of all previous studies attempted within AGBA, most of which relied on physical distance as their proxy for access.

Given its fundamental role in this analysis, the Google Distance Matrix—and its limitations—dictated the type of accessibility measurement adopted. In particular, the strict quotas placed on origin/destination requests made it difficult to implement a true cumulative-opportunities measure, as was intended. These measures, which are also known as “contour” or “isochrone” accessibility measures, are centered on the “degree to which two places or points on the same surface are connected” and measure “the number of opportunities which can be reached within a given travel time, distance, or cost, or the measure of the (average or total) time or cost required to access a fixed number of opportunities” (Geurs and Van Wee 2004, 133). Their advantage is that they are quickly operationalized, easily interpretable, and relatively undemanding of data; little outside knowledge of accessibility dynamics is needed as is often required for complex utility- or gravity-based calculation.

Still seeking to take advantage of the ease of communication that characterizes these measures, I opted for a slightly-modified version of cumulative-opportunity measure. Instead of tabulating the number of destination sites within a given transit-based travel time threshold, I looked only at the travel time to the closest location of a given destination category. In some cases, there are hundreds of iterations of some feature classes (e.g., schools, health centers) and calculating the travel time to each of them, for each *asentamiento,* requires an immense number of requests. In the interest of time-efficiency and the desire to examine accessibility conditions across multiple parts of AGBA, as well as for multiple *asentamientos*, I looked at just the travel time to each *asentamiento’s* “nearest neighbor” within each feature class. Perhaps this approach could be called “cumulative **opportunity**” since only one destination is being identified for each case.

While it is absolutely true that identifying the nearest activity site to an origin does not actually incorporate individual perceptions or preferences—it assumes that all locations are equally desirable to all people, when certain sites may be more attractive than others even if further away—calculating the travel times to all of the features in an activity class is unfeasible with the API. With unlimited access to the tool, as well as more detailed information on the attractiveness of different destination sites, perhaps a more complex accessibility metric could be adopted. Similarly, accounting for daily and weekly variation in transit schedules, another common criticism of cumulative-opportunity measures, is also challenging since separate requests are needed to capture any variation in departure date or time. As will be explained, particular times and dates are selected, and justified using background information on the *asentamientos*, but findings that account for diurnal and weekly variations are only possible with expanded access to the API tool.

Selecting API-compatible origin coordinates for the *asentamientos*, was an intricate task. I began by visiting the TECHO website and downloading—from their interactive online map—a shapefile of all informal housing neighborhoods in Argentina.[[6]](#footnote-6) Once uploaded into ArcGIS, I then selected from this file only those neighborhoods classified as *asentamientos* (TECHO also logs *villas*) that belong to one of the thirty departments of AGBA. This yielded a total of 687 units, as shown on the map in **Figure 4.1**.

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| **Figure 4.1** |
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While it made initial sense to use the center-points of these polygons as the “origin” points of my API matrix requests, knowing the travel times from these neighborhoods is useful only for understanding *absolute* accessibility. Without some type of comparison points, limiting my requests to just the *asentamientos* would provide me only with their accessibility levels **relative to each other** and not give any indication as to whether they enjoy greater or lesser transit accessibility relative to people who live **outside** of the *asentamientos*. As a result, I needed a new unit of spatial analysis that permitted the selection of a “control” group of neighborhoods to compare against the *asentamientos*. There is no immediate solution to this problem because the *asentamientos* vary greatly in shape and size and, therefore, do not universally align with any preexisting spatial or geographic administrative units. Nonetheless, I ultimately gravitated towards the census geographies created by INDEC as part of the 2010 Argentine national census, shown in **Figure 4.2**. The smallest unit of analysis from their survey—known as the *radio*—turned out to be the best option; groups of radios are nested inside of “*fracciones*” (fractions), which are, in turn, further nested inside of the departments.

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| **Figure 4.2** |
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Roughly equivalent to the “block” unit within the United States, census *radios* are quite small, often a few city blocks in size. While *asentamientos* rarely overlap perfectly with individual census radios, they are often similar in size. See **Figure 4.3** for an example from La Matanza department. This allows census radios—based on their degree of overlap—to be a nominal stand-in for many of my study sites. Since the entire study area is covered with radios, there are 13,521 in AGBA alone, it is possible to draw a sample of non-overlapping radios to compare against those that contain part of an *asentamiento.* This was the approach I took. Furthermore, INDEC publishes a robust amount of data—through the 2010 census—on demographic and household characteristics at the radio-level, which I can compare against my eventual travel time data to see if they produce statistically-significant correlations.[[7]](#footnote-7)

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| **Figure 4.3** |
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In turn, I used ArcGIS to calculate the degree to which each of those 13,521 radios overlapped with the 687 *asentamiento* polygons. Given the relative dispersion of *asentamientos* across the metro area, it is hardly surprising that the average overlap was only 1.98% and that over 94% of all radios registered no overlap at all (12,700 of 13,521). Conversely, nine recorded total overlap (100%) and 821 saw more than 1% of their territory covered by an *asentamiento.* The map below in **Figure 4.4** depicts all AGBA census radios, colored by their degree of overlap.

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| **Figure 4.4** |
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To create “study” and “control” groups for this project, I grouped the population of census radios into: (a) those that overlap with an *asentamiento,* and (b) those that did not. Furthermore, I subdivided the “study” group into “majority” (greater than 50% of territory occupied by an *asentamiento*) and “minority” (between 1% and 50% of territory covered) groups; 206 fell into the former and 615 in the latter. Summary statistics on the overlap calculations, per district and agglomeration level, are shown in **Table 4.5**. With unlimited time, I would have started to make API queries here, requesting travel time information for each of these *radios*. However, as was noted before, standard Google accounts are only allowed 2,500 free origin/destination API requests per day, with only 25 origins or destinations at one given time. Performing travel time requests with all these origins—even with one single destination for each—was not feasible given time and budget constraints, forcing me to narrow my scope even more.

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| **Table 4.5** | | | | | | | | | |
| **Department** | **% of AGBA Population** | **% of *Asent.* in AGBA*.*** | **No. of fam. in *Asent.***  **(est.)** | **Radios** | **Avg. Overlap** | **Radios, by Overlap** | | | **Agglom.,**  **Class (2003)** |
| **Maj.** | **Min.** | **None** |
| **C.A. Buenos Aires** | **21.55%** | **0.00%** | **0** | **3,555** | **0.00%** | 0 | 6 | 3,549 | *CABA* |
| **Quilmes** | 4.33% | 7.40% | 19,995 | 557 | 4.29 | *16* | *61* | *480* | *GABA,*  *Totally*  *Agglom.* |
| **José C. Paz** | 1.98% | 4.48% | 6,575 | 218 | 6.00 | 0 | 35 | 175 |
| **Malvinas Argentinas** | 2.40% | 3.44% | 3,495 | 281 | 2.43 | 2 | 30 | 249 |
| **Lomas de Zamora** | 4.58% | 2.93% | 11,440 | 612 | 2.44 | 14 | 19 | 579 |
| **San Miguel** | 2.05% | 2.93% | 7,642 | 256 | 4.75 | 12 | 16 | 228 |
| **Ituzaingó** | 1.25% | 2.07% | 819 | 160 | 0.92 | 0 | 9 | 151 |
| **Hurlingham** | 1.35% | 1.89% | 3,011 | 170 | 0.48 | 0 | 6 | 164 |
| **Avellaneda** | 2.55% | 1.20% | 2,305 | 387 | 0.24 | 0 | 5 | 382 |
| **General San Martín** | 3.08% | 1.03% | 6,245 | 435 | 1.93 | 8 | 7 | 420 |
| **Lanús** | 3.41% | 0.86% | 2,200 | 517 | 0.78 | 3 | 6 | 508 |
| **Morón** | 2.39% | 0.52% | 125 | 357 | 0.02 | 0 | 2 | 355 |
| **San Isidro** | 2.18% | 0.52% | 320 | 320 | 0.15 | 0 | 3 | 317 |
| **Tres de Febrero** | 2.53% | 0.34% | 315 | 377 | 0.06 | 0 | 1 | 376 |
| **Vicente López** | 2.00% | 0.00% | 0 | 344 | 0 | 0 | 0 | 344 |
| **Zone 1** | **57.62%** | **29.60%** | **64,487** | **4,991** | **1.75** | **63** | **200** | **4,728** |
| **La Matanza** | 13.20% | 11.88% | 34,681 | 1,302 | 3.09 | *36* | *65* | *1,201* | *GABA. Partially Agglom.* |
| **Moreno** | 3.36% | 11.36% | 18,423 | 389 | 3.09 | 4 | 57 | 328 |
| **Florencio Varela** | 3.17% | 8.26% | 17,925 | 360 | 6.74 | 20 | 46 | 294 |
| **Merlo** | 3.93% | 7.92% | 19,490 | 453 | 6.69 | 28 | 43 | 382 |
| **Almirante Brown** | 4.11% | 3.79% | 11,040 | 484 | 2.61 | 10 | 28 | 446 |
| **Esteban Echeverría** | 2.24% | 3.27% | 13,800 | 254 | 2.56 | 4 | 16 | 234 |
| **Tigre** | 2.80% | 2.75% | 2,920 | 320 | 0.71 | 0 | 19 | 320 |
| **Ezeiza** | 1.22% | 2.07% | 10,020 | 146 | 8.83 | 12 | 14 | 120 |
| **Berazategui** | 2.41% | 0.52% | 460 | 290 | 0.37 | 1 | 3 | 286 |
| **San Fernando** | 1.21% | 0.34% | 520 | 164 | 0.59 | 1 | 1 | 162 |
| **Zone 2** | **37.64%** | **52.15%** | **129,279** | **4,162** | **3.44** | **116** | **292** | **3,754** |
| **Greater Buenos Aires** | **95.26%** | **81.75%** | **193,766** | **12,708** | **1.82** | **179** | **498** | **12,031** |
| **Pilar** | 1.73 | 6.02% | 13,170 | 279 | 3.45 | *6* | *40* | *233* | *Non-GABA,*  *Partially Agglom.* |
| **Escobar** | 1.32 | 3.79% | 7,980 | 194 | 3.69 | 3 | 28 | 163 |
| **General Rodríguez** | 0.65 | 3.61% | 5,178 | 113 | 4.86 | 3 | 29 | 81 |
| **San Vicente** | 0.33 | 2.58% | 4,685 | 83 | 0.56 | 4 | 11 | 68 |
| **Presidente Perón** | 0.45 | 1.55% | 6,780 | 73 | 13.50 | 11 | 6 | 56 |
| **Marcos Paz** | 0.32 | 0.69% | 2,340 | 58 | 0.62 | 0 | 3 | 55 |
| **Zone 3** | **4.80%** | **18.24%** | **40,133** | **800** | **4.64** | **27** | **117** | **656** |
| **Agglom. Buenos Aires** | **100.0%** | **100.0%** | **233,899** | **13,508** | **1.98** | **206** | **615** | **12,687** |  |

While there are *asentamientos* found across AGBA’s suburban periphery, I selected just three of these departments—those highlighted in purple in **Table 4.5**—to serve as representative case studies, thus reducing the time to complete my API requests. Seeking to produce results that applied to the largest number of people possible, I first prioritized departments by the number of families residing in their respective *asentamientos*, eyeing those with the largest values **Table 4.5**. When these raw data are mapped, however, the districts with the most *asentados* are all on AMBA’s western side (La Matanza, Moreno, Merlo) and off to the southeast (Quilmes and Florencio Varela)—see **Figure 4.6** below. This distribution corresponds to general socio-economic patterns in AGBA and their north/south gradations.

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| **Figure 4.6** |
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While selecting these five would account for accessibility conditions among a large proportion of the conurbation’s total population of *asentados*, it could miss trends in some of the other districts, especially those further removed from CABA’s core. As a result, I decided to categorize the departments using INDEC’s urbanization hierarchy (considering history in GABA and degree of agglomeration) mentioned at the beginning of the paper. Considering that each of these categories represents departments of varying degrees of urbanization—exhibiting different densities, infill, age of development, and dispersion of services—selecting radios from each provides a snapshot of accessibility as it relates to each of AGBA’s different zones.

With this conceptualization in mind, I selected the department from each “agglomeration zone” with *the largest population of asentamiento families* (a statistic tabulated by TECHO during their survey): Quilmes (GABA + total agglomeration; 19,995 families in 43 communities), La Matanza (GABA + partial agglomeration; 34,681 in 69), and Pilar (non-GABA + partial agglomeration; 13,170 in 35). Shown on **Figure 4.7**, these departments are spatially distinct, each representing districts of varying age and development (Quilmes the most established, Pilar the youngest, and La Matanza in between) as well as Buenos Aires’ socioeconomically distinct edges: the historically wealthy north (Pilar), the working-class west (La Matanza), and the impoverished south (Quilmes). Maps of these districts, and their asentamientos (shown in **green**), are provided in **Figures 4.7a-c**. Nonetheless, the number of census radios comprising each of these districts (**Table 4.8**) was still massive. I had to perform one last sub-sampling to reduce the number of origins to numbers compatible with the API’s strict quotas.

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| **Figure 4.7** |
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| **Figure 4.7a** |
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| **Figure 4.7b** |
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| **Figure 4.7c** |
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To complete this task, I performed a series of stratified random samples on the census radios belonging to each case study. For all three districts, I began by dividing their radios into those classified as “majority overlap,” “minority overlap,” and “no overlap.” **Table 4.8** summarizes the number, and percentage, in each category.

