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Banks on a Plane: Disparities in Financial Access and Critiques of Geospatial Accessibility

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by

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ABSTRACT

Banking and credit are necessary to build wealth, but they are unequally available across space, race, and class. Research on the spatial distribution of financial services indicates a robust pattern of banks retreating from low-income and predominantly minority communities to be replaced by alternative financial services (AFS); however, the methods used to measure and visualize the availability of services create different spatial imaginaries of financial exclusion that alter understandings of urban inequality. This project examines disparities in access to financial services in Atlanta area using five geospatial accessibility estimates. Locations for bank branches and alternative services are used to calculate Census tract-level access to each service category and then visualized to identify areas with poor financial access - areas underserved by traditional banks or overserved by alternatives. More complex spatial estimations provide smoother visualizations and more significant statistics, yet the simplest metric emphasizes the stark, disjointed nature of structural inequality.

INDEX WORDS: Critical GIS, Financial exclusion, Urban geography, Racial capitalism

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

AFS: Alternative Financial Services

FDIC: Federal Deposit Insurance Corporation

GIS: Geographic Information Systems

GIScience: Geographic Information Science

OLS: Ordinary Least Squares (in relation to regression analysis)

1 INTRODUCTION

Money is the key to economic opportunity. Whether called currency, cash, dough, or financial capital, money enables people to buy necessities and comforts in the marketplace. In economic terms, it is the medium through which one's labor is converted into the material goods one needs to live and enjoy life, and in our capitalist society, having ample sources of it has become a necessity for survival. As the U.S. Census reveals, income, the rate at which people earn money, and wealth, people's accumulated collection of money, are not distributed equally throughout society. Racialized, gendered, and class-based income and wealth concentrate money in the highest levels of society. In 2021, the top 10% of the US population earned thirteen times more than the bottom 10% (Semega & Kollar, 2022), while women earned an average of 18% less than that of men in 2022 (Aragão, 2023). Most starkly, the average Black and Latinx household has roughly half the income of the average white household and about twenty percent of the wealth (Aladangady & Forde, 2021).

Atlanta is one of the ten largest metropolitan areas in the United States, and it has a rich history of Black-owned business and wealth creation (Hobson, 2017; Kruse, 2005). However, that history has not prevented Atlanta from becoming economically inequal in the 21st century (Keating, 2001). In contrast, today, the city of Atlanta has the country's most prominent racial income gap (Berube, 2018). At the same time, housing in Atlanta's Black communities has gained value at slower rates than in white communities (Markley et al., 2020). Nationally, similar racialized disparities in housing markets will extend the wealth gap for generations (Burd-Sharps & Rasch, 2015). These recent patterns continue decades of racialized exclusion from financial institutions in the 20th century. Infamously, Black homeowners were excluded from the federally subsidized mortgage programs in the mid-20th century, in practice dubbed red-lining, which created wealth for a generation of white middle-class families (Jackson, 1987). Subsequent expansion of mortgage programs to Black homeowners in the 1970s and 80s became an act of "predatory inclusion" where banks locked Black homeowners into disproportionately risky and costly deals (Taylor, 2019), leading to the kind of subprime lending that precipitated the foreclosure crisis and concentrated its worse effects among minority families and neighborhoods.

The modern, post-2008 financial marketplace is characterized by a two-tiered system of banks and alternative financial services (AFS). Conventional banks, both national chains and the increasingly rare local institutions, continue to serve as the primary institutions for checking and saving services and the primary originators of mortgages and small-business loans. However, increased fees and requirements on account and lending services have made conventional services expensive for many consumers. AFS, like check-cashers and payday lenders, have become more common since the 1990s as conventional banking services failed to meet the needs of middle and working-class Americans (Servon, 2017), especially Black and Latinx households who are more likely to rely on AFS than white households (Baradaran, 2015). Given its unique history and geographies of race and housing, Atlanta serves as an interesting case study of how trends in financial markets manifest in the physical landscape.

In Atlanta, this project looks for spatial disparities in financial services, specifically for differences between access to banks and alternative financial services (AFS), to expand the understanding of financialization in urban landscapes. A critical GIS and quantitative geography framework are adopted to estimate local access to financial services across the metro while foregrounding limitations of conventional quantitative methods to represent macro-scale processes that shape the financial landscape and the individual positions through which people experience financial exclusion. Through mapping and statistical analysis, this project finds persistent racial and class inequalities in access to financial services. Portions of the metro with higher median incomes and whiter populations have significantly higher concentrations of conventional banks, while areas with lower median incomes and predominantly Black populations have higher concentrations of more predatory AFS. These disparities remain across five different methods of estimating tract-level access to financial services through several visual and statistical analysis methods. Like their contingent geographies of race and wealth, financial services are not spread evenly or equitably across the Atlanta metro.

1.1 Setting the Terms: Defining Banks and Alternative Services

For this project, “financial services” refers to formal, private institutions that sell financial resources to consumers. These services are divided into two broad categories: traditional banking services and alternative financial services (AFS). Traditional banking services are privately owned institutions that offer checking and savings accounts, as well as loan and mortgage services. The US government regulates the operations and products of conventional banks, and the Federal Deposit Insurance Corporation (FDIC) insures deposits up to $250,000. Banks’ loan services are relatively well-regulated to ensure that loans have equitable and consistent interest rates, but accessing bank services requires a strong credit history and stable income in the formal economy. Those restrictions systematically exclude consumers with informal employment and shaky credit histories. Additionally, traditional services have lengthy application and approval processes that prohibit their use as sources of emergency credit. These limitations create a hole in financial markets that are then filled by AFS.

Alternative financial services include a range of businesses that offer types of credit consumers cannot obtain from banks. The credit extended by these services tends to be more expensive and smaller than loans from banks, but AFS generally have looser lending requirements, if any. The more prominent AFS are check cashers, pawnshops, title loans, and payday lenders. Check-cashing offices directly substitute the checking services offered by banks but charge a fee for converting a check where the bank does not. Pawnshops and title loans extend credit based on the value of the items or vehicles offered as collateral. If the borrower fails to repay the loans on time, the lenders take possession of the collateral. While this transaction might appear to be a more accessible form of collateralized credit, title loan providers profit most from extended payback programs that some companies structure to extend indefinitely (Coker, 2023).

Payday lenders offer small, short-term loans against a borrower's next paycheck. Often, a borrower only needs an ID and proof of work to receive a loan. In principle, these loans help consumers pay for unexpected expenses that arise between pay cycles; however, they can lock borrowers into a cycle of fees and further loans. Payday borrowers increasingly use the loans to pay for necessities they could not otherwise afford (Charron-Chenier, 2018), and lenders are often the only option open to their borrowers (Charron-Chenier, 2020). This combination of necessary purchases, limited credit availability, and debt cycles leads many scholars and consumer advocates to view payday lenders and other AFSs as predatory services that take advantage of financially marginalized groups. Notably, Georgia made payday lending illegal in 2010 (*Payday Lending*, n.d.), but other AFS, especially title lenders, continue to operate and offer expensive credit to economically marginalized areas.

1.2 Payment Schedule: Preview of Chapters

This thesis unfolds in five sections. First, a literature review introduces relevant literature on financial exclusion and geospatial accessibility. The literature review in Chapter 2 also provides a primer to the core concepts of critical GIS and quantitative geography research, which serve as the guiding templates for my methodology and critiques thereof. The above research questions are formally stated and operationalized following the literature review. A discussion of my data and methodologies in Chapter 3 sets the stage for the empirical analysis. This section details what data I use and where it came from, and it explains the rational and computations behind the metrics I use to calculate spatial accessibility to financial services. Together, the literature review and methodology sections provide the theoretical and substantive context for the following two analysis chapters.

Chapters 3 and 4 contain this project's core empirical analysis. Chapter 3 visually analyzes disparities in financial services as seen through visualizations of tract-level spatial accessibility. The results of each accessibility estimation are individually inspected for how their spatial clustering connects to Atlanta's race and income geographies. The five accessibility estimates are compared to see how the conceptions of spatial access evolve as the estimating methodologies become more theoretically complex. Chapter 4 expands the visual analysis of financial access with a series of statistical summaries and models. Summary statistics evaluate the aspatial distributions of access estimates and socioeconomic variables, and basic spatial statistics evaluate the tendency of banks and AFS to cluster. Aspatial and spatial regressions statistically evaluate the connection between financial access, race, and income. Throughout the empirical analysis, critiques of the methodologies and their results evaluate the ability of the mapping and statistical methods to effectively represent the core theoretical connection between race, class, and financial access in a capitalist system. This project's empirics are consistently and intentionally situated within their theoretical and practical limitations.

The conclusion summarizes the empirical results of the previous chapters. The dual threads of visual and statistical analysis are woven together to summarize the evidence for a bifurcated and racialized pattern of financial exclusion in Atlanta. Similarly, the conclusion also pulls together the critiques of geospatial accessibility present throughout the analysis. Those critiques are then expanded into an evaluation of how conventional statistics fit into a critically minded quantification of spatial accessibility. Finally, this thesis closes with a discussion of potential expansions for studying financial accessibility in Atlanta.

2 HITTING THE BOOKS: LITERATURE REVIEW

Mapping access to financial services provides a unique opportunity to view the material manifestations of usually abstract economic forces. In order to contextualize this research, this chapter reviews four overlapping sets of literature that have shaped the questions, methods, and interpretive approach to this project. First, the discipline of financial geography explores how financial markets vary across space and how they act to shape our social and built environments. While placing financial trends and actors helps to understand the landscapes of capitalism, the second literature on “financial exclusion” addresses the material inequalities created by class and racialized biases in financial access and availability. Third, quantitative “accessibility” studies operationalize GIS and statistical analysis to identify variations in the spatial prevalence of financial services. However, most contemporary accessibility studies rely on absolute notions of space and positivist epistemologies that limit their connections to critical social theory and broader human geography research agendas. Fourth and finally, the growing tradition of critical GIS and quantitative geography provides a framework to augment conventional GIS methodologies, like access estimations, with geographic theory for progressive, socially relevant research. The following literature research explores each of these areas in turn to provide a background for this project’s exploration of financial exclusion in Atlanta.

2.1 Financial Geography

Financial geography is a subfield of human geography that focuses on the role of financial institutions, like banks, and trends, like recessions, play in the creation and maintenance of spatial formations. Within geography, it lies within the broader realms of economic and urban geography, particularly concerning the accumulation of capital and the formation of urban spaces. While a cohesive financial geography literature did not appear until the 1990s (Aalbers, 2015), finance has long been recognized as core to economic and urban geographies. For instance, British geographers in the 1970s studied the role of building societies, financial institutions similar to credit unions, in forming and maintaining neighborhood identity (Boddy, 1976; Williams, 1976). Financial geography work into the 1990s continued to primarily focus on the UK or comparison of the impact of financial institutions between the US and UK (Aalbers, 2015). During this period, geographers began to note the impact of new technological and organizational practices on the structure and geography of financial markets (Leyshon & Pollard, 2000; Martin & Turner, 2000). Work centered in the Anglophone has expanded to include the dynamics of mortgages and finance on housing (Aalbers, 2019; Gotham, 2012; Leyshon et al., 2008; Wyly et al., 2009) and the international flow of capital through tax evasion (Aalbers, 2018; Genschel & Schwarz, 2011; Griffith et al., 2010).