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| **Table 4.8** | **Radios** | | | **Overlap** | | | |
| **District** | **Radios,**  **Total** | **Average**  **Overlap** | **Avg. Pop., per Radio** | **Majority** | **Minority** | **Any** | **None** |
| Quilmes | 557 | 4.29% | 1,046.6 | 16  (2.9%) | 61  (11.0%) | 77  (13.8%) | 480  (86.2%) |
| La Matanza | 1,302 | 3.09% | 1,363.9 | 36  (2.8%) | 65  (5.0%) | 101  (7.8%) | 1,201  (2.2%) |
| Pilar | 279 | 3.45% | 1,072.0 | 6  (2.2%) | 40  (14.3%) | 46  (16.5%) | 233  (83.5%) |
| **Totals** | **2,139** | **3.45%** | **1,234.1** | **58**  **(2.7%)** | **166**  **(7.8%)** | **224**  **(10.5%)** | **1,914**  **(89.5%)** |

Serving as “study” groups, I first randomly selected thirty radios from all three districts’ populations of “majority overlap” and “minority overlap” radios; in the cases where there were not thirty available, I selected all that were available. Once these thirty were identified, I then added together the number of “majority” and “minority” radios, per case study, into a secondary categorization called “any overlap.” I then drew a random sample from the “no overlap” radios belonging to each district, selecting a sample sized in correspondence with the number of radios in each district’s “any overlap” category. I did this because the pool of “no overlap” radios was always much larger than those with overlap, and I wanted to ensure I was drawing a proportionally-representative sample of “no overlap” radios to match those drawn for the other two categories. Those numbers are reported in **Table 4.9**, while maps of the sampled radios are given in **Figures 4.10a-c**.

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| **Table 4.9** | | **Sample Selection** | | | | |
| **District** | | **Majority** | **Minority** | **Any** | **None** | **Total** |
| Quilmes | Sample | 16  (100.0%) | 30  (49.2%) | 46  (59.7%) | 46  (9.6%) | **92**  **(16.5%)** |
| Total | 16 | 61 | 77 | 480 | **557** |
| La Matanza | Sample | 30  (83.3%) | 30  (46.2%) | 60  (59.4%) | 60  (5.0%) | **120**  **(9.2%)** |
| Total | 36 | 65 | 101 | 1,201 | **1,302** |
| Pilar | Sample | 6  (100.0%) | 30  (75.0%) | 36  (78.3%) | 36  (15.5%) | **72**  **(25.8%)** |
| Total | 6 | 40 | 46 | 233 | **279** |
| **All 3** | Sample | 52  (89.7%) | 90  (54.2%) | 142  (63.4%) | 142  (7.4%) | **284**  **(13.0%)** |
| Total | 58 | 166 | 224 | 1,914 | **2,183** |

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| **Figure 4.10a** |
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| **Figure 4.10b** |
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| **Figure 4.10c** |
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Some census statistics and ENMODO results for the three districts are shown in **Table 4.11,** with a focus on variables traditionally associated with the *asentamientos*. La Matanza has the largest overall population and is actually the most populous department in AGBA outside of CABA. Cells highlighted in pink represent the district with the “poorest” score for a given category. Note how Pilar, for instance, scores the worst in many development indicators (piped water, sewerage, basic needs unmet, illiteracy, bus trips, and school attendance) yet also has the highest rates for university attendance, car ownership, trips by auto, and homes in gated communities: inequities are discernable even at the aggregate district scale. Also note how, paradoxically, Pilar’s *asentamientos* scored the worst is nearly all access metrics, with the important exception of public transit access.

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| **Table 4.11** | | | | | |
| **Source** | **Variable** | **Quilmes** | **La Matanza** | **Pilar** | **AMBA** |
| **INDEC,**  **2010 census** | Total population | 520,552  (4.01%) | 1,398,891  (10.77%) | 266,564 (2.53%) | 12,985,885  (100.00%) |
| People per radio | 1046.576 | 1363.914 | 1072.064 | 1005.957 |
| Homes per radio | 327.14 | 343.55 | 335.07 | 345.28 |
| % homes with *“basic needs unmet”* | 8.82 | 11.37 | 11.77 | 9.10 |
| % homes, owner does not own land | 5.42 | 4.94 | 4.42 | 4.90 |
| % homes, public network sewage | 61.57 | 47.15 | 18.58 | 56.03 |
| % homes, piped water inside home | 92.37 | 85.47 | 79.65 | 90.99 |
| % people, illiterate | 5.45 | 5.93 | 6.71 | 5.05 |
| % people, never attended school | 1.97 | 2.52 | 2.66 | 1.78 |
| % people, attended university | 10.67 | 6.31 | 10.02 | 14.00 |
| % people, born in Argentina | 92.73 | 90.75 | 93.11 | 91.50 |
| % homes, “insufficient” services | 25.71 | 36.02 | 65.17 | 30.38 |
| % homes, “insufficient” const. quality | 14.39 | 19.66 | 22.72 | 12.38 |
| **ENMODO respondents, 2009-10** | Trip generation rate | 1.43 | 1.48 | 1.51 | 1.52 |
| Average people per home | 3.07 | 3.49 | 3.77 | 3.23 |
| Homes, average income quintile | 2.86 | 2.61 | 2.45 | 2.87 |
| % homes, *villa de emergencia* | 4.0 | 2.3 | 2.7 | 2.3 |
| % homes, gated community/country | 0.1 | 0.1 | 8.4 | 0.4 |
| % homes, with automobile | 36.1 | 35.1 | 38.3 | 36.9 |
| % people, employed as domestic help | 2.2 | 3.0 | 3.2 | 2.6 |
| % people, attending school | 9.0 | 9.3 | 10.0 | 9.3 |
| % students, public school | 67.9 | 73.1 | 69.0 | 70.4 |
| % students, private school | 32.1 | 26.9 | 31.0 | 29.6 |
| % people, actively working | 39.6 | 39.1 | 37.5 | 40.9 |
| % people, working in private sector | 36.2 | 37.0 | 34.0 | 37.7 |
| % people, working in public sector | 4.9 | 3.8 | 4.0 | 4.5 |
| % trips, made 5x weekly | 57.8 | 24.1 | 58.9 | 53.3 |
| Most common hour of trip departure | 12:00 PM | | | |
| % trips, on bus | 43.4 | 45.9 | 23.4 | 39.4 |
| % trips, on rail | 3.8 | 2.9 | 7.9 | 7.1 |
| % trips, in private auto | 19.1 | 15.6 | 27.4 | 17.9 |
| % trips, on foot | 23.6 | 25.7 | 28.9 | 23.5 |
| **TECHO, 2013** | % asent., irregular electricity access | 69.0 | 71.6 | 50.0 | 62.4 |
| % asent., water from public network | 11.9 | 16.4 | 0.0 | 4.8 |
| % asent., firewood/coal for heat | 9.5 | 14.9 | 26.7 | 12.8 |
| % asent., ambulance always responds | 71.4 | 25.4 | 60.0 | 45.3 |
| % asent., floods with every rain | 42.9 | 31.3 | 53.3 | 35.2 |
| % asent., hospital beyond 5km | 35.7 | 59.7 | 63.3 | 54.0 |
| % asent., public transit inside neigh. | 23.8 | 13.4 | 36.7 | 19.8 |
| % asent., major prob., service access | 33.3 | 34.3 | 20.0 | 29.4 |
| % asent., public sewerage | 7.1 | 1.5 | 0.0 | 3.3 |

With the number of “origins” down to just 284, I was nearly ready to move on to the next steps of selecting destinations and setting my parameters. The only other step was to convert these census radios into points (with latitude and longitude coordinates) that could be fed into the API interface. My initial idea was to use the centroid of each polygon; however, in the case of the spatially-expansive radios (many of those in Pilar and La Matanza), I ran the risk of having the center point of the polygon located far from the actual population center of the radio.

I crafted my own solution to this problem. I first visited the website of the Socioeconomic Data and Applications Center (SEDAC) at Columbia University.[[8]](#footnote-8) They maintain a repository of geospatial data on world population distributions. From the available SEDAC files, I downloaded a raster dataset of the estimated distribution of people throughout Argentina. Using their in-house calculation methods, SEDAC uses interpolation techniques (“random forest classification and regression”) to estimate “likely residence locations at a 100-meter scale” (Rodriguez et al., 2017, pp. 36–37).” Their results for AGBA for 2015 are shown in **Figure 4.12,** with the three case studies outlined in purple.

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| **Figure 4.12** |
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From this raster, I extracted the areas corresponding to each case study and then converted the raster into a point field: one point was placed at the center of each 100-meter raster cell, with that point assigned the value of that raster grid cell. I then used a spatial join to identify the specific census radio to which each point belongs and then calculated the approximate mean center of population for each individual census radio. The result is a series of points corresponding to the weighted mean population centers of each census radio, shown on the map in **Figure 4.13** below. These points, I assume, will ensure that the API’s “origins” correspond to actual human locations.

The only other step required was to calculate the X/Y coordinate for each point, an easy process in ArcGIS. To make sure these values were compatible with the Distance Matrix API, I created a special column in the attribute table called “YX coordinate” where the coordinate was stored in the proper text-string format (“Longitude+Latitude”, for example: “-34.7098979561128+-58.2342871680724”). I then exported, for each district, its list of points as a CSV, which could then be easily imported into R to serve as the origins input for gmapsdistance API requests.

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| **Figure 4.14** |
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Acquiring and preparing the coordinates of my destinations was more straightforward. Seeking to heed the advice of Handy and Neimeier, I sought datasets representing the activity sites of importance to those people living in Buenos Aires’ *asentamientos*. To do this, I returned to the qualitative and quantitative sources discussed earlier: TECHO’s survey data, INHABITAT’s interviews, and ENMODO’s survey statistics. Unfortunately, none of these sources directly asked *asentados* transit-specific questions about travel times, trip types, or common destinations. What we do know, however, is that buses are the most commonly reported mode of travel, that most respondents have transit within a short distance of their settlement, with schools, clinics, and jobs relatively close by, whereas and hospitals and recreation centers were reported to be more distant. Whether transit is favored for certain trip types or destinations, however, remains a mystery, with nothing to prioritize any one feature for inclusion with the API.

Since the purpose of this project is ultimately comparative (looking at differences between the *asentados* and their “legal” neighbors), I used the ENMODO results as an initial guide because they summarize trips by all travelers. The most common trip destination was work (37%), followed by education/accompanying someone to school, (34%), shopping (7%), personal business (5%), health (4%), family (3%), and recreation (2%) (ST 2011). While searching for geospatial datasets depicting these activities, I looked only for those activity sites with a corresponding reliable, region-wide location point dataset. If the location data for a given activity site was only available for a section of the study area, or if it was inconsistently depicted across the whole region, it was discarded. This proved difficult given the paucity of geospatial data made public by national, provincial, and municipal governments. The City of Buenos Aires, for instance, has a well-maintained repository of GIS layers, but those do not suit the suburban scope of this project. Ultimately, I located comprehensive data for only schools and healthcare sites and, in turn, had to create proxies for employment and shopping/commerce. My findings are summarized in **Table 4.15**.

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| --- | --- | --- | --- | --- | --- | --- |
| **Table 4.15** | | | | | | |
| **Destination Type** | **Sub-Type** | **AGBA** | **Quilmes** | **La Matanza** | **Pilar** | **All 3 Cases** |
| Central Business Districts | C.A. Buenos Aires | 1 | | | | |
| Department C.B.D. | 30 | 1 | 1 | 1 | **3** |
| Proximate C.B.D. | 21 | 6 | 8 | 9 | **23** |
| Railroad Stations | | 240 | 19 | 42 | 23 | **84** |
| Healthcare | Public Urgent Care | 15 | 7 | 9 | 6 | **22** |
| Diagnostic/Treatment | 1,076 | 70 | 81 | 51 | **202** |
| Hospitals | 80 | 11 | 19 | 10 | **40** |
| Public  Schools | Kindergartens | 1,602 | 120 | 148 | 66 | **334** |
| Primary Schools | 1,973 | 109 | 203 | 77 | **389** |
| Secondary Schools | 1,674 | 78 | 199 | 74 | **351** |

As the most common trip type in metropolitan Buenos Aires, the first type of destination I sought to include were major employment centers. The Argentine government, lamentably, does not publish geographic information on employment locations. Finding that the types of employment associated with low-income *asentamiento*-dwellers (e.g., carpenters, domestic workers, and street vendors) were not location-specific enough to permit specific pinpointing, I elected to instead use central business districts. While the evidence shows that employment in AGBA is more dispersed than ever, CBD’s still have high employment densities and their general roles as centers of commerce and local government make them reasonable proxies for some of the job and shopping trips made by *asentados*. Obviously, this assumption does not account for all jobs, especially those in the service sector that could be more dispersed across the terrain and industrial jobs along AGBA’s new outer highways (relocated from southern CABA, where they had been concentrated for much of the city’s history).

I performed three CBD-related queries for each *asentamiento*. The first was from each radio to Buenos Aires’ central business district (in CABA), the second was from each radio to the CBD of its department, and the third was from each radio to the nearest CBD of any department within AGBA. This variation captured those 8.7% of *asentados* (according to Cravino et al., 2008) who work in the federal district, the 17.7% who worked in separate departments, and the 48.1% who worked in their home department. Including the neighboring departments also accounted for people living in the far periphery of any of the three case study areas who may, in fact, live closer to a neighboring CBD (and its corresponding commercial/employment opportunities) than their own. Understanding the travel times to known employment centers can not only show whether *asentados* have a more difficult journey to work but also, should those times by significantly longer compared to people from formal neighborhoods, why so many of their fellow residents (26% of respondents) need to work in or nearby their home neighborhood.