While the UK and US financial markets were the initial focus of financial geography, scholars quickly began studying financial markets in different locations and cultures. Sidaway and Pryke (2000) investigate capital investment into ‘emerging’ markets, a major economic trend in the ‘80s and ‘90s, which characterize investment into the Global South as a continuation of colonial power through financial control. Similarly, Pollard and Samers (2007) explore Islamic banking practices and firms as an alternative institution to Western banking and as an opportunity to evaluate critically economic assumptions built in the Western context. They argue in later papers that spaces of interaction between Islamic banking and conventional Western banking create complex “cosmopolitan legalities” that blend neoliberal ideologies with Southern ethics (Pollard & Samers, 2013).

Continuing the theme of recentering financial geographies, scholars have more recently called for adopting critical frameworks developed in other geographic subdisciplines to evaluate the intersectional dynamics of finance systems (Pike et al., 2016). The prompts include studying geographies and times away from recent economic crises (Christophers, 2014) and including feminist theories about economic development (Pollard & Samers, 2013). These recent developments have shown that financial geography is defined by a shared focus on financial markets and their impacts on individuals and communities rather than a unifying epistemology or methodology. As a result, it can borrow from other geographic and social science disciplines to better understand the contingent relationship among communities, urban environments, and financial markets.

This project addresses that contingency through a focus on the “financialization” of contemporary capitalist economies. The financialization literature provides the most relevant discourse on how financial trends impact local economic geographies. On the highest level, financialization refers to the increased prominence of financial markets in capitalist economies (Sawyer, 2013); stock price and shareholder return have become the guiding principles of modern corporate organizations (Davis & Kim, 2015). Put simply, the going-ons of Wall Street have become more important to the social organization on Main Street.

In a human geography context, financialization increases the need for individual households to interact with the financial sector. The newfound dominance of financial logic in neoliberal capitalism has turned households from passive into engaged actors in the financial sector (Hall, 2012). For example, the shift away from collective financial management in pension funds to private retirement savings has forced individual households to engage with the rules and fluctuations of the stock market (Langley, 2006). The financialization of everyday life has changed the relationship between individual subjectivities, place, and the economy. Consumers now have to engage with risk insurance mechanisms to secure their economic well-being (French

& Kneale, 2009), fundamentally shifting the dynamics between place and political economy (Pike & Pollard, 2010). This increased personal responsibility makes access to banking and other financial services an increasingly critical component in economic equity. However, individual agency in the financial system remains constrained by the material geographies of the urban environment. The location of financial services and the ability of individuals to access them is geographically uneven, excluding some people and places from participating in the increasingly financialized economy.

2.2 Financial Exclusion

Financial exclusion refers to "those processes that prevent poor and disadvantaged social groups from gaining access to the financial system" (Leyshon & Thrift, 1995, p. 312), and it provides a conceptual framework for materializing abstract patterns and relations in financial markets. The global flows of financial capital and financialization are macro-level phenomena determined by factors in the abstracted spaces of policy and boardrooms and on the trading floor of stock exchanges. These trends are experienced "on the street" through the physical location of financial service providers and the social dynamics within and around those services. Research on the dimensions and extent of financial exclusions connects abstract financial trends to specific places, times, and people.

Access to various financial services empowers consumers to make informed decisions about their financial health. Unfortunately, access to financial services has historically differed across class, race, and gender. Exclusion from financial services has been and continues to be a core dimension of economic and social marginalization. Perhaps most infamously in the US, New Deal federal mortgage programs, administered through banks, systematically excluded minority neighborhoods through "redlining" while incentivizing white homeownership in suburban communities (Jackson, 1987; Rothstein, 2017). Black households continue to have lower levels of credit and debt than white households of the same socio-economic class, suggesting racialized differences in engagement with financial services (Charron-Chenier & Seamster, 2021). Financial services like mortgages, which practically enable middle-class homeownership, and investment services are key pillars in modern wealth generation. Exclusion from those services has contributed to contemporary racialized wealth gaps, and continued exclusion hinders efforts to reduce that gap and create more equitable futures.

While this project generally approaches financial inclusion as the better alternative to systemic exclusion, financial institutions in the United States operate on a for-profit basis and are not equally extractive to all populations. For instance, banks extended federal-subsidized housing loans to Black homeowners in the 1970s and 80s after decades of exclusions from programs that fueled white suburbanization. However, those loans were offered with more severe terms and higher interest rates than offers to white consumers, a practice dubbed “predatory inclusion” (Taylor, 2019). So long as financial institutions exist within a capitalist system, they will profit off the services they offer consumers. Furthermore, the intrinsic link between capitalism and institutional racism (Bledsoe & Wright, 2019) means that equal exposure or accessibility to capitalist finance will not erase racialized economic inequality. As such, this project explores financial exclusion as a geographic, spatial consequence of unequal urban environments and economic opportunities created by racial capitalism. Financial exclusion is a symptom of a larger disease. It needs to be identified and treated, but doing so will not cure the underlying problem.

Much of the financial research in the last two decades has responded to bank branch closures in post-industrial cities at the turn of the century. The collapse of the industrial middle class in many cities, the absorption of local banks into national institutions, and the rise of online banking services allowed commercial banking institutions to close branch locations without diminishing their market share. These closures were more likely to occur in marginalized communities (Brennan et al., 2011; Leyshon et al., 2008). In post-industrial cities across the country, banks are less common in low-income and predominantly Black and Latinx communities than in more affluent, whiter areas (Hegerty, 2016, 2020). Communities without bank branches have higher interest rate spreads between borrowers and fewer mortgage originations (Ergungor, 2010). Branch closures in marginalized neighborhoods also reduce the number of small business loans extended to the community (Nguyen, 2019). Bank closures, therefore, reinforce the uneven development of urban landscapes and highlight the need to look for disparities in the broader landscapes of financial exclusion.

In tandem with wide-scale bank closures, alternative financial services (AFS) have become more geographically prevalent and widely used in the last three decades. Though this is not to say that alternatives to conventional banking have not been available for centuries; indeed, pawnshops in Britain's North American colonies predate US independence by several decades (Caskey, 1994, p. 16). The recent scholarly attention to AFS focuses on more modern institutions like check cashers, payday lenders, and car title lenders. These institutions offer similar services to conventional banking, but they charge significantly higher fees and interest rates, leading some scholars and financial activists to consider them predatory institutions that target economically marginalized communities. AFS are more common in the country's most racially segregated cities (Faber, 2019), and check cashers opened more frequently in NYC neighborhoods hit hardest by the 2008 recession (Faber, 2018). Households living in areas with more AFS than banks are less likely to have savings accounts, which indicates the building of intergenerational wealth (Friedline et al., 2019). AFS could be seen as a modern form of predatory inclusion as they are more likely to be used by Black households than white ones (Charron-Chenier, 2020), primarily to pay for everyday necessities rather than longer-term investments (Charron-Chenier, 2018). Regardless of the potentially harmful nature of AFS, their increased prevalence has changed the landscape of financial services and the dimensions from which financial exclusion can be viewed.

Contemporary studies of financial access have analyzed the relative mix of conventional banks and AFS to determine a community's integration into the financial sector. In this research, communities saturated with conventional banks and low numbers of AFS are considered more integrated into the financial system than areas with few banks or many AFS. While some scholars are interested in finding "banking deserts" (Hegerty, 2016, 2020), many more are concerned with understanding the "spatial void" pattern (Smith et al., 2008) of communities with few or no conventional banks but numerous AFS. This dichotomous pattern has been found in many North American cities and is often common in minority and low-income communities. In Winnipeg, Canada, bank closures and AFS openings from 1990 to the mid-2000s were concentrated in poor urban communities (Brennan et al., 2011). Similarly, payday lenders in turn-of-the-century Chicago were concentrated in minority communities with few bank branches (Graves, 2003). This tendency of AFS to cluster in predominantly Black and Latinx communities is robust across the rural-urban divide, being repeated in Mississippi (Wheatley, 2010), southeastern Pennsylvania (Dunham, 2019), and North Carolina (Burkey & Simkins, 2004). Nationally, the concentration of AFS is also related to local levels of education and average credit scores in addition to racial composition (Prager, 2014). While some county-level studies call into question the spatial substitutability of banks and AFS (Fowler et al., 2014), the relative mix of financial services is robustly related to local demographics. The racial composition of neighborhoods, often measured at the scale of Census tracts, seems to determine the types of financial services within it, even when controlling for factors of commercial density and income (Cover et al., 2011).

Studying the spatial extent and intensity of financial exclusion rests on the ability to effectively estimate the local availability of banks and alternative financial services. The methodological decisions about scale and measurements impact the magnitude of results and the relative importance of explanatory variables in quantitative research. Differences in underlying methodological outlook account for much of the contradictory conversation within financial exclusion literature. Although most research finds evidence of racialized disparities in financial services, conversations about the relative importance of those racial differences relative to other demographic and built-environmental factors abound (Burkey & Simkins, 2004; Dunham, 2019; Graves, 2003; Hegerty, 2016; Prager, 2014; Wheatley, 2010). Understanding how financial exclusion is measured quantitatively and spatially facilitates this project's critical exploration in viewing financial exclusion.

2.3 Accessibility

The local presence of financial exclusion is most commonly measured by estimating the spatial accessibility of financial services. Access broadly refers to the ability to use services when and where they are needed (Aday & Andersen, 1981), and it is a concept inherently rooted in questions of equity and justice. The concept can be further broken into five material and experiential components: availability, accessibility, accommodation, affordability, and acceptability (Penchansky & Thomas, 1981). Viewing accessibility along these five dimensions highlights how both social and material conditions impact the ability of individuals to use services. The cultural expectations and acceptability of utilizing services matter just as much, if not more than, the physical proximity of services. For instance, spatial proximity to banks matters little if consumers are systematically excluded from using these services like Black consumers were for much of US history. A holistic understanding of accessibility must grapple with all dimensions of access, but practical analysis requires that methodologies focus on the measurement of individual components of the broader concept of accessibility.

This project takes a quantitative and spatial approach to measuring disparities in the accessibility of financial services. As such, the data and methodology primarily measure the “availability” and “accessibility” dimensions of Penchansky and Thomas’ five-part definition. “Availability” will be used to refer to the spatial proximity of services, while “accessibility” refers to the ability to get to those services. Other cultural, social, and economic positionalities change the ability of individuals to utilize services. However, analyzing those factors is beyond this project's scope except for some discussion of this major ontological limitation. Instead, this project and the remainder of this section are concerned with the spatial estimations and imaginaries created by different quantitative measurements of accessibility.

Quantitative accessibility research was primarily developed by public health researchers hoping to measure differences in the physical “availability” of health services or risk factors. Early accessibility studies grappled with the limited ability to create theoretically complex estimations of spatial access within GIScience frameworks. Simple aggregation methods, like counting the services within a bounded neighborhood, create unreliable estimates of accessibility (Hewko et al., 2002). “Gravity” functions, which account for the decay of relatability over distance, have been proposed and implemented as an improved estimate of potential connectivity between communities and services (Khan, 1992). Spatially-weighted functions model the relationship between “availability” and “accessibility” by acknowledging that the ability to get to service diminishes as the distance to it increases. Similar methodologies have incorporated distance decay functions alongside methods of accounting for competition for services that create even more realistic estimates of spatial access (Dai, 2010; Dai & Wang, 2011; Luo & Wang, 2003; Yang et al., 2006). Despite their limitations and the availability of alternatives, a review of epidemiological studies of spatial accessibility found that simple aggregation and proximity metrics are the most common form of measuring spatial relationships (Auchincloss et al., 2012).

These commonalities hold true within financial exclusion research that quantitatively models the spatial accessibility of financial services. The majority of studies use some form of an aggregated metric of bank or alternative financial service location as a proxy for community access by using GIS software to count the number of services within a bounded area, like a Census tract (Brennan et al., 2011; Burkey & Simkins, 2004; Cover et al., 2011; Faber, 2018; Friedline et al., 2019; Hegerty, 2016, 2020; Nguyen, 2019; Smith et al., 2008; Wheatley, 2010). Other studies bypass the need for GIS by using pre-aggregated datasets provided by the government and, therefore, never engage with the underlying location of services (Faber, 2019; Fowler et al., 2014; Friedline et al., 2019). Several studies attempt to understand more complex spatial relationships like those proposed by early public health researchers. They might apply a function representing the distance decay between service and residential locations (Dunham, 2019; Ergungor, 2010) or create access metrics that account for the competition for financial services (Hegerty, 2020; Langford et al., 2021). This project's use of several methods to estimate local access to the same set of financial services highlights how the choice of spatial estimate alters the perception of financial access and the geographies of exclusion.

Alternative measures of accessibility arise from critiques of the ability of contemporary GIS measures to estimate the complex relationships that form individuals' access. Assigning accessibility scores to places based on their spatial proximity to services prioritizes the characteristics of the place over the experiences of the people living there (Miller, 2007). The accessibility measures cited above and explored in this project focus on a spatial relationship grounded on the proximity between residential centers and services. However, spatial relationships that rely exclusively on absolute distance or travel costs rely on dated understandings of urban dynamics and mobility. With changing social structures and new information technologies, temporal context plays as important a role in mobility in the 21st century as spatial proximity (Kwan & Weber, 2003). The biases created by atemporal estimates significantly impact measuring the access of schedule-constrained individuals, like women (Kwan, 1999) and parents (Schwanen & de Jong, 2008). Incorporating ethnographic and participant research alongside GIS modeling can create a more "people-based" GIScience (Miller, 2007, p. 503) that incorporates a unified spatiotemporal understanding of access (Kwan, 2013). While this project does not directly incorporate temporal components, these critiques create a call to critically engage with the ontological and epistemological implications of conventional accessibility metrics, which serves as the final touchstone of this project.

2.4 Critical GIS and Quantitative Geography

Mainstream accessibility studies like those described above depend on statistical tests to verify the true nature of spaces created through Census boundaries and GIS. These methods produce meaningful knowledge about differentiated access, but they forgo situating that knowledge within the broader epistemological and political context that these methods and scholars operate within. Critical approaches to GIS research, therefore, help to extend geospatial research on financial exclusion by making this context more visible and calling into question the assumptions that these quantitative approaches make. Critical quantitative geography adds to the methodological rigor of quantitative analysis by introducing the concepts of reflexivity and positionality from feminist scholars (Kwan, 2002; Kwan & Schwanen, 2009) while also rejecting the idea that positivist epistemologies and neoliberal politics are inherent in quantitative and spatial methods (Wyly, 2009, 2011). Quantitative geographers can create meaningful insights that forward radical political goals and have the potential to make meaningful social change.

The critical GIS literature dates back to debates from the 1990s about the software's place in geographic research. Borrowing from Schuurman's (2000) historical summarization of that discourse, critiques of GIS methods and studies focused on the connection between the software and positivist epistemologies. Since GIS relied on quantification, these critiques largely echoed concerns from critical scholars about the role of empirical science in general (Schuurman, 2000, p. 572). However, after a concerted effort to bring together GIS practitioners and critics, new approaches that adapted GIS frameworks with critical social theory emerged, at first labeled "GIS and society" and then "critical GIS" (O'Sullivan, 2006). Critical GIS practitioners and critical quantitative geographers, more generally, recognized that numerical and computational methodologies do not inherently bring along positivist epistemologies or neoliberal politics (Wyly, 2009). Numerical quantification has historically been a key tool for critical social theorists from Karl Marx to the radical geographers of the 1970s and 80s, such as William Bunge (Barnes, 2009). The ability of GIS to render and visualize demographic data and spatial phenomena at large scales provides new vantages from which geographers can theorize (Pavlovskaya, 2006), and politically, numerical analysis is critical in creating progressive change under neoliberal regimes (Plummer & Sheppard, 2001; Schwanen & Kwan, 2009). Contemporary critical GIS scholarship adapts GIScience tools and methodologies to create insightful and progressive social insights.

In addition to these epistemological and political questions, critical GIS presents an opportunity to both critique and expand upon the conceptualization of space in quantitative geospatial research. Contemporary geospatial statistics and GIS rely almost exclusively on using Cartesian coordinate systems to represent space as an undifferentiated plane, but geographic theory has long held that space is actively created and measured through various processes that exceed the x/y coordinate grid (Poorthuis & Zook, 2020). Quantifying spatial phenomena does not necessarily require representation in Cartesian space, and maps can just as well represent alternative conceptualizations of space, such as social connection or demographic similarity. Early quantitative geographers like Bunge and Tobler experimented with visualizations and projections that represented relational spaces (O'Sullivan et al., 2018), and advances in imaging software and coding tools have made new relational GIS tools increasingly viable (Bergmann & O'Sullivan, 2018). New alternative methodologies can emerge from charting the limitations of existing methods (Sheppard, 2001), and focusing on the relational patterns within conventional GIS analysis can facilitate new views of known sociospatial phenomena (Shelton, 2018). Acknowledging the critiques of spatial accessibility metrics can facilitate the creation of quantifications and visualizations that better represent the material realities of these inequalities and peoples' experiences of them.

This project operationalizes a critical GIS framework to analyze spatial disparities in financial service access as a material consequence of racial capitalism while simultaneously acknowledging the limitations of its quantitative GIS methodology. This directly follows Shelton's (2022) call for a "situated mapping" that incorporates the critiques of traditional GIS with the analytical power of mapping to create positive social change. That methodological ethos builds on Wyly's wider call to mobilize a "strategic positivism" (2009) that furthers the research and political goals of critical social theory. This project also specifically foregrounds the role of race and racial capitalism in its analysis of banking disparities by acknowledging that racialized processes shape urban landscapes (Carter, 2009), regardless of the statistical significance assigned to neighborhood racial composition. This project intentionally situates itself within the limitations of its methodology to perform an analysis informed by critical social and urban theory.

3 SETTING THE STAGE: DATA AND METHODOLOGY

3.1 Research Questions

This research seeks to answer a single, two-part research question. First, I ask whether there are inequalities in financial access in Atlanta and, if so, what they are. This question closely follows other geospatial research on financial inclusion, and answering it will provide specific knowledge about the city while adding to the academic understanding of financial access. Second, I systematically compare the results generated from several different estimates of financial access. Estimating financial access in several ways will create a deeper understanding of financial services and develop an illustrative case study of the differing pictures competing methods can create with a shared data source.

3.2 Data

In order to answer this question about financial access, this project combines business location data from ReferenceUSA, a business and residential information database, with publicly available US Census data. ReferenceUSA provided the locations of banks and alternative financial services as both addresses and latitude and longitude coordinates. These locations had to be cleaned and filtered to give an accurate list of services. I also collected local demographics and territorial boundaries from the US Census Bureau. Business locations and neighborhood demographics constitute the entirety of the data collected for this project.

ReferenceUSA is an online, commercial database of reference information on residences and businesses in the United States. I accessed it through Georgia State University's persistent subscription. Pertinent to my research, the service allows users to search for businesses using various geographic and industry filters. I used North American Industry Classification System

(NAICS) codes to identify banks and alternative services within the Atlanta metro[1]. I collected banks and alternative services as two separate datasets, using the NAICS codes in Table 1 to define each group. Once businesses are identified, the database can provide a "basic" report of a business' ownership and address or a "detailed" report with specific information on size and revenue. I downloaded detailed reports because they included businesses' latitude and longitude coordinates, allowing for mapping without geolocating the addresses.

Table 1: NAICS codes by financial service type

Business Type	**NAICS Code**
Banks	
Commercial Banking	52211002
Alternative Financial Services	
Check Casher	52232003
Payday Loans	52229111
Pawnbroker	52229813
Pawn Tickets - Bought	52229815
Automobile Title Loan	52222002
Title loans	52229109

The business information from ReferenceUSA covered the entire study area but contained multiple duplicate listings and misclassified businesses. I cleaned the datasets in Rstudio by ensuring that businesses' primary industry classification fit into the categories within Table 1 and then filtered to unique combinations of business address, name, and ownership. My data processing resulted in two datasets: unique locations for banks and unique locations for alternative services. To validate that ReferenceUSA provided accurate business locations, I

[1] Defined as the ten core counties served by the Atlanta Regional Commission (ARC): Fulton, DeKalb, Gwinnett, Rockdale, Henry, Clayton, Fayette, Douglas, Cobb, and Cherokee counties.

collected a random sample of twenty-five businesses from each set and searched the addresses in Google Maps. All fifty locations matched their description from ReferenceUSA, and I am confident that this process generates accurate sites for financial services.

The remaining data for this project came from the US Census Bureau. All tract-level Census data came from 2015-2019 ACS 5-year estimates; block group populations came from the 2010 decennial census. These years were the most recent version of the data when I began the project, and I plan to continue using it because of systemic issues with the 2020 Census estimates (Rothbaum et al., 2021). In addition to demographic estimates, I use Census block group and tract boundary shapefiles, specifically the 2010 boundaries. Boundaries are updated after every decennial Census, so 2019 tracts contain the same block groups as they did in 2010. I downloaded and processed all Census data through their online API using the R programming language and the 'tidycensus' package.

3.2.1 Spatial Patterns of Financial Services

The ten-county research area includes 738 Census tracts. In addition to the ten core metro counties, I collected business locations and Census information for the twenty-nine surrounding counties to ameliorate the systemic underestimation for the tracts at the edge of the study area. Tract boundaries are not barriers to access, so including services in the surrounding counties better represents the range of options available at the edge of the primary study area[2]. With the inclusion of 332 tracts in the surrounding counties, the dataset includes a total of 1,070 tracts in thirty-nine counties.

[2] Business locations in the perimeter counties are used for spatial accessibility estimates that include services beyond the geographic boundaries of a given Census tract. For those metrics, failing to include services beyond the core study area would result in underestimation of access for tracts at the edge of the study area since residents in those tracts can pull from services outside the artificial study boundaries. The large number of additional counties reflects the wide catchment areas created by the 30-minute travel time accessibility estimates detailed in Sections 4.4 and 4.5.