Data on central business districts was downloaded from the geographic data portal of the Ministry of the Interior, Public Works, and Housing.[[9]](#footnote-9) More specifically, I used a layer called “Localities’ head of local government” (“Localidades cabecera de gobierno local segun tipo de gobierno”) based on locations identified during Argentina’s 2010 national census.[[10]](#footnote-10) The data were most recently updated on 19 January 2018. The layer, a point shapefile, was uploaded into ArcGIS, where I used the program’s database query tools to select the points individually pertaining to the three case studies: Quilmes, La Matanza, and Pilar. I then used the program’s spatial query tools to select those departments that bordered each these three: nine for Pilar, eight for La Matanza, and six for Quilmes. Once identified, I selected the CBD that corresponded to each. For each of my three case studies, I exported (1) a point file that included its own CBD and (2) a file for those identified as its neighbors’. Lastly, I exported these points as separate files. As for CABA’s CBD, I created a custom point file with a single feature placed at the *Obelisco*, a major landmark along Buenos Aires’ central 9 de Julio Avenue widely considered the city’s center point. These points are shown on **Figure 4.16**.

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| **Figure 4.16** |
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The second destination type was the closest railroad stations; while railroad usage has been on the decline for decades in metropolitan Buenos Aires, it still serves as the primary mode of travel for trips between CABA and the departments in the province (56%) and, as a mode, is frequented more by people in the lowest two income quintiles than those at the top (ST 2011). Furthermore, the areas around train stations, given the history of Buenos Aires, are some of the most densely populated pockets outside of CABA and, as a result, serve as local centers of employment and residence (Blanco 2014). While Cravino et al. (2018) found only 5% of the surveyed *asentados* chose to ride the train, this was because the settlements being studied were all quite distant from the nearest train station. This last characteristic, in fact, speaks to the importance of studying access to rail: longer relative travel times will showcase the *asentamientos* physical isolation relative to existing infrastructure and highlight another way that *asentados* are inherently disadvantaged when looking for employment, especially low-skill positions commonly found in the urban core.

As with the central business districts, I acquired my data on railroad station locations from the geographic data portal of the Ministry of the Interior, Public Works, and Housing. The specific layer was called “Railroad Stations” (“Estaciones de Ferrocarril”) and was last updated on 28 December 2016.[[11]](#footnote-11) I uploaded it to ArcGIS and found it to contain 240 stations. Since the goal of this API request, compared with those for the CBDs, is to identify the *nearest* stop to each origin point, the ideal situation would have been to upload all 240 as destinations, calculate travel time between each origin and all stations, and then select the minimum value. This, however, would have required a prohibitively large number of API requests, so I invented an ad-hoc technique to cut down on the number of queries. (This would also be a process I would employ for schools and hospitals).

I began by assuming that most travelers if making a rail trip would only use a station if it was within a reasonable distance of their home; ENMODO, in fact, tells us that most trips—whether for work, school, and health—are within the same or adjoining departments, 80%, 91%, and 85%, respectively. I thus used ArcGIS’ spatial proximity tools to determine which train stations, of the 240, were one of the ten closest, using Euclidean distance, to each of the origins for each district. I assumed it unlikely that a train station outside of the ten closest to my study sites was going to the closest station when considering transit-based network times.

For each of the three study districts, I created a separate point file of just those train stations that qualified under this scheme; this reduced the number of destinations to just 19 for Quilmes, 23 for Pilar, and 42 for La Matanza. In each case, some of these stations (if not most of them) were geographically outside of the bounds of the home department. I collected the latitude and longitude coordinates of each station, formatted those coordinates for compatibility with the API engine (“LATITUDE+LONGITUDE”), and exported the values as a csv file whose data could easily be read into R. A map of the rail stations is shown in **Figure 4.17**.

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| **Figure 4.16** |
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While prior studies suggest that most *asentamientos* have schools nearby, I included them anyway, primarily because data were easy to find and school trips account for a large share of the modal split. The Province of Buenos Aires, within its open data portal, publishes a spreadsheet of all the schools in its territory.[[12]](#footnote-12) Officially titled “Educative Establishments” (Establecimientos educativos), it has attributes for the latitude/longitude coordinates of each school, its level, and whether it is private or public.[[13]](#footnote-13) Downloadable as a comma separated values (csv) file, these data’s coordinates were easily displayed as point files within ArcGIS. This file was last updated on 21 February 2018.

With 22,290 schools, I had to narrow down the pool of destinations for the API. I first sub-selected the public schools (“estatales”). Aside from colloquial advice from Argentine contacts that *asentados* were more likely to attend to public schools (which are free in Argentina), the results from ENMODO show public schools as not only favored by the population at large (71%) but also by students from all five income quintiles. Furthermore, the lowest quintile (the most likely to contain *asentados*) showed a remarkable 84% of its students as public-school attendees (ST 2011). This reduced the pool of schools to just 16,035.

To whittle the total even further, I selected just three types of public schools: kindergartens (“jardin de niños”), primary schools (“primarios”), and secondary schools (“secondarios”). I based this decision on the INHABITAT results showing that most *asentados* had little more than a primary education: 71.9% completed any primary and 23.3% for secondary. Less than 2% had made it beyond (ST 2011). While it is certainly possible that tertiary- or university-level schooling was not pursued for reasons of access, the total number of potential students is certainly smaller than those at other lower levels. This narrowed the number of schools to: 2,671 (kindergartens), 4,262 (primary), and 2,729 (secondary). WHAT ABOUT SCHOOLS IN CABA?

Lastly, I selected, using the same Euclidean distance technique as before, only those schools that were one of the ten-closest to any one of my “origins”; I replicated this task for all three study areas, reducing the pool significantly. This produced a total of nine files: the list of nearest schools in all three categories for all three districts. Like before, I took the initial step, before exportation, to tabulate the coordinates and re-format them for the API. A map of all public schools from which the closest ten of each type were slected is shown in **Figure 4.17** below.

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| **Figure 4.17** |
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The last destination category was health care; unlike the other activity classes, these came from multiple sources. My first intention was to use the “public healthcare establishments” (“establecimientos de salud públicos”)[[14]](#footnote-14) and “private healthcare establishments” (“establecimientos de salud privados”) spreadsheets published in the same data portal from the Province of Buenos Aires. However, neither differentiates subcategories within each file, making it impossible to know the facilities’ sizes or scopes: small clinics are included together with hospitals and other specialist facilities. The only exceptions are “urgent care units” (“unidades de pronta atención” or “prompt attention units”), fifteen of which were included in the public establishments sheet. According to local news sources, UPA’s (an acronym I adopted) are meant to assist cash-strapped hospitals in the provision of first-aid services to members of the community.[[15]](#footnote-15) I included them because they made sense as possible destinations for low-income *asentados.* I do not, however, have evidence of *asentados* actually using UPA’s, or any other health facilities.

To supplement these data with information on hospitals and healthcare clinics, I returned to the GIS portal from the Ministry of the Interior, Public Works, and Housing. Here, I found two layers: “centers with general hospitalization” (“centros de internecion general”)[[16]](#footnote-16) and “centers of diagnosis and treatment without hospitalization” (“centros de diagnóstico y tratamiento sin internación”).[[17]](#footnote-17) Both derived from data from the Ministry of Health, and both were last updated in May 2017. These are point shapefiles with attributes on the address, geographic coordinates, the name of each facility, and the governmental level (federal, municipal, or national) responsible for that outlet. Separating out the hospitals from the diagnostic/treatment centers (a full definition of which was not immediately provided) was important to distinguish between their levels of service and, therefore, their likely variation in accessibility thresholds. I assume that hospitals, which allow patients to stay overnight, offer a greater array of services than a diagnostic/treatment center, which does not house patients; in turn, the former likely draws people from further distances than the latter. I selected public establishments under the assumption that low-income *asentados* were more likely to seek services where they are free; this opinion was informed by a conversation with professor Jorge Blanco, the chair of the geography department at the University of Buenos Aires.

Given that all three datasets, in their raw form, represented large scales (the whole province for the UPA’s and the entire country for the hospitals and diagnostic/treatment centers), I had to narrow the pool of destinations ahead of my API requests. For the UPA’s, I first sub-selected them from the provincial dataset of public health establishments (2,586 units); only 19 were found in the Greater Buenos Aires region. With this step complete, I then added the nationwide point-shapefiles for hospitals (1,114) and diagnostic/treatment centers (7,985). Next, I then determined, using the same Euclidean distance technique, whether individual establishments were one of the ten closest sites to any of the origins. Performed for each combination of healthcare site-type and department, this produced nine files, each of which also contained the same standardized latitude/longitude information for the corresponding points. The destinations falling into each health care category are shown in **Figure 4.18**.

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| **Figure 4.18** |
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After acquiring the latitude and longitude coordinates of my origins and destinations, I then set values for the remaining travel-time request parameters: the mode of travel, the departure time, and the departure date.

Given the topic of this paper, the mode was naturally set to “transit,” the API’s generic setting allowing the computation of travel time using all public transportation modes in an area: bus, rail, and subway. Considering bus (39%) and rail (5%) together, public transit was easily the most common mode preferred in INHABITAT’s survey. There was no obvious reason to prioritize any of these three modes over the others, so I opted to include them all. This choice was aided by ENMODO’s generalized findings that public transit was the favored mode of transit for workers (57% versus 27% for private and 16% for non-motorized) and represents the choice of greater than 60% of domestic workers, industrial workers, and company employees. Income-wise, those from the lowest quintile were also less likely to take private transit to school and more likely to walk or take the bus on health-trips. Students, meanwhile, were also more likely to travel on public transit, although, it should be noted, primary-school students were more likely to take non-motorized travel (ST 2011).

It would be interesting to eventually compare hypothetical travel times across the other modes offered by the API (driving, walking, or biking), although there are arguments for their exclusion. For instance, driving is irrelevant to *asentados* given its price exclusivity (less than 2% of INHABITAT respondents used a car for travel). Knowing the minimum driving times to activity sites from the *asentamientos* might be interesting from a comparative standpoint (showcasing the transit/driving dichotomy in accessibility that is growing in Buenos Aires), but auto travel does not represent a feasible choice for typical *asentados*. Walking and biking are necessitated by the absence of reasonable transit, or simple outright poverty. In fact, more than 50% of non-motorized trips to school are done by those in the first income quintile. Nonetheless, walking is likely not a viable option for many of the trip-types studied by this project; features like CBDs, hospitals, and some schools are simply too far away for travel on foot. *Asentados* are more likely to simply not travel than walk or bike to jobs in far-off locations. Additionally, knowing the walking or driving times to activity sites is not of much use without first knowing the quality of transit, which could then contextualize any long walking or biking trips made out of necessity (ST 2011).

As for departure date, I wanted to capture the transit services that would be available to the citizens of AMBA on an average work or school day, so I selected Wednesday mornings to serve as the model generic weekday. I picked Wednesdays also because, based on personal experience living in Argentina, Wednesdays are not likely to overlap with public holidays, which often take place on the days immediately preceding or following the weekend and feature special transit schedules akin to those on a typical weekend day. Justification of a general weekday falls in line with ENMODO statistics showing that 74% of all trips, regardless of type, are made five-times a week, an indication that trips on Wednesday are probably similar to those made on the other four days.

When it came to travel time, however, I opted for a more nuanced approach. Using the time-of-travel information from the ENMODO survey, I gleaned the peak hour of different trip types: 7:00am for work trips (9-10% of all work trips—the highest evening peak was 9% at 5pm and 8.5% at 6pm), 10:30am for health-related travel (peaks at 10am and 11am, with smaller peaks around noon, 9am, and 3-4pm), and 12:00pm for school trips (there were other peaks at 7am and 5pm—corresponding to the start of morning session and culmination of the afternoon session) (ST 2011). Students returning home after class, going to school before class, and returning home just for lunch (some attend morning and afternoon sessions) all contribute to the noontime peak. There is no clear way, however, to determine what percentage of these trips are going in either direction it could be that most of the home-to-school trips are also at 7am. Nevertheless, I also chose noon simply to capture accessibility trends during a different time of day than the work-trips, already set to the early morning hours.

Once I set all the Distance Matrix API parameters—API keys, origins, destinations, modes, day-of-week, and times-of-departure—I made my requests. I requested data over the course of five weeks between February and March 2018. In cases where the number of origins or destinations exceeded the API’s limit of 25 entries, I sub-divided the latitude and longitude sites into groups of twenty-five and fed them into the API separately. The total number of requests is summarized in **Table 4.19** below.