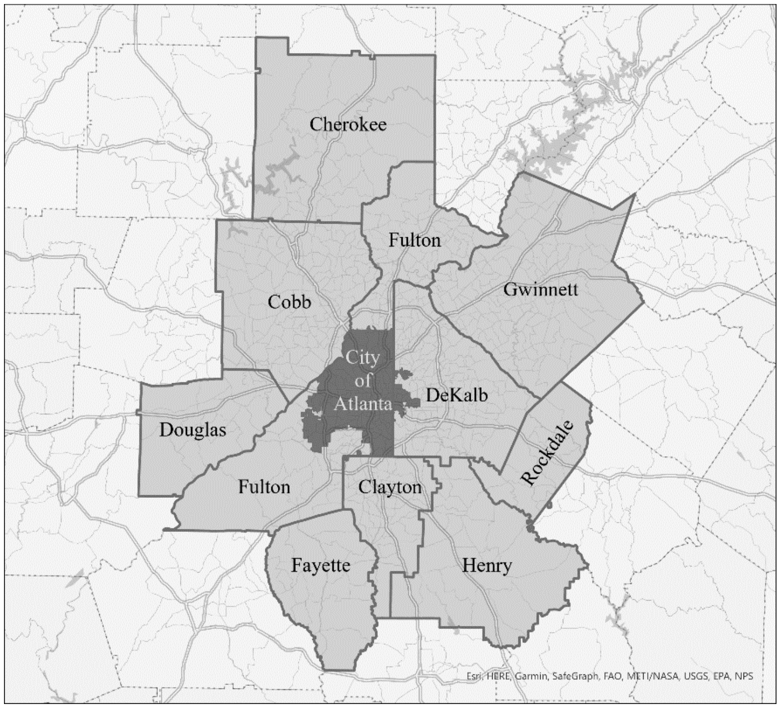

Figure 1: Primary Study Area

Commercial banks are the most prevalent financial services institutions in the Atlanta metro. The core research area contains 972 banks, with 408 locations in the surrounding counties. These locations all offer a range of banking services like account operations, and many of them offer loans or mortgage services. Importantly, this dataset does not capture solitary ATMs operated by traditional banks, which have become a common method for banks to maintain their physical presence in a given neighborhood without maintaining full branches. Mapping bank locations, as seen in Figure 2, reveals noticeable spatial patterns and clusters. Banking services are clearly concentrated in clusters with many points stacked on top of each other or strung out in a line. Those point patterns represent concentrations around business districts or along major roadways. Additionally, bank locations visually appear to be more prevalent in the central and northern portions of the metro. Although analyzing point locations naïvely ignores factors like population density, visual analysis shows that bank services have an uneven spatial distribution.

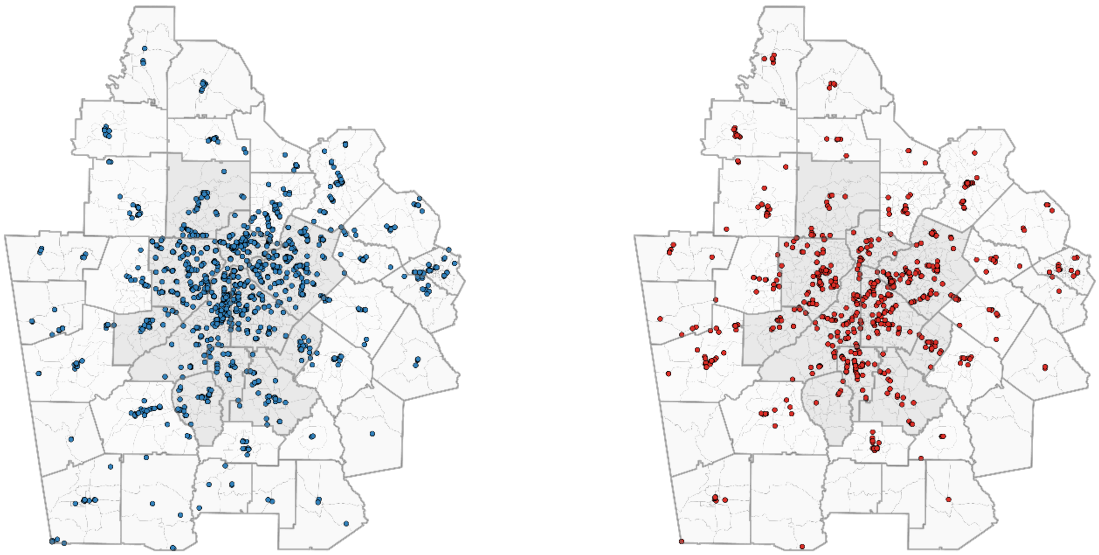

Figure 2: Conventional Bank (Left) and AFS (Right) Locations

Alternative financial services (AFS), which include a wider range of institutions, are significantly less prevalent in the Atlanta metro. Within the core research area, there are 492 alternative services with an additional 272 AFS in the peripheral counties (for a total of 764 in the whole dataset). The map of alternative services, Figure 2, shows that AFS also present significant local clustering, but they have a more even overall distribution throughout the metro. Similarly to banks, AFS visually cluster in lines, which likely represent commercial "strips" along major roadways, and in clumps, which likely indicate more densely developed business districts. The distribution of AFS throughout the metro appears to be more even than banks; AFS do not display the same spatial preference for the northern half of the metro as conventional banks do. Even through a visual analysis of this point pattern data, conventional banks and alternative financial services portray noticeably different spatial organizations.

3.2.1.1 Atlanta's Geographies of Race and Income

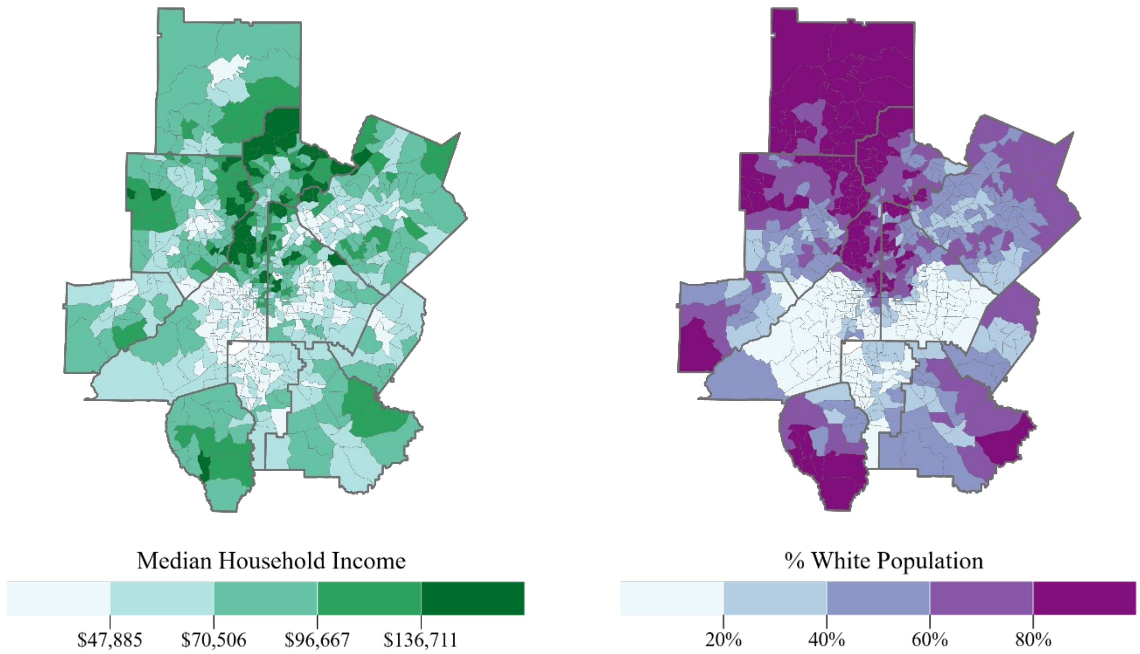

Figure 3: Median Household Income (Left) and White Population Proportion (Right)

Measuring spatial accessibility at the Census tract level allows for a simple comparison between access and various demographics. Because banking has been historically restricted along racial and socio-economic lines, my analysis pays special attention to the connection that financial access has to Atlanta's geographies of race and income. To that end, Figure 3 provides an important reference point for the remainder of this project by visualizing the tract-level median household income on the left and the proportion of white residents on the right.

Taken together, these maps show some important patterns in the metro's spatial organization. The area's highest income tracts are concentrated in a small, predominantly white portion of the northern Fulton and DeKalb counties. That cluster includes the highly affluent neighborhood Buckhead to the north of Downtown and continues north along GA-400 to the wealthy suburbs in north Fulton County. Conversely, predominantly non-white tracts in Clayton

County and southern Fulton and DeKalb counties are also many of the metro's lowest income areas. While Figure 3 (right) visualizes the white population, it should be noted that those predominantly non-white tracts have a predominantly Black population. Atlanta has areas with large Latinx and AAPI populations, particularly in Gwinnett County, but the primary historic and contemporary racial divide exists within a Black-white paradigm. Southern Fulton and DeKalb counties have been predominantly Black areas since Atlanta's racial transitions and white flight in the 1950s and 60s (Kruse, 2005). Clayton County, however, was predominantly white until a recent and rapid demographic transition since the 1980s. The racialized and class-based bifurcation of the Atlanta metro is a defining feature of its spatial organization.

3.3 Methods Overview/Technical Explanation

This project uses and compares five metrics to measure physical accessibility to financial services: (1) the number of services located within a Census tract, (2) the number of services within a buffered tract boundary, (3) the number of services within a distance of the tract's center, (4) the number of services within a travel time of the tract's center, and (5) a two-step floating catchment area technique following Luo and Wang (2003). Each measure utilizes the spatial relationships between business locations and tract geometries to estimate the number of financial services within the communities that tracts represent. These measures vary in conceptual and computational complexity. Counting the number of services within a tract gives the least complex and most intuitive estimate. The second method makes the small adjustment of counting within a buffer around each tract, softening the rigidity of tract boundaries. The third method evolves by counting services within a uniform catchment around each tract's center, which creates more robust yet easily explainable metrics. A fourth method moves toward a more relational form of distance by counting services within a travel-time buffer around the tract centers. Finally, the two-step floating catchment measure adds computational steps and complexities that simulate theoretically rich spatial relationships, and while its resulting estimates have easily communicated units, its methodology requires a lengthy explanation for full transparency. The two-step floating catchment measure provides the most substantive insights, but calculating all three allows me to confirm results across metrics and facilitates a discussion of the relative merits of each as a proxy for material accessibility.

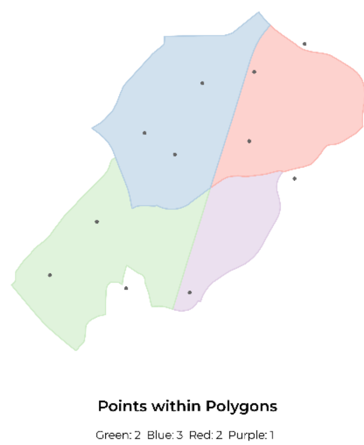

Figure 4: Points within Polygons Illustration

Starting with the most straightforward measure, counting the number of services within a tract boundary provides a rough estimation of residents' physical access to services. It can be implemented using GIS software to count the number of service locations within the bounds of every tract. This method benefits from requiring the simplest calculations, resulting in an easily interpretable metric: the number of services within the tract boundary. I have included this method because of its common use in studies measuring financial exclusion (Brennan et al., 2011; Burkey & Simkins, 2004; Cover et al., 2011; Faber, 2018, 2019; Fowler et al., 2014; Friedline et al., 2019; Graves, 2003; Hegerty, 2020; Nguyen, 2019; Wheatley, 2010). The main drawbacks of the technique come from treating tract boundaries as impermeable barriers. Census tract boundaries group residents into equal size groups of about 4000 (Bureau, n.d.), and their borders present no material restriction on residents' mobility. Treating each tract as an island provides lower access estimates than the other four methods.