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 4.19 | | Number of Destinations | | | | | | | | | | | | | | | | | | | |
| Departments of Origin | Number of Origins | Buenos Aires CBD | | Departmental CBD | | Train Station | | Nearest Dept. CBD | | Public Urgent Care Center | | Public Hospital | | Pub. Diagnostic/Treatment | | Public Kindergarten | | Public Primary School | | Public Secondary School | |
| # | Requests | # | Requests | # | Requests | # | Requests | # | Requests | # | Requests | # | Requests | # | Requests | # | Requests | # | Requests |
| Pilar | 72 | 1 | 72 | 1 | 72 | 23 | 1656 | 9 | 648 | 6 | 432 | 10 | 720 | 51 | 3,672 | 66 | 4,752 | 77 | 5,544 | 74 | 5,328 |
| Quilmes | 92 | 1 | 92 | 1 | 92 | 19 | 1748 | 6 | 552 | 7 | 644 | 11 | 1,012 | 70 | 6,440 | 120 | 11,040 | 109 | 10,028 | 78 | 7,176 |
| La Matanza | 120 | 1 | 120 | 1 | 120 | 42 | 5040 | 8 | 960 | 9 | 1,080 | 19 | 2,280 | 81 | 9,720 | 148 | 17,760 | 203 | 24,360 | 199 | 23,880 |
| Travel Mode | | “Transit” | | | | | | | | | | | | | | | | | | | |
| Departure Time | | 7:00 AM | | | | | | | | 10:30 AM | | | | | | 12:00 PM | | | | | |
| Departure Day | | “Wednesday” | | | | | | | | | | | | | | | | | | | |

Post-processing was simple, although a few extra steps were required for destination categories with more than one feature. The output, for each request, was a matrix of origins and destinations, with time values in seconds. The unique identifier for the origins (rows) and destinations (columns) was the “LATITUDE+LONGITUDE” script that was fed into the API. For the two cases where there was only one destination—Buenos Aires’ CBD and the local departmental CBD—I only had to convert the times from seconds to minutes. For the remaining tables, I had to perform an extra function—using a tool within R—to select the minimum time in all the columns for each row. This script, in turn, produced a new matrix with just two columns: the unique identifier for a given origin and the travel time to the closest iteration of that activity class. Lastly, I converted this value to minutes. With the original shapefiles and these new time matrices sharing a common attribute (the latitude and longitude in “LATITUDE+LONGITUDE” format), I could join the R-output times tables to my shapefiles in ArcGIS to map my results.

Given that the primary question underlying this project is whether the *asentamientos* enjoy better or worse transit accessibility than the rest of metropolitan Buenos Aires, I naturally opted for statistical procedures that test differences of means. More specifically, I was interested in comparing the average travel times between: (1) those census radios designated as “majority overlap,” “minority overlap,” and “no overlap,” as well as, (2) between those designated “any overlap” and those with “no overlap.” The former, given its three-sample comparison, warranted an ANOVA (analysis of variance) test, while the latter required an independent-sample t-test.

ANOVA, or analysis of variance, is a test that compares the means of three or more samples of ratio or interval data to see if they are statistically independent. Simultaneously looking at differences in variation within and across the study samples, an ANOVA can test both the variation of each sample around the “total mean” of all samples and the variance within each of these samples around their respective means. As stated by McGrew et al. (2014), “if the variability between the group means is relatively large as contrasted with the relatively small amount of variability within each group around its group mean, then the statistical conclusion is likely that the different groups have been drawn from different populations” (p. 175). In other words, if the means of the independent samples are sufficiently different from one another, they are probably from different populations and, therefore, statistically-significantly different.

The test statistic for an ANOVA test is the F-statistic and is directly derived from the relative difference in variances between and within the different samples. High F-scores indicate that the between-group variance is much larger than the within-group variances (the former is divided by the latter to get the F-score), and it is unlikely that all the samples were drawn from the same population and that *at least one* of those samples is from a separate population. This would reject the null hypothesis for an ANOVA test that all samples are from the *same* population, and that their means and variances are all equal. The higher an F-score, the more likely the null hypothesis is not true. Nevertheless, such a conclusion can only be met if the ANOVA’s main assumptions are met: (1) that there are three or more independent random samples, (2) that each population is normally distributed, (3) that each population have equal variance, and (4) that the variables are measured on an interval or ratio scale.

In my case, I am comparing travel times between the three samples of census radios, grouped by their overlap with AGBA’s *asentamientos*: majority overlap, minority overlap, and none. Performed on the travel time estimates for all ten activity sites, the goal is to see whether the mean times of the “majority” or “minority” radios are statistically-significantly different from those qualified as “none.” An ANOVA test on these samples will determine if the travel times for the majority or minority overlap groups are from a different population of travel times than those in the control group. What the test will not do, however, is indicate which specific samples are different from one another; if the F-statistic is high, this could be because all three samples are different, are as a result of differences just between one and the other two.

Given the main weakness of the ANOVA test, that it does not specify which, or how many, of the sample means are different from the others, I sought to add robustness by employing a series of independent-sample T-tests. Similar in nature to the ANOVA, these are used to compare the means and variances of two independent samples, instead of three of more. Requiring that the two samples be independent and random, normally distributed, and measured on an interval or ratio scale, the resulting statistic can, if significant, reject a null hypothesis that the two samples’ means are equal (and, therefore, from the same population). The higher the t-score, the lower the likelihood that the two samples are from the same population. One caveat with the t-test has to do with whether the population variances for the two samples are known; if they are not, which is the case with my study, then the sample mean will have to stand in for the population mean. If the sample is small, that is, less than 30 cases, then it is probable that the sample mean is not a good representation of the population mean and that a t-distribution should be referenced. If the sample is greater than 30, the sample mean is probably more representative of its’ population-level equivalent and a Z-distribution can be assumed.

For this study, there are several plausible t-tests, each characterizing the initial ANOVA results. I will look at the differences-in-means between: (a) majority- and minority-overlap radios, (b) any-overlap (majority + minority) and no-overlap, (c) minority- and no-overlap, and (d) majority- and (e) non-majority-overlap (minority + none). Alongside the F-test from the initial ANOVA, I can perform a t-test on the travel times in each district (and to each destination) and see if the radios belonging to these respective categorizations display significant differences. A significant ANOVA test, say for the “distance to Buenos Aires CBD” measure, alongside significant t-tests for all the paired combinations of overlap-categorizations (and especially for the majority-none and minority-none tests) would provide strong evidence that the *asentamientos* enjoy worse transit-based accessibility than their neighbors. Contrary results, perhaps a significant F-statistic but insignificant T-tests, would help clarify, if not nullify, the initially expected conclusion.

The results of these various tests are given in the next chapter.

# Chapter 7: Results

The average, standard deviation, minimum, and maximum travel time values for all trips for all study area radios, as well as for the four overlap categories of spatial units (majority, minority, any, and none) to each of the ten destination activity types are shown in **Table 5.1a**. The range of values for each destination activity type are shown on the box plots in **Figure 5.1b**. Lastly, the average times for each of the five overlap categories—vis-à-vis destination activity types—are shown on the line graph in **Figure 5.1d.**

|  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Table 5.1a – Descriptive Statistics | | | | | | | | | | | |
| Sample | Statistic | Buenos Aires CBD | Departmental CBD | Nearest CBD | Railroad Station | UPA | Hospital | Diag./Treat. | Kindergarten | Primary School | Secondary School |
| All | Average | 114.09 | 64.74 | 59.75 | 34.53 | 63.48 | 44.70 | 14.67 | 11.73 | 10.01 | 10.79 |
| St. Dev. | 40.51 | 39.62 | 38.15 | 24.46 | 34.30 | 27.62 | 10.40 | 9.03 | 8.68 | 8.35 |
| Minimum | 41.85 | 2.20 | 2.20 | 2.55 | 9.15 | 1.50 | 0.22 | 0.08 | 0.08 | 0.10 |
| Maximum | 274.60 | 232.60 | 232.60 | 182.55 | 188.53 | 195.88 | 72.48 | 54.92 | 50.63 | 57.50 |
| Majority | Average | 123.33 | 80.71 | 76.66 | 42.31 | 56.97 | 54.18 | 14.36 | 9.50 | 9.31 | 11.17 |
| St. Dev. | 37.10 | 40.33 | 39.32 | 28.32 | 26.44 | 30.01 | 8.60 | 6.53 | 6.96 | 7.40 |
| Minimum | 66.63 | 12.68 | 12.68 | 12.67 | 17.68 | 11.18 | 4.07 | 2.15 | 2.20 | 2.82 |
| Maximum | 274.60 | 232.60 | 232.60 | 182.55 | 129.55 | 195.88 | 39.02 | 40.22 | 42.50 | 42.37 |
| Minority | Average | 122.92 | 72.23 | 67.09 | 39.96 | 64.89 | 52.10 | 16.14 | 13.88 | 12.33 | 12.31 |
| St. Dev. | 43.33 | 38.15 | 38.09 | 23.98 | 40.53 | 26.19 | 10.87 | 8.68 | 9.22 | 7.68 |
| Minimum | 56.63 | 8.22 | 8.22 | 11.25 | 11.00 | 8.75 | 0.22 | 1.50 | 1.62 | 0.88 |
| Maximum | 240.60 | 198.82 | 198.82 | 133.87 | 188.53 | 157.90 | 43.05 | 42.28 | 49.07 | 41.25 |
| Any Overlap | Average | 123.07 | 75.37 | 70.63 | 40.83 | 61.94 | 52.87 | 15.49 | 11.28 | 12.88 | 11.23 |
| St. Dev. | 40.97 | 39.04 | 38.69 | 25.58 | 36.02 | 27.57 | 10.10 | 7.38 | 8.31 | 8.56 |
| Minimum | 56.63 | 8.22 | 8.22 | 11.25 | 11.00 | 8.75 | 0.22 | 0.88 | 1.50 | 1.62 |
| Maximum | 274.60 | 232.60 | 232.60 | 182.55 | 188.53 | 195.88 | 43.05 | 41.25 | 42.37 | 49.07 |
| No Overlap | Average | 105.23 | 54.26 | 49.03 | 28.23 | 64.99 | 36.66 | 13.83 | 10.30 | 10.57 | 8.79 |
| St. Dev. | 38.18 | 37.46 | 34.53 | 21.60 | 32.58 | 25.28 | 10.66 | 9.22 | 9.58 | 8.66 |
| Minimum | 41.85 | 2.20 | 2.20 | 2.55 | 9.15 | 1.50 | 1.18 | 0.10 | 0.08 | 0.08 |
| Maximum | 238.68 | 193.68 | 193.68 | 128.73 | 187.65 | 155.43 | 72.48 | 57.50 | 54.92 | 50.63 |

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| **Figure 5.1b** |
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There are some noteworthy initial results. For one, the range of expected values is substantially different for the different destination activity types. Noteworthy on **Figure 5.1b**, nearly all the schools, as well as the diagnostic/treatment centers, were within an hour’s minimum travel, regardless of where in the conurbation those trips originated. Conversely, the variation in values for travel times to the central business districts is enormous, with trips ranging from less than half-an-hour to some requiring nearly four hours. Each distribution presents a right-ward skew, with abundant outliers, suggesting that there are some radios with unusually long travel times to destinations. This is even true for those activity types that are more accessible like travel to schools. The skew, meanwhile, is to be expected given the impossibility of extreme negative outliers (i.e., negative values) with time-based values.

Given the spatial distribution of these types of activity sites, these results are as would be predicted. Those activity types with largely numbers of destination locations, like schools, will generally require less average travel than those with fewer, like the central business districts, hospitals, and railway stations. One other thing to keep in mind when inspecting these data is that they include values from across the region, so values from Pilar (which is farther from CABA than Quilmes) skew the distribution to the right.

One of the weaknesses of this study, and all Google Distance Matrix API data in Buenos Aires, is the difficulty in verifying these travel times. There is no way, without having some monitoring mechanism for real-time observation of people’s actual movements, on the ground, to determine if these estimations are entirely accurate. The studies that surveyed people residing in *asentamientos* about their actual daily behavior never considered time. Perhaps the only comparison point are those trip times reported to ENMODO; the table below shows the travel times recorded by respondents based on trip type and mode choice. School trips most commonly took only 10 to 20 minutes, whereas work trips and health trips frequently required more than a half-an-hour. A similar pattern is observed with my data, with schools requiring less time than the other two.

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| Table 5.1c | | | | | | | | |
| Travel Time | Trip Mode | | | Trip Types | | | | |
| Public Transit | Bus | Rail | Workers | Study | School, Primary | School, Secondary | Health |
| < 10 minutes | 2% | 2% | 1% | 17% | 26% | 36% | 27% | 8% |
| 11-20 minutes | 11% | 12% | 3% | 20% | 29% | 37% | 30% | 20% |
| 21-30 minutes | 17% | 19% | 7% | 18% | 19% | 16% | 21% | 25% |
| 31-60 minutes | 34% | 35% | 30% | 27% | 18% | 9% | 18% | 31% |
| 60 > minutes | 36% | 32% | 59% | 18% | 8% | <5% | 5% | 16% |
| Source: ST 2011 | | | | | | | | |

The study area aggregate data only demonstrate general differences between the different trip types. Sub-dividing the travel times based on whether they represent radios that contain *asentamientos* begins to reveal results pertinent to the goal of the study regarding differential access The graph below in **Figure 5.1d** depicts the variation in the mean expected travel time values to each destination for each category of census radio: majority-overlap, minority-overlap, any-overlap, and no-overlap. There are some clear trends visible here, even before examining the results of difference-of-means tests

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| **Figure 5.1d** |
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The travel times associated with the majority- and minority-overlap radios are substantially higher than those with no-overlap for five of the first six destination categories: the three central business districts, railway stations, and hospitals (all activity sites with dispersed patterns). In the case of the local CBD measures, these gaps are wide, with thirty minutes separating the two. The gap is lesser for the Buenos Aires CBD, railway station, and hospital measures, but a gap nonetheless is evident. Conversely, there is little-to-no gap for any of the types of schools or diagnostic/treatment centers, although this is likely related with the minimal absolute variance in travel time scores associated with these destination types relative to the others. The urgent care units (UPA’s) provide an unexpected result: the no-overlap radios enjoy *worse* travel times than those radios that overlap an *asentamiento*, an promising result given that the UPA’s were purposively constructed in underserved areas.

The table below presents the results from the ANOVA and t-tests for all of the sampled radios, regardless of district.

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| **Table 5.1e –** ANOVA and independent-sample t-tests | | | | | | | | | | | |
| **Samples of Comparison** | **Statistic** | Buenos Aires CBD | Departmental CBD | Nearest CBD | Railroad Station | UPA | Hospital | Diag./Treat. | Kindergarten | Primary School | Secondary School |
| ANOVA | | | | | | | | | | | |
| Majority, Minority, None | F-statistic | 6.830 | 11.160 | 12.941 | 9.764 | 1.103 | 12.835 | 1.387 | 2.381 | 4.916 | 3.886 |
| p(F) | 0.001 | 0.000 | 0.000 | 0.000 | 0.333 | 0.000 | 0.252 | 0.094 | 0.008 | 0.022 |
| T-Tests | | | | | | | | | | | |
| Any vs. None | t-statistic | 3.702 | 4.553 | 4.861 | 4.389 | -0.732 | 5.055 | 1.341 | 2.170 | 2.380 | 0.991 |
| p(t) | 0.000 | 0.000 | 0.000 | 0.000 | 0.465 | 0.000 | 0.181 | 0.031 | 0.018 | 0.323 |
| Mean diff. | 17.841 | 21.118 | 21.604 | 12.602 | -3.057 | 16.210 | 1.659 | 2.310 | 2.432 | 0.982 |
| St. Err. (diff.) | 4.819 | 4.639 | 4.445 | 2.871 | 4.179 | 3.207 | 1.237 | 1.064 | 1.022 | 0.991 |
| Majority vs. Minority/  None | t-statistic | 1.794 | 3.210 | 3.542 | 2.516 | -1.488 | 2.718 | -0.237 | -0.496 | -0.757 | -1.234 |
| p(t) | 0.074 | 0.001 | 0.000 | 0.012 | 0.138 | 0.007 | 0.813 | 0.620 | 0.451 | 0.218 |
| Mean diff. | 11.339 | 19.574 | 20.717 | 9.540 | -7.979 | 11.612 | -0.378 | -0.688 | -0.857 | -1.580 |
| St. Err. (diff.) | 6.321 | 6.098 | 5.849 | 3.792 | 5.362 | 4.273 | 1.599 | 1.387 | 1.133 | 1.280 |
| Majority vs. Minority | t-statistic | 0.055 | 1.221 | 1.393 | 0.515 | -1.367 | 0.423 | -1.080 | -1.887 | -2.207 | -2.315 |
| p(t) | 0.956 | 0.224 | 0.166 | 0.607 | 0.174 | 0.673 | 0.282 | 0.061 | 0.029 | 0.022 |
| Mean diff. | 0.403 | 8.480 | 9.572 | 2.350 | -7.914 | 2.085 | -1.786 | -2.708 | -3.023 | -2.811 |
| St. Err. (diff.) | 7.346 | 6.945 | 6.871 | 4.562 | 5.791 | 4.929 | 1.654 | 1.435 | 1.369 | 1.215 |
| Minority vs. None | t-statistic | 3.170 | 3.451 | 3.640 | 3.778 | -0.021 | 4.362 | 1.594 | 2.652 | 2.958 | 1.724 |
| p(t) | 0.002 | 0.001 | 0.000 | 0.000 | 0.983 | 0.000 | 0.112 | 0.009 | 0.003 | 0.086 |
| Mean diff. | 17.691 | 17.977 | 18.059 | 11.738 | -0.104 | 15.438 | 2.313 | 3.302 | 3.539 | 2.011 |
| St. Err. (diff.) | 5.581 | 5.208 | 4.961 | 3.107 | 4.970 | 3.539 | 1.451 | 1.245 | 1.196 | 1.166 |
| Majority vs. None | t-statistic | 2.887 | 4.188 | 4.663 | 3.613 | -1.561 | 3.984 | 0.319 | 0.404 | 0.386 | -0.575 |
| p(t) | 0.004 | 0.000 | 0.000 | 0.000 | 0.120 | 0.000 | 0.750 | 0.686 | 0.700 | 0.566 |
| Mean diff. | 18.094 | 26.457 | 27.631 | 14.088 | -8.018 | 17.522 | 0.527 | 0.593 | 0.516 | -0.800 |
| St. Err. (diff.) | 6.267 | 6.318 | 5.925 | 3.899 | 5.138 | 4.398 | 1.648 | 1.467 | 1.336 | 1.392 |

As indicated by the darkest green shading, the ANOVA tests for six of the destinations were significant at a 99% confidence level (all the central business districts, the railway stations, public hospitals, and, curiously, primary schools), one at 95% (kindergartens and secondary schools), and another at 90% (kindergartens). There does indeed seem to be a statistically-significant difference in the average travel times between those census radios showing majority-overlap, minority-overlap, and no-overlap; we can reject the null hypotheses that those samples are drawn from the same population. Nevertheless, as noted before, this does not immediately prove my overarching hypothesis about relative accessibility in the *asentamientos*; these differences between each of these overlap-categories need to be considered individually, using t-tests, to see exactly where these differences lie.

Looking first at the six destinations whose ANOVA tests were highly-significant, their t-tests returned remarkably similar results. For the central business districts, railway stations, and hospitals, the greatest differences were between those radios with any degree of overlap (majority/minority) with an *asentamiento* and those without; the t-tests were highly significant (+99% confidence) for those comparing majority-overlap to no-overlap, minority-overlap to no-overlap, and any-overlap to no-overlap. These provide stronger evidence that the *asentamientos* enjoy worse relative access to these activity sites than their neighbors, in support of the project hypothesis. In the case of the local CBD’s, the t-tests comparing the majority-overlap radios with all others were also very significant, suggesting that, in these cases, the radios with the greatest likelihood of representing *asentados* are those with the worst travel times.

The schools present interestingly different results. While they each returned ANOVA tests of differing levels of significance, the differences-in-means seem to lie between different overlap-categories then the five discussed above. For the kindergartens and primary schools, the greatest differences, per the t-test results, are between the minority- and no-overlap radios (both 99%+ significance) with less of a difference between those in the majority and minority samples and any and none (~95% significance). This suggests that, while there appears to be some difference in estimated travel time between the *asentamientos* and their neighbors, those differences are greatest in those census radios that are less likely to fully consist of *asentados*. The secondary schools, meanwhile, only display a significant difference (95% confidence) between the majority- and minority-overlap radios (the significance for this test was equal to that for the ANOVA for the same activity sites). These results, while interesting, do not lend as strong support for the overarching project hypothesis.

All the while, the inequalities in accessibility exhibited by the schools illustrate the importance of measuring access in a *relative* manner; even though there are hundreds of schools scattered across AGBA—with average travel times around fifteen minutes for each sub-category—there are still students spending significantly more time getting to school than their classmates. Even if the absolute differences are not as great for students as for other trip-makers, significant differences exist nonetheless (some are over 45 minutes) a burden on those few students who must take extra steps or acquire the fare to account for an earlier departure in the morning or late arrival home in the evening.

The last two activity destination types, the urgent care centers and diagnostic/treatment centers, returned insignificant results for all tests. This could suggest a degree of equity in the distribution of these opportunities, because all census radios seem to enjoy a similar degree of time-based access; this is especially interesting for the UPA’s of which there are just over a dozen across the entirety of AGBA. Perhaps this reflects good locational planning by public officials.

While the majority of these initial findings provide suggest strong support for the argument that there is an inequality in public transport access to the *asentamientos* of metropolitan Buenos Aires, additional results can further help reveal differences in the spatial patterns of accessibility. Unique geographies and urban landscapes are found in each of the study area’s departments, Quilmes, La Matanza, and Pilar, so it is of interest whether differential accessibility is common to all three cases and, if so, to what extent it differs. The raw travel time estimations for each of these study areas are vastly different and reflective of different urban environments. While Quilmes, for instance, features the shortest travel times to all activity sites, this does not necessarily indicate equitable accessibility for all residents. Consideration must be given to variations within the territory of each case study.

In the subsequent sub-sections, I explore the results for Quilmes, La Matanza, and Pilar to see how the *asentados* fare relative to their neighbors when living in different urban/suburban environments (shown again on **Figure 5.2** below). To review the INDEC classification of each, Quilmes represents fully-urbanized departments within traditional “greater Buenos Aires” (GABA), La Matanza for the partially-urbanized departments in GABA, and Pilar those departments not historically considered part of the conurbation but that are being progressively urbanized and enveloped into the agglomeration at large. As will be seen, these characteristics are reflected in the corresponding travel time patterns.

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| **Table 5.3b** | | | | | | | | | | | |
| **Sample** | **Statistic** | Buenos Aires CBD | Departmental CBD | Nearest CBD | Railroad Station | UPA | Hospital | Diag./Treat. | Kindergarten | Primary School | Secondary School |
| **All** | **Average** | **81.19** | **48.96** | **43.34** | **33.96** | **46.28** | **33.42** | **8.62** | **8.12** | **6.90** | **10.82** |
| **St. Dev.** | 18.14 | 22.22 | 19.07 | 15.62 | 19.39 | 13.64 | 4.85 | 3.90 | 3.42 | 5.13 |
| **Minimum** | 41.85 | 7.62 | 7.62 | 2.55 | 11.00 | 6.98 | 0.22 | 1.87 | 0.10 | 1.73 |
| **Maximum** | 118.70 | 95.08 | 81.03 | 69.73 | 100.67 | 64.95 | 30.90 | 24.08 | 19.62 | 28.33 |
| **Majority** | **Average** | **90.40** | **53.21** | **50.17** | **41.93** | **51.47** | **37.52** | **8.77** | **8.55** | **7.96** | **12.53** |
| **St. Dev.** | 15.25 | 23.19 | 21.68 | 14.80 | 22.53 | 15.53 | 2.68 | 4.47 | 4.00 | 5.69 |
| **Minimum** | 66.63 | 12.68 | 12.68 | 17.53 | 17.75 | 11.18 | 4.37 | 2.15 | 2.20 | 4.35 |
| **Maximum** | 108.65 | 81.03 | 81.03 | 69.73 | 82.03 | 64.95 | 14.67 | 16.50 | 16.00 | 22.05 |
| **Minority** | **Average** | **85.03** | **55.96** | **48.73** | **37.60** | **41.01** | **37.12** | **8.03** | **8.19** | **7.30** | **11.86** |
| **St. Dev.** | 16.02 | 20.13 | 16.70 | 12.75 | 22.23 | 12.51 | 6.01 | 3.36 | 3.09 | 5.28 |
| **Minimum** | 56.63 | 8.22 | 8.22 | 11.78 | 11.00 | 8.75 | 0.22 | 1.87 | 1.65 | 1.73 |
| **Maximum** | 118.70 | 82.58 | 73.30 | 58.67 | 100.67 | 53.70 | 30.90 | 16.03 | 15.33 | 24.97 |
| **Any Overlap** | **Average** | **86.90** | **55.01** | **49.23** | **39.11** | **44.65** | **37.26** | **8.29** | **8.31** | **7.53** | **12.09** |
| **St. Dev.** | 15.80 | 21.02 | 18.35 | 13.49 | 22.65 | 13.47 | 5.08 | 3.73 | 3.40 | 5.37 |
| **Minimum** | 56.63 | 8.22 | 8.22 | 11.78 | 11.00 | 8.75 | 0.22 | 1.87 | 1.65 | 1.73 |
| **Maximum** | 118.70 | 82.58 | 81.03 | 69.73 | 100.67 | 64.95 | 30.90 | 16.50 | 16.00 | 24.97 |
| **No Overlap** | **Average** | **75.47** | **42.92** | **37.44** | **28.81** | **47.92** | **29.58** | **8.96** | **7.93** | **6.27** | **9.56** |
| **St. Dev.** | 18.69 | 21.94 | 18.10 | 16.04 | 15.56 | 12.83 | 4.64 | 4.10 | 3.36 | 4.58 |
| **Minimum** | 41.85 | 7.62 | 7.62 | 2.55 | 11.23 | 6.98 | 2.68 | 1.90 | 0.10 | 3.23 |
| **Maximum** | 108.98 | 95.08 | 76.98 | 67.90 | 77.47 | 58.83 | 24.08 | 24.08 | 19.62 | 28.33 |

Looking only at the distribution of estimated travel times in Quilmes (TABLE REFERENCE NEEDED), there are some numbers that warrant attention. For one, the ranges of the travel times for each destination are considerably smaller than across the entire AGBA, with less absolute variance. This is reflected in the relatively small number of outliers; some of the activity site categories have none at all. Schools and diagnostic/treatment centers again exhibit the shortest travel times (despite being the only features to show outliers) whereas longer travel times are found, as expected, for the central business districts, railway stations, urgent care centers/UPAs, and hospitals (all of which require 45 minutes, on average). Unlike what we will see for the other two case studies, there are no trips longer than two hours. For trips whose destination is within Quilmes’ boundaries, the upper limit is only 90 minutes.