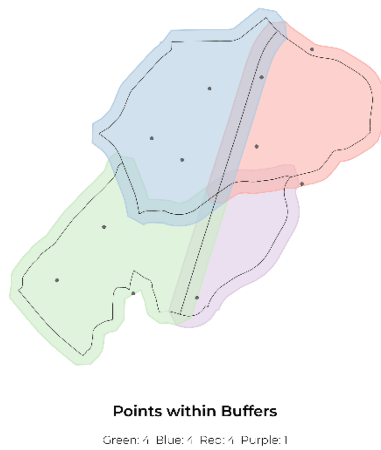

Figure 5: Points within Buffers Illustration

The "counting" metric could address the rigid boundary issue of the prior method by introducing a buffer around each tract. I used a quarter-mile buffer around each tract's borders to "soften" the rigid boundaries created by the previous method. The small buffer captured services next to tract boundaries while not overlapping far into adjacent tracts, except in the densest parts of the study area where the tracts are smallest. This small buffer is additionally effective in this project because major roadways often serve as boundaries between tracts, so the buffer captured many services that were on the line between tracts. By counting services in neighboring tracts, this improvement provides a better assessment of local access to financial services; however, it continues to suffer from the issue that tracts have differing areas because they are designed to contain equal populations. Additionally, populations are not uniformly distributed within Census tracts; actual residents are more likely clustered in particular places throughout a given tract.

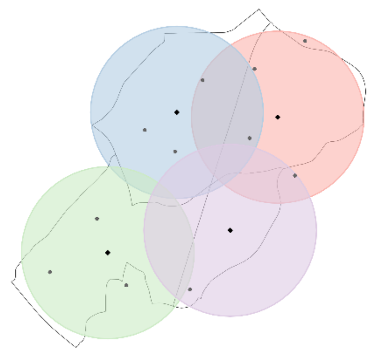

Figure 6: Buffers around Centroids Illustration

Generating the buffers around the population-weighted center of each tract ameliorates both of those concerns. First, a uniform buffer normalizes the area where tracts can pull services. In practice, this reflects that an individual's willingness to travel for banking services is not tied to the size of their Census tract. For this project, I chose a five-mile buffer based on research about consumers' willingness to travel for banking services (Brevoort & Wolken, 2008) and robustness testing of various buffer sizes. Second, the population-weighted centroid uses the population and location of Census block groups, the geography contained within tracts, to calculate a central point that better approximates the center of each tract. This center accounts for the relative density of the population within each tract and significantly shifts the centroid in the study area's larger tracts.

Counting within a buffer around tracts corrects many of the conceptual issues from simply counting within the tract, but it also creates a veil of calculation between the metric and the reader. Measuring accessibility as the number of services within a set distance from the tract or its center requires additional explanation to the reader and causes maps made with the data to become less transparent. The resulting maps display access measures within the cartographic bounds of the tract, so a measurement that goes beyond the boundaries of a tract creates a disconnect between the data and the visualization. Despite these limitations, using buffers around tract boundaries or center points is a standard metric of service access (Dunham, 2019; Ergungor, 2010; Hegerty, 2016, 2020; Smith et al., 2008).

The fourth method replaces the absolute distance used to calculate previous buffers with a travel time buffer around population-weighted centroids. Visually, this would appear similar to Figure 6, except that the buffers around each centroid would have variable sizes and edges based on the connectivity of each tract. From an ontological perspective, using the road network and travel time to approximate the connection between a tract and a service location recognizes the relational spaces that shape the perceived distance between places. Pragmatically, travel time provides a more even estimate of distance moving through the various densities of the Atlanta metro; more ‘connected’ tracts will have physically larger catchments to reflect their increased connection to the road network. While this method better estimates distance, the access measure still fails to account for potential consumer preferences for nearer services over farther ones and for competition for the limited capacity of each service site. Both of those considerations influence the level of service residents receive from financial services.

The two-step floating catchment area (2SFCA) method, outlined by Luo and Wang (2003), corrects many issues from counting around buffers while generating an easily interpreted measure of accessibility: the number of services per 10,000 residents. Floating catchments account for competition between tracts for the same service locations by incorporating the number of tracts served by a financial institution and the number of institutions that serve a tract. The namesake “two steps” come looking at the catchments of service sites in addition to population centers. “Catchment” refers to the distance around every point from which supply and demand are drawn. In this project, the catchments are also weighted so that locations closer to the center have higher weights than those nearer the edge. The final standardized value assigned to each tract denotes the population-normalized number of services available to its residents.

The first floating catchment calculation centers on financial services. This step identifies the population served by each service site by finding Census tract centroids within a set travel time. Within those catchments, I also applied a distance decay function so that populations nearer to service sites are more heavily weighted than farther ones. This weighting scheme is used throughout the 2SFCA method to account for diminished geographic connections over space consistently. After applying the weights, I summed the weighted populations of all centroids around each service site. The resulting value represents the weighted total of residents served by each financial service location and estimates the local demand for each site.

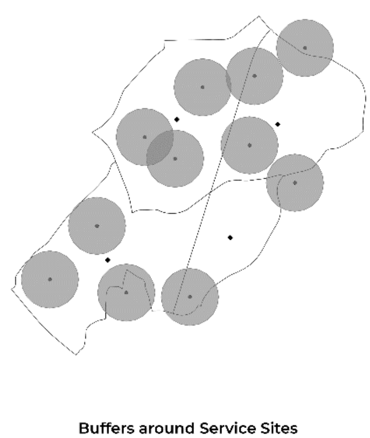

Figure 7: Buffers around Service Sites Illustration

The second calculation shifts focus to the centroids. Mirroring the first calculation, it estimates the supply of services to each tract. This estimation begins by modifying the previously calculated demand for services into the supply provided by each service site. The reciprocal of the first calculation gives the fraction of each service site available to local customers; I multiplied that fraction by 10,000 to make the resulting values more interpretable. The next operation identifies the service sites around each tract centroid and finds the weighted sum of their fractional supplies using the same distance decay weights from the previous step. This final value estimates the supply of financial services available to each Census tract, measured in the number of services per 10,000 residents.

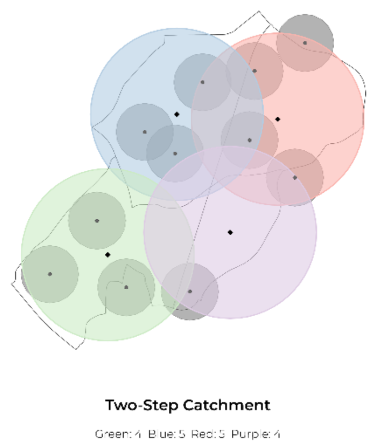

Figure 8: Two-Step Floating Catchment Illustration

The following equations, adapted from Luo and Wang (2003), illustrate the two steps of calculation:

1. For each financial service location *j,* identify all census tract centroids (*k*) within a threshold travel time (d_0) from location *j*, and compute the service to population ratio R_j within the catchment area (measured in services per 10,000 people):

$$R_j = \frac{w_{kj} * 10{,}000}{\sum_{x \in \{d_{kj} \le d_0\}} w_{kj} * P_k}$$

where w_{kj} is the inverse distance weight between *k* and *j*, P_k is the population of tract *k* whose centroid falls within the catchment (i.e. $d_{kj} \le d_0$), and d_{kj} is the travel time between *k* and *j*.

2. For each tract centroid i, search all of the service locations (j) within the threshold time (d_0) from location i, and sum their population to service ratios:
$$A_i^F = \sum_{j \in \{d_{ij} \leq d_0\}} R_j = \sum_{j \in \{d_{ij} \leq d_0\}} \left(\frac{w_{kj} * 10{,}000}{\sum_{x \in \{d_{kj} \leq d_0\}} w_{kj} * P_k} \right)$$
Where A_i^F represents the accessibility metric for centroid i measured in the number of financial services per 10,000 residents.

My floating catchment calculations use financial service locations as the supply points and population-weighted centroids as the demand. As outlined above, tracts' population-weighted centroids are derived from weighting the centers of the nested block groups according to their populations. This provides a better reference point than the geometric center by shifting the centroid to account for the population distribution within the tract. The financial service locations are represented by the latitude and longitude coordinates provided by ReferenceUSA. Rather than using the absolute distance between these two points to define catchment areas, my floating catchment method uses travel time. Since Atlanta's road networks combine relatively fast expressways and slower residential streets, travel time provides a better estimate of the perceived distance between locations than either network or Cartesian distance.

I calculated every accessibility metric in ArcGIS Pro. The two-step floating catchment calculations will use origin-destination cost matrices to measure connections between census tract centroids and financial services. The calculations in equations (1) and (2) utilize table joins between the OD matrices and information about the tract demographics and financial service locations. I used buffer and spatial join tools to calculate the other four metrics in this section. The following chapter analyzes the maps created by visualizing the resulting estimations to visualize the spatial concentration of financial service access.

4 VIEWS OF FINANCIAL EXCLUSION: CARTOGRAPHIC ANALYSIS

4.1 Points within Polygons

Counting points within polygons is the first tract-level estimate of physical access to financial services. It is a computationally and conceptually straightforward method since it simply aggregates the service locations within the tract boundaries. Because it does not transform any spatial relationships, the method displays the same basic information as Figure 2 in a way that makes spatial disparities more apparent. Despite its previously discussed limitations, the "points within polygons" method provides an informative view of physical accessibility.

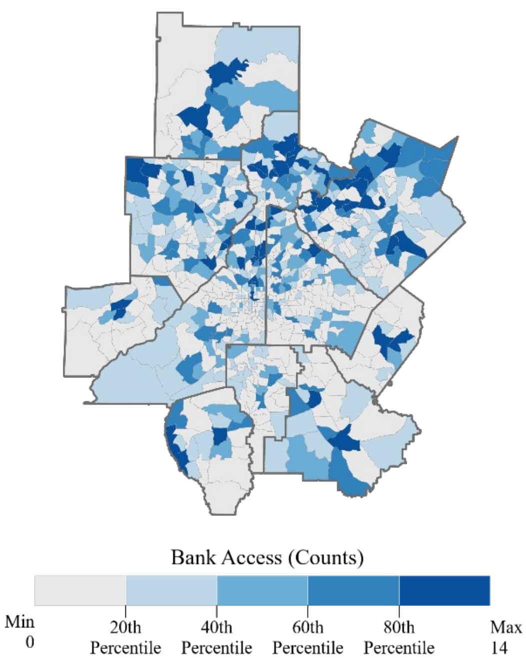

Figure 9: Points within Polygons - Bank Access (Left) and AFS Access (Right)

Figure 9 begins to show some spatial patterns in conventional bank access. There are clearly clustered areas of high bank access and areas with very few banks, which confirms the insights from the point pattern maps. Within each county, a visible central banking district can be seen from one or more connecting tracts with high access to banks. Northern Fulton and DeKalb counties and Cobb and Western Gwinnett counties have many tracts with high or very high access to conventional banks. This northern concentration visually stands out against large portions of the southern metro that have few or no access to banks. Although the disjoint nature of the map makes it difficult to discern, the "points with polygons" method begins to reveal unequal access to banking services.