The history of Quilmes, which is representative of other fully-urbanized departments proximate to CABA, can explain some of these tendencies. According to Keeling (1996), Quilmes was first settled as a suburb of Buenos Aires during the 1950s; people working in the factories on the southern side of Buenos Aires City lived in its neighborhoods and commuted to their jobs using the commuter railway line (the Roca Line) that connected CABA with Quilmes and the other departments on the city’s southeastern flank. Most of its urbanization took place rapidly during the 1960s and 1970s as more and more working- and lower-class people settled within its confines. Consequently, Quilmes is one of the poorest departments in the city, a haven for working-class porteños, and, once the *asentamiento* proliferated as a housing recourse, “a favored location for self-help settlements due to its proximity to the Federal District and to industrial plants” (Keeling, p. 56).

Providing services to traditional neighborhoods, let alone informal settlements, has been a struggle for the cash-strapped municipality, whose population jumped from 300,000 in 1970 to over 500,000 in 1991 and then to nearly 600,000 in 2010 (Keeling, 1996; INDEC 2010). While its small size relative to those departments on Buenos Aires’ periphery means that travel times within the district are relatively short, its location and working-class legacy have meant it houses an unusually large share of *asentados* within its boundaries. Geographically, most of its *asentamientos* are along a riverbank on its western edge and along the Buenos Aires–La Plata motorway that runs along its northern boundary (**Figure 5.3a**).

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| **Figure 5.3c** |
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Of most interest, however, are the travel times when disaggregated based on whether they originate in radios that overlap with an *asentamiento*. The corresponding averages are depicted on **Figure 5.3d** below, showing that the majority-overlap radios enjoy the longest travel times, compared to the other categories, for nearly every destination class; accessibility is markedly worse for these radios than those with no-overlap for six for the first activity sites (CBD’s, railroad stations, UPA’s, and hospitals) while also marginally higher for primary and secondary schools. Those with “minority-overlap” are also worse than their “no overlap” counterparts in each of those same categories, save the urgent care units. Looking only at raw travel times, the schools all showed similar average travel times, just like was observed at the regional level. The gaps that exist between the “majority” and “minority” overlap radios and the “no” overlap radios, while still noticeable, are smaller than AGBA overall, with the difference hovering around 15 minutes.

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| **Figure 5.3d** |
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**Table 5.3e** presents the results of the difference-of-means tests for Quilmes. Looking first to the ANOVA tests, the F-statistic was very highly significant (99%) for two categories, the Buenos Aires CBD and the railroad stations; highly-significant (95%) for three (Quilmes’ CBD, the nearest departmental CBD, and public hospitals); and moderately-significant (90%) for one (secondary schools); the remaining four were insignificant. These results provide initial evidence, at least for the very-highly- and highly-significant destinations, to support the hypothesis that the *asentamientos* enjoy poor relative accessibility. For these five we can reject the null hypothesis that the independent samples (majority-, minority- and no-overlap radios) came from the same population.

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| **Table 5.3e** | | | | | | | | | | | |
| Samples of Comparison | Statistic | Buenos Aires CBD | Departmental CBD | Nearest CBD | Railroad Station | UPA | Hospital | Diag./Treat. | Kindergarten | Primary School | Secondary School |
| ANOVA | | | | | | | | | | | |
| Majority, Minority, None | F-statistic | 5.517 | 3.692 | 4.792 | 5.997 | 1.881 | 3.886 | 0.337 | 0.153 | 1.783 | 3.037 |
| p(F) | 0.006 | 0.029 | 0.011 | 0.004 | 0.159 | 0.024 | 0.715 | 0.859 | 0.174 | 0.053 |
| T-Tests | | | | | | | | | | | |
| Any vs. None | t-statistic | 3.167 | 2.699 | 3.102 | 3.334 | -0.808 | 2.801 | -0.662 | 2.437 | 1.786 | 0.472 |
| p(t) | 0.002 | 0.008 | 0.003 | 0.001 | 0.421 | 0.006 | 0.510 | 0.017 | 0.078 | 0.638 |
| Mean diff. | 11.426 | 12.091 | 11.788 | 10.303 | -3.276 | 7.683 | -0.671 | 2.538 | 1.259 | 0.386 |
| St. Err. (diff.) | 3.608 | 4.480 | 3.801 | 3.090 | 4.052 | 2.743 | 1.015 | 1.041 | 0.705 | 0.817 |
| Majority vs. Minority/  None | t-statistic | 2.286 | 0.841 | 1.589 | 2.299 | 1.178 | 1.330 | 0.133 | 1.475 | 1.372 | 0.477 |
| p(t) | 0.025 | 0.403 | 0.116 | 0.024 | 0.242 | 0.187 | 0.894 | 0.144 | 0.173 | 0.634 |
| Mean diff. | 11.152 | 5.148 | 8.267 | 9.655 | 6.273 | 4.968 | 0.179 | 2.066 | 1.286 | 0.515 |
| St. Err. (diff.) | 4.878 | 6.121 | 5.202 | 4.199 | 5.323 | 3.736 | 1.342 | 1.401 | 0.937 | 1.078 |
| Majority vs. Minority | t-statistic | 1.1 | -0.418 | 0.25 | 1.038 | 1.513 | 0.095 | 0.467 | 0.4 | 0.625 | 0.305 |
| p(t) | 0.277 | 0.678 | 0.804 | 0.305 | 0.138 | 0.924 | 0.643 | 0.691 | 0.535 | 0.762 |
| Mean diff. | 5.366 | -2.749 | 1.433 | 4.331 | 10.457 | 0.402 | 0.741 | 0.672 | 0.663 | 0.356 |
| St. Err. (diff.) | 4.879 | 6.569 | 5.742 | 4.174 | 6.914 | 4.215 | 1.587 | 1.679 | 1.06 | 1.167 |
| Minority vs. None | t-statistic | 2.303 | 2.617 | 2.739 | 2.527 | -1.483 | 2.529 | -0.758 | 2.017 | 1.345 | 0.291 |
| p(t) | 0.024 | 0.011 | 0.008 | 0.014 | 0.145 | 0.014 | 0.451 | 0.047 | 0.183 | 0.772 |
| Mean diff. | 9.559 | 13.047 | 11.29 | 8.797 | -6.913 | 7.543 | -0.929 | 2.304 | 1.029 | 0.262 |
| St. Err. (diff.) | 4.151 | 4.986 | 4.122 | 3.481 | 4.662 | 2.982 | 1.226 | 1.142 | 0.765 | 0.898 |
| Majority vs. None | t-statistic | 2.875 | 1.594 | 2.3 | 2.874 | 0.583 | 2.019 | -0.153 | 2.099 | 1.651 | 0.508 |
| p(t) | 0.006 | 0.116 | 0.025 | 0.006 | 0.567 | 0.048 | 0.879 | 0.040 | 0.104 | 0.614 |
| Mean diff. | 14.925 | 10.298 | 12.723 | 13.127 | 3.544 | 7.946 | -0.188 | 2.976 | 1.692 | 0.618 |
| St. Err. (diff.) | 5.192 | 6.46 | 5.531 | 4.567 | 6.082 | 3.935 | 1.229 | 1.418 | 1.025 | 1.217 |

Supplementing these results with the t-tests helps to understand whether these ANOVAs captured variance that fully pertains to the research question. For all five activity sites that returned highly-significant F-statistics, the t-tests indicate that most of the variation between those three independent samples was between, on the one hand, the radios with majority- and minority-overlap and, on the other hand, those without any. Very highly significant differences were registered between the “any” and “none” radios for all five activities (e.g., CBDs, railway stations, and hospitals), with very-highly- or highly-significant differences recorded individually between the “majority” and “minority” radios and those with “none”. The differences within the “minority” and “minority” radios were insignificant. Strong evidence is thus found that there is an inequality in transit-facilitated access to CBD’s, public hospitals, and railway stations between Quilmes’ *asentamientos* and their neighbors. Confidence is especially strong for travel to the Buenos Aires CBD and to railway stations since the largest differences are for those majority-overlapped radios where we can be most certain *asentados* are living.

As for the other five activity sites—UPA’s, diagnostic/treatment centers, and all three schools—these seem to be transit-accessible in a much more equitable manner. The two health centers, alongside primary schools, showed no significant differences at all, whereas secondary schools, curiously, only showed a mildly-significant difference (90%) for the ANOVA tests, with nothing at any other level. The most interesting of these classes, however, are the kindergartens: the ANOVA test showed very little significant variance between the three primary classes (minority, majority, and none) but then showed highly-significant differences between the no-overlap radios and those with minority, majority, and any overlap.

While Quilmes’ relatively-compact size produces absolute travel times shorter than what we will observe when moving on to examine the results for the other two study areas, inequalities are clearly present between its *asentados* and their neighbors; differences are greatest when considering travel to hypothesized employment/commercial-centers like central business districts and railway stations.

The second case study is La Matanza, located to the southwest of CABA. For reference, maps of Quilmes and its asentamientos are shown below in **Figure 5.4a**.

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| **Table 5.4b** | | | | | | | | | | | |
| Sample | Statistic | Buenos Aires CBD | Departmental CBD | Nearest CBD | Railroad Station | UPA | Hospital | Diag./Treat. | Kindergarten | Primary School | Secondary School |
| All | Average | 129.47 | 79.68 | 78.14 | 37.63 | 55.18 | 55.20 | 17.41 | 9.75 | 8.89 | 9.41 |
| St. Dev. | 40.45 | 47.35 | 47.42 | 33.04 | 19.38 | 35.48 | 11.12 | 7.14 | 7.45 | 7.85 |
| Minimum | 57.80 | 2.20 | 2.20 | 7.13 | 9.15 | 1.50 | 1.18 | 0.10 | 0.08 | 0.08 |
| Maximum | 274.60 | 232.60 | 232.60 | 182.55 | 129.55 | 195.88 | 72.48 | 40.22 | 42.50 | 42.37 |
| Majority | Average | 143.38 | 96.84 | 95.93 | 45.98 | 52.63 | 64.94 | 18.18 | 10.15 | 10.19 | 9.66 |
| St. Dev. | 35.81 | 40.07 | 40.55 | 35.42 | 20.45 | 34.62 | 9.40 | 7.85 | 8.49 | 8.33 |
| Minimum | 103.32 | 48.57 | 48.57 | 12.67 | 17.68 | 16.55 | 4.07 | 2.83 | 2.82 | 2.93 |
| Maximum | 274.60 | 232.60 | 232.60 | 182.55 | 129.55 | 195.88 | 39.02 | 40.22 | 42.37 | 42.50 |
| Minority | Average | 143.84 | 102.85 | 98.96 | 48.16 | 55.47 | 72.41 | 21.91 | 12.78 | 13.02 | 12.56 |
| St. Dev. | 40.51 | 43.93 | 45.92 | 35.67 | 17.64 | 32.24 | 10.58 | 7.33 | 7.71 | 7.25 |
| Minimum | 93.95 | 35.38 | 35.38 | 11.25 | 20.30 | 28.12 | 4.00 | 0.88 | 1.50 | 1.62 |
| Maximum | 239.07 | 198.82 | 198.82 | 133.87 | 91.37 | 157.90 | 42.82 | 36.23 | 34.50 | 34.38 |
| Any Overlap | Average | 143.62 | 99.95 | 97.50 | 47.10 | 54.10 | 68.80 | 20.05 | 11.46 | 11.60 | 11.11 |
| St. Dev. | 37.98 | 41.86 | 43.06 | 35.25 | 18.93 | 33.32 | 10.10 | 7.64 | 8.17 | 7.88 |
| Minimum | 93.95 | 35.38 | 35.38 | 11.25 | 17.68 | 16.55 | 4.00 | 0.88 | 1.50 | 1.62 |
| Maximum | 274.60 | 232.60 | 232.60 | 182.55 | 129.55 | 195.88 | 42.82 | 40.22 | 42.37 | 42.50 |
| No Overlap | Average | 115.79 | 60.08 | 59.43 | 28.47 | 56.23 | 42.06 | 14.77 | 8.03 | 7.22 | 6.66 |
| St. Dev. | 38.26 | 44.27 | 44.09 | 28.13 | 19.91 | 32.66 | 11.54 | 6.20 | 6.93 | 6.30 |
| Minimum | 57.80 | 2.20 | 2.20 | 7.13 | 9.15 | 1.50 | 1.18 | 0.10 | 0.08 | 0.08 |
| Maximum | 238.68 | 193.68 | 193.68 | 128.73 | 86.23 | 155.43 | 72.48 | 39.83 | 41.87 | 34.38 |

More than any of the other cases, La Matanza exhibits the widest ranges of travel times, with values ranging from less than five minutes for some radios to as great as three hours for others. La Matanza is an interesting case, as reflected by its INDEC classification: it is part of the area traditionally considered to be “greater Buenos Aires” but, unlike some of its contemporaries (such as Quilmes), it is not fully urbanized and, therefore, not entirely part of agglomerated Buenos Aires. As noted by Keeling (1996), La Matanza is one of the departments that “may still have land available for ranching, agriculture, or leisure (p. 49).” A large territory, it extends from the border of CABA off towards the southwest. As of 2010, it had the largest population of any department within AGBA.

Within its expansive territory, La Matanza represents both sides of development in Buenos Aires’ urban periphery: intense urbanization to the east and agrarian lands to the west. Located along the La Matanza River, which forms its south-western boundary, there are over one million people living in its eastern half. Its citizens are primarily from the middle- and working-classes, with many commuting into service-sector jobs in CABA or working in one of the district’s many factories and industrial centers. Keeling (1996) remarks that the development of the eastern half of the district closely followed the railroad, with the highest densities around stations. These neighborhoods, he notes, follow a pronounced grid pattern, dispersing outward from the original settlement nodes. The other half of the district is sparsely populated, with substantial open land dedicated to agriculture and horticulture. For the department as a whole growth has been continuous, with population increasing from 700,000 in 1970 to 1 million in 1990 and then 1.8 million by the mid-1990s (Keeling 1996, p. 50).

In some ways, this east-west dichotomy is reflected in the map of *asentamientos* in La Matanza (**Figures 5.4a** above). There are none in the northern or eastern quadrants where the cities are found. This is the most densely-populated part of the department where, presumably, all the vacant space has long since been occupied by formal housing units. All its precarious settlements, meanwhile, are along the two edges of CABA, far from its active railway lines and even the major national highway that cuts down the length of the department. In fact, those on the southeastern edge of the department are up against its namesake river, an example of how unofficial settlements are often found on hazard-prone territory. The peripheral locations of the *asentamientos* are accentuated in La Matanza, where residents are away from the core, isolated from centrally located employment opportunities.

With such a large expanse, it is not surprising to see such huge variances in travel times in La Matanza. Travel times to the central business districts, for instance, range from less than 15 minutes all the way up to four hours; public hospitals displayed a similar variance, whereas UPA’s and railway stations, relative to other features with similarly-dispersed patterns, were somewhat more easily reached. Illustrating the large size of the department, there are several radios requiring more than three hours’ time on public transportation for their resident to reach the municipal center of their own department! While people in these locations may not need to make such journeys often (perhaps only for governmental issues requiring travel to municipal offices), this is an incredible burden, especially to someone with no other mobility options. Schools and diagnostic/treatment centers, however, featured the shortest travel times of any activity type, with few travel times above sixty minutes. All features showed numerous outliers, with rightward skews present for all opportunity classes.

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| Figure 5.4c |
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Like with Quilmes, the most pertinent findings for La Matanza concern the degree of overlap between the sampled census radios and the *asentamientos*. In some ways, the results are quite like those from Quilmes, with the majority- and minority-overlap radios showing markedly higher expected travel times across most of the categories: twenty to thirty additional minutes of travel are required to most destinations (e.g., the CBDs, railroad stations, and public hospitals) for people living in a radio that overlaps with an *asentamiento*. Values are higher, although by a smaller absolute margin, for those same people when traveling to schools or diagnostic/treatment centers. The only exceptions, curiously, are travel times to urgent care centers, which are actually *longer* for non-*asentados*. These results provide evidence to confirm the project hypothesis.

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| **Figure 5.4d** |
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The statistical tests for La Matanza provide overwhelming evidence of access inequalities in the department. The ANOVA tests produced very highly-significant (99% confidence) F-scores for eight of the ten destination categories and a highly-significant statistic (95%) for another. The outliers are the urgent care units, which showed little-to-no difference between the three study samples: majority-, minority-, and no-overlap census radios.

The t-tests indicate that individual differences-of-means contributing to the high ANOVA scores are those between those radios of any- (whether minority *or* majority) and no-overlap; the t-tests for any-versus-none and minority-versus-none are very-highly significant (99%) for all of the destination categories. For hospitals, CBDs, and railroad stations, the majority-versus-none distinction was also at least highly-significant (95%+); the “majority-minority” difference was insignificant across the board.

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| Table 5.4e | | | | | | | | | | | |
| Samples of Comparison | Statistic | Buenos Aires CBD | Departmental CBD | Nearest CBD | Railroad Station | UPA | Hospital | Diag./Treat. | Kindergarten | Primary School | Secondary School |
| ANOVA | | | | | | | | | | | |
| Majority, Minority, None | F-statistic | 7.792 | 12.684 | 11.194 | 5.046 | 0.331 | 10.039 | 4.464 | 4.776 | 7.162 | 6.123 |
| p(F) | 0.001 | 0.000 | 0.000 | 0.008 | 0.719 | 0.000 | 0.014 | 0.010 | 0.001 | 0.003 |
| T-Tests | | | | | | | | | | | |
| Any vs. None | t-statistic | 3.965 | 5.025 | 4.743 | 3.179 | -0.597 | 4.402 | 2.663 | 3.167 | 3.415 | 2.703 |
| p(t) | 0.000 | 0.000 | 0.000 | 0.002 | 0.552 | 0.000 | 0.009 | 0.002 | 0.001 | 0.008 |
| Mean diff. | 27.830 | 39.875 | 38.071 | 18.632 | -2.137 | 26.741 | 5.273 | 4.379 | 4.448 | 3.435 |
| St. Err. (diff.) | 7.020 | 7.936 | 8.026 | 5.861 | 3.579 | 6.074 | 1.980 | 1.383 | 1.303 | 1.271 |
| Majority vs. Minority/  None | t-statistic | 2.115 | 2.234 | 2.315 | 1.539 | -0.797 | 1.675 | 0.436 | 0.621 | 0.655 | 0.353 |
| p(t) | 0.037 | 0.027 | 0.022 | 0.126 | 0.427 | 0.097 | 0.664 | 0.536 | 0.513 | 0.725 |
| Mean diff. | 18.240 | 22.510 | 23.325 | 10.943 | -3.349 | 12.760 | 1.025 | 1.031 | 1.031 | 0.533 |
| St. Err. (diff.) | 8.626 | 10.077 | 10.076 | 7.109 | 4.201 | 7.620 | 2.352 | 1.660 | 1.574 | 1.511 |
| Majority vs. Minority | t-statistic | -0.046 | -0.543 | -0.266 | -0.233 | -0.567 | -0.851 | -1.445 | -1.353 | -1.439 | -1.344 |
| p(t) | 0.964 | 0.589 | 0.791 | 0.816 | 0.573 | 0.398 | 0.154 | 0.181 | 0.156 | 0.184 |
| Mean diff. | -0.462 | -6.007 | -3.032 | -2.179 | -2.838 | -7.473 | -3.734 | -2.833 | -2.901 | -2.635 |
| St. Err. (diff.) | 10.069 | 11.067 | 11.408 | 9.340 | 5.005 | 8.778 | 2.584 | 2.094 | 2.017 | 1.960 |
| Minority vs. None | t-statistic | 3.216 | 4.332 | 3.955 | 2.856 | -0.179 | 4.173 | 2.842 | 3.603 | 3.980 | 3.223 |
| p(t) | 0.002 | 0.000 | 0.000 | 0.005 | 0.859 | 0.000 | 0.006 | 0.001 | 0.000 | 0.002 |
| Mean diff. | 28.053 | 42.775 | 39.535 | 19.684 | -0.766 | 30.348 | 7.140 | 5.795 | 5.899 | 4.752 |
| St. Err. (diff.) | 8.724 | 9.874 | 9.996 | 6.891 | 4.291 | 7.272 | 2.512 | 1.608 | 1.482 | 1.474 |
| Majority vs. None | t-statistic | 3.214 | 3.737 | 3.708 | 2.499 | -0.784 | 3.003 | 1.399 | 1.771 | 1.905 | 1.395 |
| p(t) | 0.002 | 0.000 | 0.000 | 0.014 | 0.435 | 0.004 | 0.165 | 0.080 | 0.060 | 0.166 |
| Mean diff. | 27.591 | 36.768 | 36.503 | 17.504 | -3.604 | 22.876 | 3.405 | 2.962 | 2.998 | 2.117 |
| St. Err. (diff.) | 8.584 | 9.840 | 9.844 | 7.005 | 4.595 | 7.618 | 2.434 | 1.673 | 1.573 | 1.518 |

These results provide strong evidence in favor of transit-based access inequalities within La Matanza department. For nine of ten activity sites, census radios containing some proportion of an *asentamiento* displayed significantly longer travel times. When it comes to accessibility vis-à-vis CBDs, public hospitals, and railway stations, some of the most significant gaps are for those radios that most likely containing *asentados* (i.e., majority overlap). La Matanza’s geography may inherently provide for longer travel times but it seems that the longest of those trips are still being made by some of its most marginalized people; the current transportation system appears to be neglectful of serving the mobility needs of all.

MOST INTERESTING DIFFERENCES WITH THE FIRST CASE STUDY; WHY ARE DIFFERENT RESULTS EXPLAINED BY GEOGRAPHIES

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| **Figure 5.5b** | | | | | | | | | | | |
| Sample | Statistic | Buenos Aires CBD | Departmental CBD | Nearest CBD | Railroad Station | UPA | Hospital | Diag./Treat. | Kindergarten | Primary School | Secondary School |
| **All** | **Average** | **134.29** | **59.72** | **49.11** | **29.47** | **106.14** | **41.47** | **17.90** | **15.94** | **16.75** | **15.85** |
| **St. Dev.** | 33.99 | 33.21 | 20.84 | 12.42 | 39.87 | 16.72 | 11.12 | 11.62 | 12.33 | 11.97 |
| **Minimum** | 95.67 | 3.00 | 3.00 | 7.45 | 35.42 | 10.35 | 2.65 | 1.68 | 1.67 | 0.77 |
| **Maximum** | 240.60 | 148.70 | 115.98 | 54.27 | 188.53 | 111.38 | 57.13 | 57.50 | 54.92 | 50.63 |
| **Majority** | **Average** | **117.55** | **78.77** | **57.38** | **26.24** | **91.94** | **48.42** | **10.14** | **8.81** | **12.44** | **11.14** |
| **St. Dev.** | 10.34 | 42.08 | 9.60 | 6.41 | 37.45 | 7.56 | 3.54 | 3.42 | 5.42 | 5.72 |
| **Minimum** | 104.12 | 45.38 | 45.38 | 16.13 | 48.70 | 37.55 | 6.55 | 3.60 | 6.77 | 5.97 |
| **Maximum** | 134.20 | 133.73 | 69.77 | 33.78 | 128.23 | 58.45 | 14.72 | 13.68 | 21.40 | 21.43 |
| **Minority** | **Average** | **144.14** | **55.02** | **50.86** | **33.24** | **106.51** | **45.70** | **18.49** | **15.96** | **16.75** | **17.13** |
| **St. Dev.** | 38.32 | 21.46 | 15.11 | 12.53 | 47.37 | 10.80 | 10.30 | 9.20 | 11.43 | 12.19 |
| **Minimum** | 105.98 | 19.00 | 19.00 | 12.30 | 35.42 | 18.90 | 2.65 | 2.40 | 1.67 | 1.77 |
| **Maximum** | 240.60 | 105.37 | 77.77 | 54.27 | 188.53 | 63.27 | 43.05 | 41.25 | 42.28 | 49.07 |
| **Any Overlap** | **Average** | **138.82** | **59.62** | **52.12** | **31.93** | **103.60** | **46.23** | **17.09** | **14.77** | **16.03** | **16.13** |
| **St. Dev.** | 36.05 | 27.47 | 14.32 | 11.87 | 45.35 | 10.20 | 9.98 | 8.89 | 10.73 | 11.53 |
| **Minimum** | 104.12 | 19.00 | 19.00 | 12.30 | 35.42 | 18.90 | 2.65 | 2.40 | 1.67 | 1.77 |
| **Maximum** | 240.60 | 133.73 | 77.77 | 54.27 | 188.53 | 63.27 | 43.05 | 41.25 | 42.28 | 49.07 |
| **No Overlap** | **Average** | **129.75** | **59.82** | **46.09** | **26.85** | **108.69** | **36.72** | **18.76** | **17.11** | **17.46** | **15.57** |
| **St. Dev.** | 31.76 | 38.57 | 25.68 | 12.65 | 34.12 | 20.44 | 12.31 | 13.85 | 13.87 | 12.55 |
| **Minimum** | 95.67 | 3.00 | 3.00 | 7.45 | 50.87 | 10.35 | 4.32 | 1.68 | 2.22 | 0.77 |
| **Maximum** | 203.00 | 148.70 | 115.98 | 53.97 | 187.65 | 111.38 | 57.13 | 57.50 | 54.92 | 50.63 |

Travel time variance in Pilar falls between those for Quilmes and La Matanza, an interesting finding given that Pilar in not one of the departments traditionally considered part of Greater Buenos Aires. It is primarily suburban with large areas still dedicated to agriculture. The ranges for the travel times to the CBD’s, public hospitals, and railway stations were not nearly as large as those for La Matanza: nearly all trips to destinations within Pilar were under two hours. Like the other two study areas, trips to schools and diagnostic/treatment centers were relatively invariant and short, with few trips taking more than an hour. The biggest difference between Pilar and the other study sites, however, was the distribution of travel times to the urgent care centers; values are all greater than forty-five minutes, with some past three hours—hardly useful for urgent care! Nevertheless, few of the destinations display highly-skewed distributions and there are very few outliers.

Observing the history of Pilar, however, makes these initial results somewhat surprising. Pilar is perhaps the most distinctive of the three case studies, especially from an urban-geographic perspective. Frequently cited as the epitome of socio-economic spatial inequality in Buenos Aires, Pilar is home to both ends of the region’s socioeconomic spectrum: wealthy gated communities and lower-class settlements. After the upgrade of its highway during the 1990s, Pilar saw a boom in the construction of gated communities. Built on formerly agricultural land, upper- and middle-income *porteños* moved into these North American suburb-style developments when immense growth came to a municipality that had previously been nothing more than a few small towns around railway stations at the far-end of one of Buenos Aires’ commuter railway lines.