The most apparent pattern in the map is the disjoint spatial pattern created by this methodology. Because of the discrete divisions between Census tracts, areas with high accessibility are located adjacent to those with low to no accessibility. This effectively treats tracts as meaningful barriers creating a system where a neighbor on one side of a boundary as a completely different experience to one on the other side; however, Census tracts are statistical accounting tools that have no material or political distinction from one another.

Access to alternative financial services, seen on the right of Figure 9, exhibits similar clustering tendencies to conventional bank access, but the location of AFS differs considerably. The "points within polygons" method again creates a disjoint visualization, but some small clusters of several tracts with similar access levels help to interpret the spatial pattern. The have/have-not nature of the method effectively highlights that many more tracts have access to banks than alternative services; more tracts fall into the lowest grey category on the AFS map than the bank map. Additionally, the location of high AFS access clusters does not perfectly overlap with high bank clusters. For instance, areas in northwestern Clayton and southern DeKalb counties that have relatively high access to AFS have low access to conventional bank services. While AFS are spatially clustered, they do so in noticeably different sites than conventional banks.

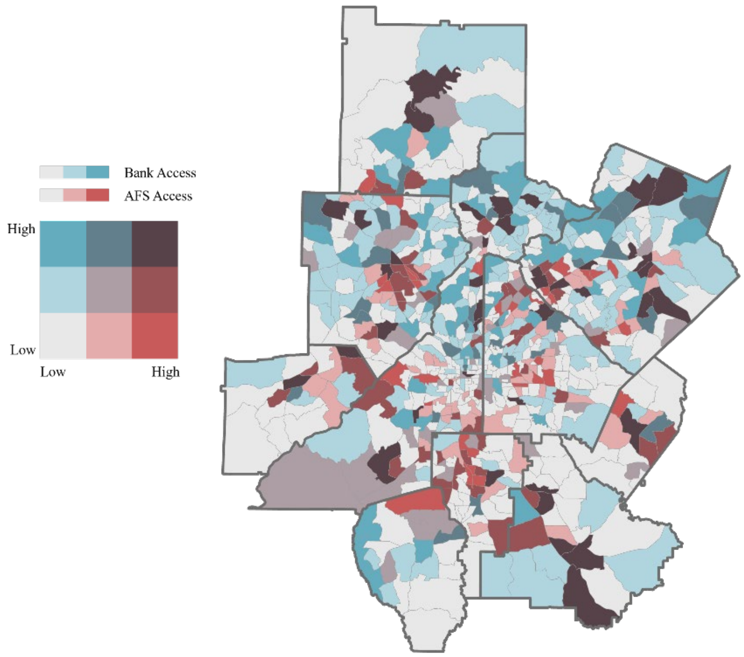

Figure 10: Points within Polygons - Bank/AFS Access

Comparing the placement patterns of banks and alternative financial services on one map highlights the spatial mismatch in their locations as well as exemplifying the limitations of the "points with polygon" method. Figure 10 visualizes access to banks and AFS as two axes on the same map. While some tracts contain both banks and AFS, most tracts are primarily served by one or the other. Local areas throughout the metro show a distinct mismatch between banks and AFS. For instance, several tracts in the center of Cobb County have high access to both financial service types, but the tracts north of that cluster contain mainly banks, while the tracts to the south contain mainly AFS. Similarly, relatively small areas in central Fulton and DeKalb counties contain mostly alternative services, while the surrounding counties contain mostly banks. In general, more tracts have banks than alternatives, and the tracts containing mainly alternatives tend to be smaller. Additionally, the north-south division seen in the point pattern maps remains in the "points within polygons" visualizations; banks appear much more prominent in the northern half of the metro, with AFS seeming more common in the south-central area. More contextually, banks appear more common in white, wealthier tracts, while AFS are more common in predominantly Black portions of Clayton County and southern Fulton and DeKalb counties.

Visually the "points within polygons" access to both types of financial service on one map illustrates the primary limitation of the method as an estimate of physical accessibility. Almost every tract with little or no access to either service, represented as grey in Figure 10, is neighbored by a tract containing at least one of the financial services. While this map clearly communicates where services are, it likely does not represent the perceived access of individuals living within the tracts. Tract boundaries do not have material impacts on the day-to-day lives of their assigned residents, so methods that better estimate the spatial relationship between residence and service locations provide a clearer picture of metro-scale inequalities in financial access.

4.2 Points within Polygon Buffers

The second access estimation takes the first step towards a better representation of the spatial relationship between tracts and financial services by softening tract boundaries. This is computationally achieved by calculating a quarter-mile[3] buffer around every tract and then counting the number of financial services within the new buffered boundaries. In effect, this creates a small overlap between all adjacent tracts that simulates the permeable nature of tract borders. Since many services are located on the border between Census tracts, the quarter-mile buffer includes them in the estimation for all adjacent tracts, whereas the previous method split

[3] A quarter-mile buffer was chosen after additional robustness testing of half-mile and one-mile buffers. The quarter-mile buffer best captured the desired "softening" effect in its spatial relationship without drawing heavily from services in adjacent tracts.

them between the bordering tracts. Put succinctly, the buffer around tract boundaries begins to break down the impermeability between tracts by including services literally on the other side of the street.

The resulting maps of bank and AFS access (Figure 11) show similar spatial patterns to maps created by counting service within unbuffered polygons. High bank access tracts continue to cluster the northern portions of the metro, with most of the top 20% access tracts located in Gwinnett, Cobb, and north Fulton counties. Notably, tracts in the top 20% of bank access rarely border one another. The overall map is less disjoint than the previous method, but the highest-access tracts are still isolated. Similarly, tracts in the bottom of 20% bank access appear more concentrated in the south-central Fulton and DeKalb counties and Clayton County. Bank access is considerably higher in the whiter, northern portions of the metro, and the lowest bank access areas are still concentrated in predominantly Black portions of the metro.

The regions of high AFS access seen in the previous method have coalesced with the softer Census boundaries. Compared to banks, AFS access is more locally concentrated, with pronounced clusters of high access surrounded by areas of gradually diminishing access. This relative concentration indicates that AFS have a more targeted location strategy than conventional banks. Importantly, their spatial clustering is noticeably different from banks. Areas like northern Clayton County, the city of Smyrna in Cobb County, and Buford Highway in Gwinnett County have many tracts with high AFS access and only moderate bank access. The Buford Highway area in central Gwinnett has become especially noticeable in this method compared to the estimates from unbuffered polygons. This is the most racially diverse area of the Atlanta metro, with a considerable Latinx and AAPI population, and its unique combination of

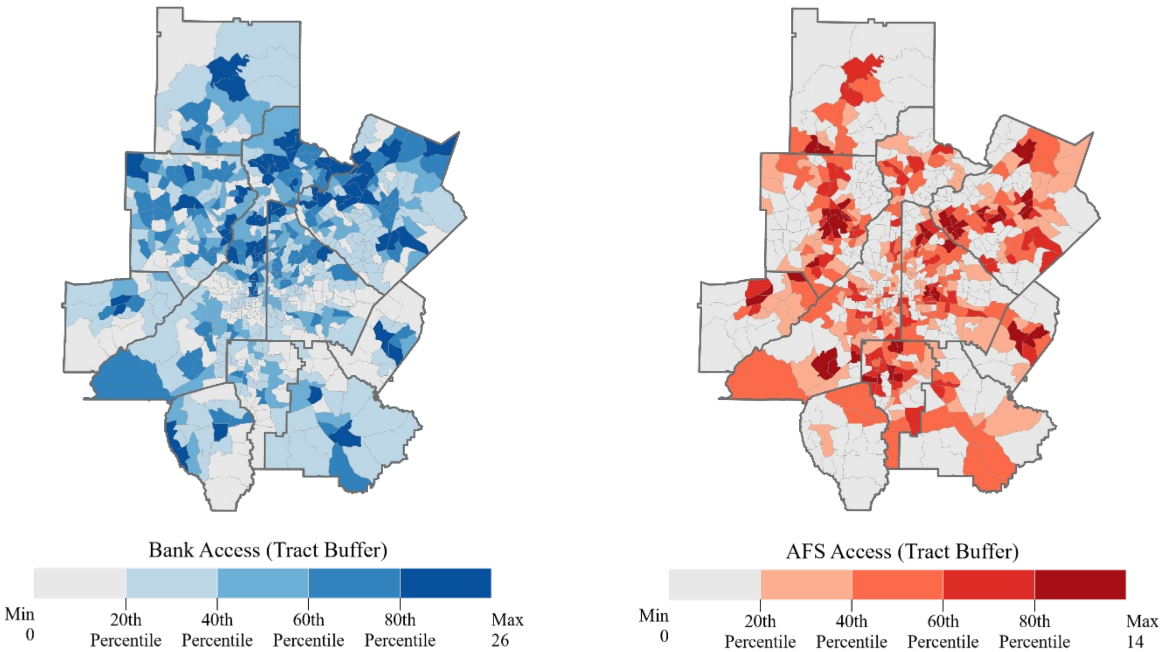

Figure 11: Points within Buffered Polygons - Bank Access (Left) and AFS Access (Right)

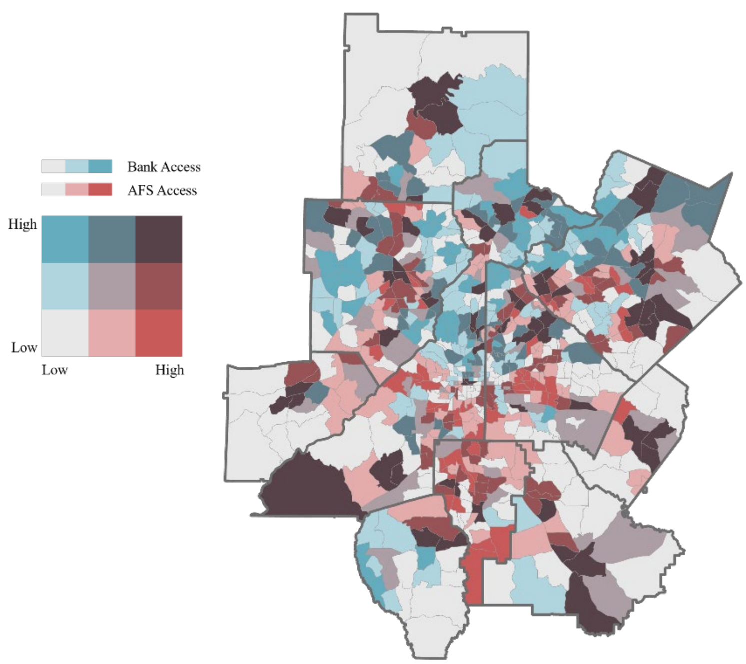

Figure 12: Points within Buffered Polygons - Bank/AFS Access

moderate bank access and high AFS access challenges the understanding of financial access as a binary.

Putting access to both types of services on one map fills out the pattern seen in the joint map of the previous method. Banks appear more common in the northern half of the metro, while AFS are more prevalent in the southern half. In the social dimension, areas primarily served by banks are mostly white and wealthier, while AFS are the primary financial service in predominantly Black areas. Visually, these maps of financial service access appear noticeably smoother than ones created with unbuffered tracts, but it still shares enough of the disjoint nature to hinder the intuitive interpretation of its macro-level patterns. Hyper-local pockets of high-bank and alternative access with areas of low financial access highlight the interrelated nature of urban poverty and affluence. While some metro-level trends can be visually identified, this series of maps serve as an important indicator that proximate spaces can differ greatly and that financial exclusion does not require vast physical distance between the included and excluded.

4.3 Points within Centroid Buffers

The third method, counting the services within a buffer of each tract's center, mitigates the arbitrary boundary issue from the previous method while normalizing the catchment distance of each tract. The analysis here specifically used a five-mile buffer to reflect the average distance that American consumers travel to their banks (Brevoort & Wolken, 2008). This decouples the access estimation from both the more-or-less arbitrary boundaries and size of each tract. Creating a more standardized metric adds statistical validity to the maps and statistics that evaluate it, but it also disconnects the reader from the map's underlying data. These maps of physical accessibility hide the calculations and transformations used to create the information represented in each tract. As a result, this more abstract version of Atlanta's financial services can become more theoretically complex at the cost of technical obfuscation.

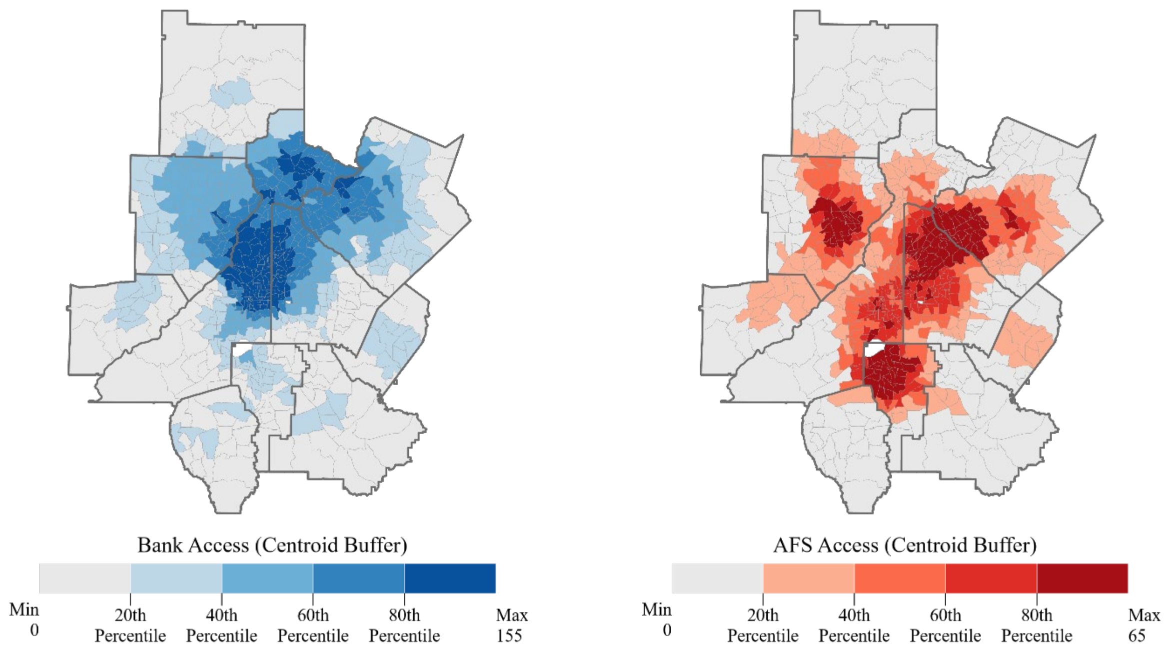

Figure 13: Points within Centroid Buffers - Bank Access (Left) and AFS Access (Right)

Under this method, bank access is again concentrated in the metro's wealthier and whiter northern half. Most of the tracts in the top 20% of bank access are clustered in the core region of central Fulton and eastern DeKalb counties; that area contains some of the highest-income tracts in the metro. The centrality of high bank access is not surprising given that metro's largest business districts are in that general area, but the wedge of tracts north of that core contains most of the tracts in the top 40% of banks. That next level of access reveals a clear preference for the metro's higher-income, predominantly white suburbs. The concentration of tracts within the bottom 20% of access in the lower-income, predominantly Black tracts compound this pattern. More than the previous methods, the "points within centroid buffers" map shows a stark disparity in banking access across the metro.

The “points within centroid buffers” method also creates more continuous or smoother visualizations of tract-level financial access. Neighboring tracts share similar access levels, and it is easier to distinguish large-scale patterns across the metro. This makes the above patterns and disparities more obvious, but the method also has a few systematic biases. The biggest limitation of the method is that it does nothing to normalize the access value assigned to each tract. As a result, this map continues to primarily reflect the increased density of service in the core of the metro and the more dispersed patterns in the periphery. It accurately reflects the number of banks within five miles of each tract’s center, but it does not reflect that those five miles in Downtown Atlanta are a much longer cognitive distance than five miles in Stone Mountain.

The maps of AFS access differ slightly from the bank access. Tracts with the top 20% access to alternative services are distributed in smaller clusters throughout the study area: one in Downtown Atlanta, one in northern Clayton County, one in southeast Cobb County, and another in northern Dekalb and western Gwinnett counties. Tracts in the next highest category, those between the top 40% and top 20%, are located around those clusters. Compared to bank access, more predominantly Black and lower-income tracts have high AFS access. Figure 14 also shows how the “points within centroid buffers” method biases higher access measurements towards more centrally located tracts. Most every tract in the bottom 20% of AFS access is located on the edge of the study area. These mismatched estimations between core and periphery tracts complicate the visual comparison of bank and AFS access. While the two services have different spatial distributions, especially between tracts in the 80th percentile of access and higher, interpreting those differences on a map requires a deep understanding of the region’s underlying demographics.

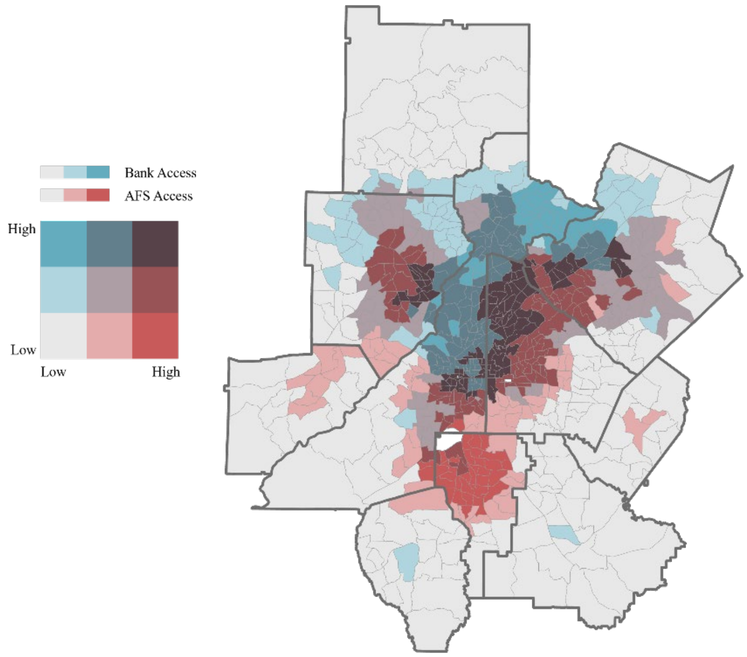

Figure 14: Points within Centroid Buffers - Bank/AFS Access

Visualizing bank and AFS access on the same map shows that the two spatial distributions mainly differ in two locations: north Fulton County is predominantly served by banks, and southeast Fulton and northern Clayton are predominantly served by AFS. Most of the other tracts are served by a mix of both services, and there is significant overlap between the tracts with the highest bank and AFS access. The relative mix of services is revealed in a few locations. A portion of central Fulton County around Buckhead has high access to banks with moderate access to alternatives, and tracts with high AFS and moderate bank access are located in lower income and less white suburban areas. The access estimations from the "points within centroid buffers" method show noticeable yet inconclusive differences in the spatial distributions of banks and alternative financial services.

This method of estimating physical access offers considerable theoretical improvements over previous methods; however, it is far from an ideal method for estimating tract-level access.

The primary limitation of this method lies in selecting the buffer distance around each centroid. Utilizing a standardized buffer around each tract's centroid will create much larger access estimations for tracts in the denser urban core than in the more rural periphery; this pattern is obvious in Figures 14 and 15. The five-mile buffer that I used is admittedly large for an urban area and comes from a national survey of consumer patterns, but the problem persists regardless of the buffer's size. The range in size and density between tracts across the metro means that any buffer size will either relatively overestimate core tracts or underestimate peripheral tracts, and because Figures 14 and 15 use a quantiles classification scheme, areas in the core will always be relatively more served than those in the periphery. In doing so, this method creates an urban image that reflects von Thunen's concentric zone model where a dense central business district is surrounded by increasingly less dense zones of industrial and residential spaces, and the multiple high access clusters in Downtown and Gwinnett and Cobb Counties points the multi-nodal modifications to the concentric zone model. This frequently used method reinforces conventional conceptualizations of urban space and organization, yet like the dated concentric zone model, it has a limited ability to portray modern urban dynamics accurately.

4.4 Points within Travel Time Centroid Buffers

The penultimate access estimation evolves the centroid buffer method by substituting travel time buffers instead of the absolute distance buffers from the previous method. The travel time buffers create a catchment size that reflects the unequal connectivity of tracts across the metro, and they represent a more nuanced spatial relationship between tracts and service sites. While the buffered centroids method standardizes the area that each tract collects services from, it falsely assumes that a uniform distance reflects the relational distance between populations and services accurately across the metro; five miles on the periphery might seem much shorter than five miles in the urban core. Creating a thirty-minute driving time buffer captures the relational nature of distance better by recognizing that travel happens on roads instead of straight lines and by treating time as the effective barrier to access instead of physical distance. As a result, the following visualizations begin to capture how tracts and financial services relate to each other in addition to where they are located.