As more suburbs have been constructed, other types of low-density development have followed: industrial plants, office parks, shopping centers, and private universities are but a few examples. While the old urban centers remained in place—clustered along the rail lines—major developments crowded along the highways, where commuters would **stop** along their way to and from work in the city. According to Keeling (1996), Pilar experienced 50% growth between 1980 and 1991; it was just 47,000 in 1970 and is now over 200,000 (p. 46; INDEC 2010). While these developments, all private, provide their inhabitants with basic utilities, the communities outside of their walls have seen little benefit, with many lacking clean water, telephone service, and sewerage. A previous table noted how Pilar had the lowest rates of service provision of the three study areas, despite some of the highest rates of car ownership and university education. In fact, several *asentamientos* have appeared nearby to these developments as housing for workers seeking low-skill, low-income employment in the gated communities and other service-sector jobs that have followed families into Buenos Aires’ new suburbs.

In terms of transportation, all the newest developments are automobile-centric, with large distances separating housing units, shopping centers, and employment sites (Blanco 2014). With most of the development taking place along motorway exits, and away from the handful of small towns along Pilar’s railway that mark its historic urban center, even residents of the department’s traditionally most-developed zones face prolonged journeys. Bus and commuter rail services are low-quality and infrequent; Blanco and Apaolaza (2018) noted that automobile licenses are especially uncommon among Pilar residents from the lowest income bracket, suggesting a reliance on these unreliable public transit modes of travel. Walking and biking are not options for many given the prioritization of automobiles on local streets and the great distances separating low-income housing from the entrances and driveways of the dispersed, low-density gated communities (De Duren 2006; Blanco 2014). Photos from some of these developments, as well as other parts of Pilar, are shown below.

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| **Figure 5.5c-I –** Gated community, “Villa del lago” | **Figure 5.5c-ii** – Highway exit commercial center |
| D:\Thesis\Fotos\20170804_104704.jpg | D:\Thesis\Fotos\20170804_101332.jpg |
| **Figure 5.5c-iii –** “Pilar Villages” | **Figure 5.5c-iv** – Strip mall development in Pilar |
| D:\Thesis\Fotos\20170804_102732.jpg | D:\Thesis\Fotos\20170804_104708.jpg |
| **Figure 5.5c-v** – Industrial plant in Pilar, along highway | **Figure 5.5c-vi –** Large private health university, Pilar |
| D:\Thesis\Fotos\20170804_112630.jpg | D:\Thesis\Fotos\20170804_134844.jpg |

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| **Figure 5.5c-vii –** Public bus, Pilar | **Figure 5.5c-viii –** Gated community, “La Delfina” |
| D:\Thesis\Fotos\20170804_133824.jpg | D:\Thesis\Fotos\20170804_135026(0).jpg |
| **Figure 5.5c-ix –** Car along arterial road, Pilar | **Figure 5.5c-x –** Bus top along arterial road, Pilar |
| D:\Thesis\Fotos\20170804_135031.jpg | D:\Thesis\Fotos\20170804_135041.jpg |
| **Figure 5.5c-xi –** Mercedes-Benz dealership in what appears to be a former church, Pilar | **Figure 5.5c-xii –** New commercial development, along highway between CABA and Pilar |
| D:\Thesis\Fotos\20170804_135841.jpg | D:\Thesis\Fotos\20170804_140353.jpg |

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| **Figure 5.5d** |
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The differences in travel times between the different census radios in Pilar are quite interesting and (at least without context) unexpected. Those radios with no-overlap enjoy worse transit-based access for six of the ten destinations (Buenos Aires CBD, UPA’s, diagnostic/treatment centers, and all schools). Radios with majority-overlap have the longest travel times to only two destination categories (departmental CBD and nearest CBD). Conversely, all radio-overlap categories require essentially the same amount of time to access railroad stations and public hospitals. The radios with minority-overlap more closely follow the no-overlap radios, with similar accessibility values in nearly all categories (even if there were only six majority-overlap radios in Pilar). Given the results for Quilmes and La Matanza, these results are initially surprising—how could the *asentados* have *better* access than their neighbors? Considering the department’s socio-economic geography, however, explains these results, as well as those produced by the corresponding difference-of-means tests.

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| **Figure 5.5e** |
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Looking at the test results in **Table 5.5f** below, we see that *none* of the ten ANOVA tests returned very highly or highly significant (99%, 95%) F-statistics; only one, public hospitals, returned a value of moderate-significance (90%). This contrasts with the other study areas, as well as AGBA overall, which all showed differences between the majority-, minority-, and no-overlap samples in their respective territories.

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| Table 5.5f | | | | | | | | | | | |
| Samples of Comparison | Statistic | Buenos Aires CBD | Departmental CBD | Nearest CBD | Railroad Station | UPA | Hospital | Diag./Treat. | Kindergarten | Primary School | Secondary School |
| ANOVA | | | | | | | | | | | |
| Majority, Minority, None | F-statistic | 2.075 | 1.248 | 0.882 | 2.146 | 0.434 | 2.715 | 1.632 | 1.327 | 0.642 | 0.419 |
| p(F) | 0.135 | 0.295 | 0.419 | 0.126 | 0.650 | 0.074 | 0.203 | 0.272 | 0.529 | 0.659 |
| T-Tests | | | | | | | | | | | |
| Any vs. None | t-statistic | 1.034 | -0.024 | 1.142 | 1.631 | -0.491 | 2.318 | -0.622 | -0.489 | 0.200 | -0.855 |
| p(t) | 0.306 | 0.981 | 0.259 | 0.108 | 0.626 | 0.025 | 0.536 | 0.626 | 0.842 | 0.396 |
| Mean diff. | 9.068 | -0.208 | 6.031 | 5.079 | -5.086 | 9.508 | -1.660 | -1.429 | 0.569 | -2.345 |
| St. Err. (diff.) | 8.772 | 8.505 | 5.280 | 3.115 | 10.361 | 4.102 | 2.671 | 2.922 | 2.840 | 2.743 |
| Majority vs. Minority/  None | t-statistic | -2.911 | 1.493 | 1.023 | -1.142 | -0.919 | 1.073 | -1.817 | -0.892 | -1.008 | -1.588 |
| p(t) | 0.008 | 0.141 | 0.310 | 0.280 | 0.362 | 0.287 | 0.074 | 0.375 | 0.317 | 0.117 |
| Mean diff. | -18.594 | 21.091 | 9.155 | -3.576 | -15.781 | 7.698 | -8.487 | -4.696 | -5.142 | -7.783 |
| St. Err. (diff.) | 6.388 | 14.124 | 8.949 | 3.132 | 17.179 | 7.173 | 4.671 | 5.265 | 5.102 | 4.901 |
| Majority vs. Minority | t-statistic | -2.991 | 1.341 | 1.001 | -1.950 | -0.698 | 0.582 | -1.942 | -1.416 | -1.859 | -3.276 |
| p(t) | 0.006 | 0.231 | 0.325 | 0.070 | 0.491 | 0.565 | 0.060 | 0.176 | 0.082 | 0.003 |
| Mean diff. | -26.586 | 23.751 | 6.514 | -7.000 | -14.576 | 2.727 | -8.344 | -4.308 | -5.997 | -7.154 |
| St. Err. (diff.) | 8.888 | 17.707 | 6.508 | 3.589 | 20.883 | 4.688 | 4.296 | 3.042 | 3.227 | 2.184 |
| Minority vs. None | t-statistic | 1.509 | -0.590 | 0.820 | 1.894 | -0.189 | 1.983 | -0.094 | -0.224 | 0.512 | -0.390 |
| p(t) | 0.137 | 0.558 | 0.416 | 0.064 | 0.851 | 0.052 | 0.925 | 0.823 | 0.610 | 0.698 |
| Mean diff. | 14.386 | -4.805 | 4.770 | 6.392 | -2.170 | 8.980 | -0.270 | -0.711 | 1.568 | -1.153 |
| St. Err. (diff.) | 9.534 | 8.150 | 5.814 | 3.375 | 11.501 | 4.529 | 2.858 | 3.169 | 3.062 | 2.959 |
| Majority vs. None | t-statistic | -1.701 | 1.087 | 1.052 | -0.174 | -1.081 | 1.372 | -1.686 | -0.868 | -0.843 | -3.079 |
| p(t) | 0.101 | 0.285 | 0.300 | 0.864 | 0.287 | 0.179 | 0.100 | 0.391 | 0.404 | 0.004 |
| Mean diff. | -12.201 | 18.946 | 11.284 | -0.608 | -16.746 | 11.707 | -8.614 | -5.019 | -4.429 | -8.307 |
| St. Err. (diff.) | 7.173 | 17.436 | 10.726 | 3.490 | 15.486 | 8.534 | 5.110 | 5.782 | 5.251 | 2.698 |

The independent-sample t-tests add little evidence to support the overarching hypothesis that there are inequalities in transit-facilitated access in the study areas. In fact, only four tests returned highly significant values, half of which were between majority- and minority-overlap radios. The fact that majority-overlap radios were on one side of some of the more significant test adds some credence to possibility inequalities in access to Buenos Aires’ CBD and public secondary schools, although neither destination’s travel times returned a significant F-statistic. A similarly lukewarm conclusion can be drawn for access to public hospitals, which only display moderately- and highly-significant differences vis-à-vis its minority-overlap radios, which are less likely to fully represent *asentados* as their majority-overlap counterparts. EXPLAIN WHY THESE RESULTS ARE INDICATIVE?

These results—when only considered alongside the results from Quilmes and La Matanza—are somewhat surprising. However, Pilar’s socio-territorial configuration provides significant context. For one, the sample of no-overlap radios includes many that are spatially distant from Pilar’s main corridors of development, whether the older, railroad-centric town centers or the new highway-centric industrial/commercial centers. As a result, they naturally have longer travel times than even the *asentamientos*, which are (relatively) more centrally-located. Furthermore, these peripheral locations are typically occupied by either farms or, as is increasingly common, gated communities, neither of which requires transit services. In fact, the latter are intensively automobile-centric and rarely have transit access (Blanco 2014). In fact, null values were returned for transit-based travel times from many of those radios along the edge, suggesting that the average travel times for Pilar’s “no overlap” radios may, in fact, be an *under-*estimation. NUMBER OF NULLS? WHERE THEY WERE FOR? MEANS CALC?

While it would be easy to suggest that it is unimportant that transit access is poor in these areas, since their residents have cars to cover these distances (let alone the fact that families in gated suburbs are not likely to be attending public schools or healthcare sites in the first place), it is important to remember that these gated communities are still employment destinations for many, especially people from Pilar’s *asentamientos* (De Duren 2006). While this project only simulates trips that originate from people’s homes, it still has implications for trips in the other direction, especially in these unique cases where home sites double as sites of employment. The fact that transit does not service these neighborhoods in a time-efficient manner tells us that arriving at work would be a struggle for those without a car.

This is a clear example of Blanco and Apaolaza’s (2018) argument that accessibility is just as much about territory as it is about socio-economics: the same transportation system that advantages Pilar’s drivers disadvantages it carless. It also invokes Handy and Neimeier’s plea to carefully consider the measure of travel impedance and destination types; while these transit-access time estimates could be compared with driving times to those destinations preferred by gated community residents, it would be meaningless for *asentados*. All the while, these travel times would, at a minimum, provide context to the transit-based access scores here. It would reflect the real disparity in accessibility that exists between Pilar’s disparate communities. That an *asentado* can arrive in Buenos Aires’ CBD twelve-minutes faster than the resident of a non-overlapping radio means little when the latter group can make the same trip in his or her car.

While the statistics seem to show that there is relative parity in transit-facilitated accessibility patterns in Pilar, inequalities are nonetheless very much present. Careful consideration must be given to the travel modes and activity sites that pertain to different social groups and how accessibility looks vastly different depending on the context. While Pilar is a glaring example of disparities in mobility, and therefore accessibility, that exist within AGBA, these problems surely take other forms in Quilmes, La Matanza, CABA, and every other part of the agglomeration.

# Chapter 8: Conclusions

# Chapter 9: Bibliography

# Appendix A:

1. <https://sustainabledevelopment.un.org/sdgs> [↑](#footnote-ref-1)
2. <http://www.techo.org/paises/us/> [↑](#footnote-ref-2)
3. <https://developers.google.com/maps/documentation/distance-matrix/intro> [↑](#footnote-ref-3)
4. <https://cran.r-project.org/web/packages/gmapsdistance/gmapsdistance.pdf> [↑](#footnote-ref-4)
5. <https://github.com/rodazuero/gmapsdistance> [↑](#footnote-ref-5)
6. <http://relevamiento.techo.org.ar/> [↑](#footnote-ref-6)
7. Data include: housing density, land ownership types, roof quality/material, possession of a bathroom, flushing toilets, sewerage, cooking heat type, floor quality/type, clean water availability, computer ownership, freezer ownership, landline ownership, cell phone ownership, literacy, age, employment, education level, age cohorts, gender, national origin, quality of services, construction quality, housing material quality, housing occupation, and housing type (INDEC 2011). [↑](#footnote-ref-7)
8. <http://sedac.ciesin.columbia.edu/data/collection/gpw-v3> [↑](#footnote-ref-8)
9. <http://sig.planificacion.gob.ar/layers/ultimas> [↑](#footnote-ref-9)
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16. <http://sig.planificacion.gob.ar/layers/detalle_capa/daniela_centros_con_internacion_gral/> [↑](#footnote-ref-16)
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