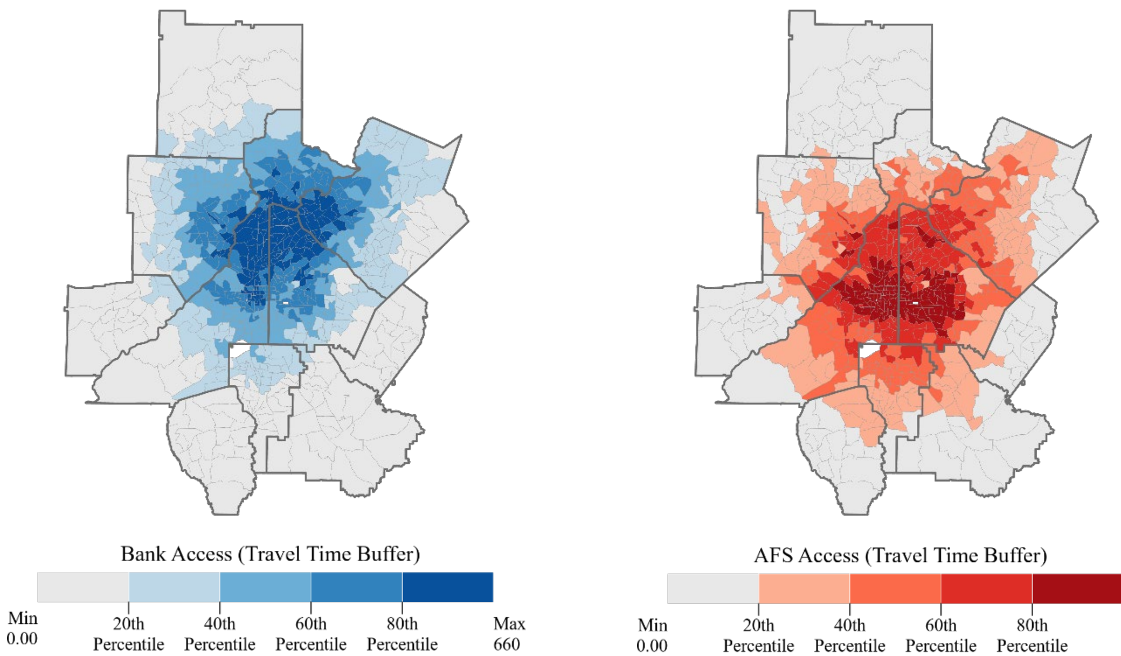

Figure 15: Points within Travel Time Buffers - Bank Access (Left) and AFS Access (Right)

This map of bank access, on the left in Figure 15, shows highly centralized banking access focused on a concentration of tracts in northern Fulton and DeKalb counties and western Gwinnett County. The top 20% of access tracts form an almost continuous mass, showing that the wealthiest portions of the urban core have the best access to banks. The next highest tiers of bank access radiate from this central concentration of tracts, with the lowest 20% of access tracts on the study area's periphery. Importantly, some of the predominantly Black tracts in south Fulton and DeKalb access have lower access to banks than estimated in the previous method, indicating that these areas are relatively more isolated on the road network than their absolute location would imply. Overall, this method creates a visualization of bank access that continues to see higher bank access in the white, more affluent northern Metro and lower bank access in the predominantly Black tracts around the southern metro.

AFS access, on the right in Figure 15, appears considerably different in this travel time method than in the previous absolute distance method. While predominantly Black tracts in Fulton and DeKalb counties still have some of the highest access to alternatives, access to AFS appears more centralized on the metro scale than in previous methods. One large cluster of the top 20% of access tracts in the southern half of the urban core replaces the three or four clusters of high AFS access seen in previous methods. The areas of Clayton, Cobb, and Gwinnett counties that had top 20% access to AFS in previous visualizations now fall between the 40th and 60th percentiles of AFS access. In general, AFS access appears categorically lower in the northern half of the metro than in previous methods. This visualization creates a stronger story about anti-Black, urban core financial exclusion than any of the other maps, but it also erases some of the nuanced examples provided by the areas of suburban Clayton County and the diverse areas around Smyrna and Buford Highway.

Looking at access to banks and AFS together highlights the centralized and bifurcated visualization created by this method. More so than previous methods, a single ellipsoid could be drawn around a core area of high access to both services. This highest access area includes part of central Fulton and northern DeKalb counties seen in previous maps, but it also contains areas in Midtown and Buckhead that have been predominantly served by banks in previous methods. From the central core, bank access is focused on tracts flowing to the north, while AFS access flows towards regions in the south. The overall trend is a highly serviced central "commercial district" with bifurcated and racialized access flowing out from it. This creates a sort of segregated concentric ring where an affluent, white area is served by conventional banks and the predominantly Black areas are served by AFS.

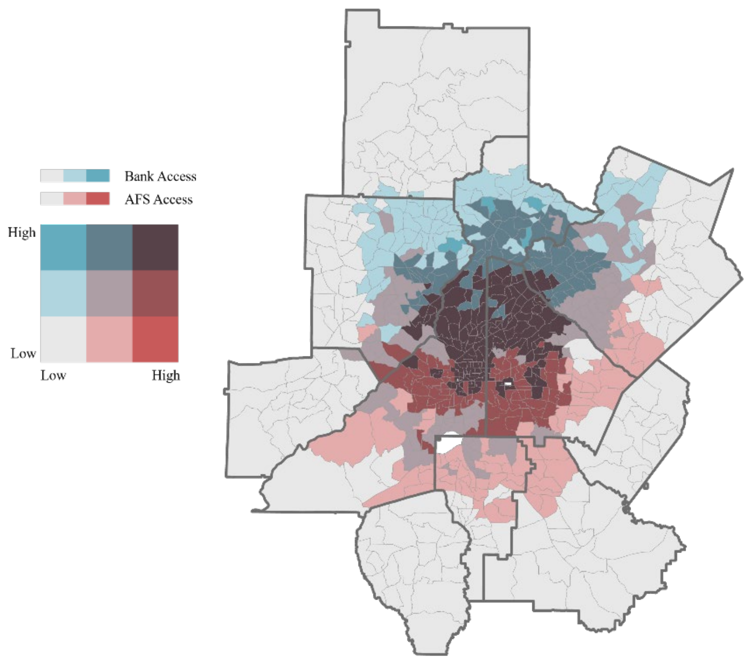

Figure 16: Points within Travel Time Buffers - Bank/AFS Access

The very centralized picture of financial access created by this method differs considerably from the other access estimations in this study. This method shows a more simplified and bifurcated pattern than previous methods. On the one hand, this visualization clearly indicates a racialized pattern of predominantly Black areas experiencing financial exclusion from banks and potential predatory inclusion to alternative services. On the other hand, it erases some of the more nuanced, Atlanta-specific examples of financial and demographic compositions in Buford Highway and Syrma. The centrality of access can also be partially explained by the shift to a road-network travel time buffer; because of the central location of interstate exchanges in Atlanta, the urban core has the widest thirty-minute catchments in the study area. This is an inevitable and methodologically intended result of using a road network buffer, but the idealistic travel times calculated on a GIS road network do not account for factors like traffic congestion or parking. As any Atlanta resident would tell you, those are defining factors in how long a car trip takes between two places in the Metro. While this method uses a more relational definition of distance, it still has computational limitations that systematically impact its estimation of physical accessibility.

4.5 Two-Step Floating Catchment

The two-step floating catchment method is a sophisticated, multi-step method for estimating the physical access of areas to location-based services. By accounting for the catchments of both service sites and population centers, the two-step method calculates access while accounting for service sites located near multiple population centers. The customer base of each service site is the summed total population of all of the tracts within its service area. While individual tracts have roughly the same population, service locations in more densely populated areas will have a higher theoretical consumer base than locations in the urban periphery. The inclusion of tract population in the access estimation creates a standardized metric that accounts for competition between tracts for the same service locations.

Additionally, the two-step method measures distance as the ideal commute time on a road network between a tract centroid and a service site. In the heterogeneous density of the Atlanta metro, I believe that travel time better reflects the perceived distance between two locations than the absolute distance. I chose a 30-minute catchment after robustness testing of several possible sizes, and a 30-minute one-way trip would reflect an hour round-trip which seems like the plausible upper limit for the sustained use of the service location. On top of the travel time catchment, the two-step method also applies a distance decay function that weights nearer service locations as more accessible than farther ones, so a tract with two banks nearby might have better access than another with three banks relatively far away. Using travel times and distance decay gives the two-step floating catchment method a significantly more sophisticated spatial understanding than the previous methods. The distance decay function reflects the portion of Tobler's first law that "near things are more related than distant things," while travel time distance steps closer towards a relational conceptualization of space. Shifting from an absolute metric of distance to a measure dependent on the topological connections between points better reflects the experiential barriers to access.

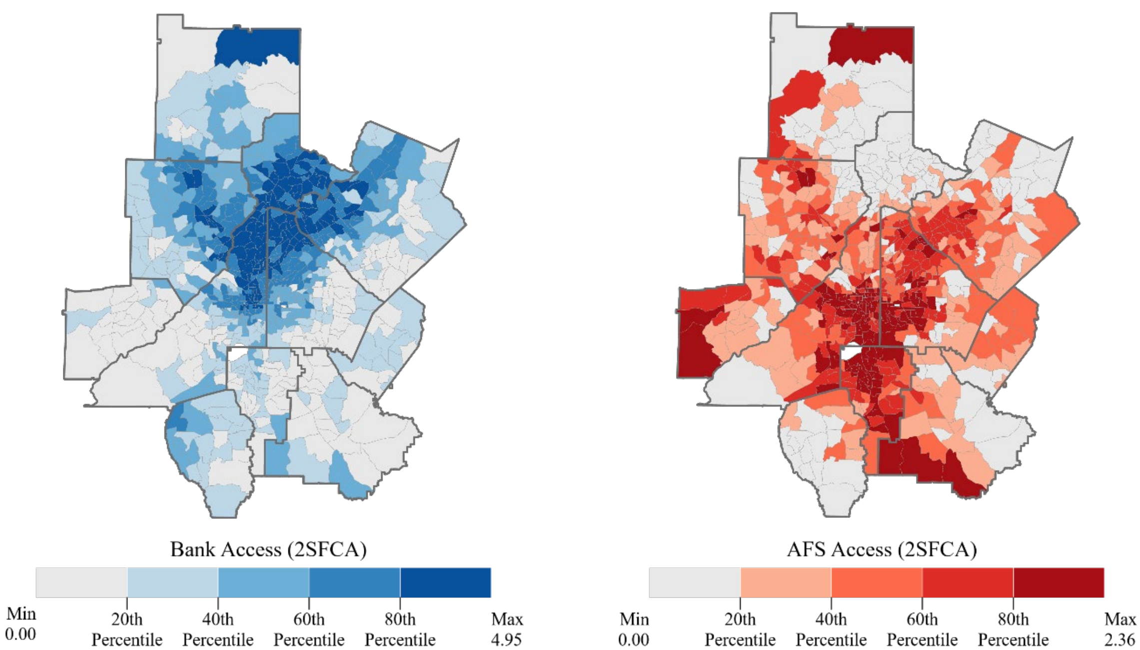

Figure 17: Two-Step Floating Catchment - Bank Access (Left) and AFS Access (Right)

The visualization of bank access using the two-step method supports and strengthens the spatial patterns seen using the previous methods. Tracts in the top 20% access are concentrated around Downtown Atlanta and in northern Fulton and DeKalb. With the exclusion of Downtown, these areas are some of the whitest and wealthiest areas in the metro. That corridor of the top 20% values is the core of banking access in the metro; most of the top 40% of tracts are located in the adjacent areas. On the other hand, large portions of east DeKalb, south Gwinnett, south Fulton, Henry, Douglas, and Clayton counties fall into the bottom 20% of access. The predominantly Black tracts in Clayton, southern Fulton, and southeastern DeKalb counties have noticeably lower bank access than the predominantly white tracts to the North.

The two-step method creates the smoothest visualization of the access metrics. The standardized units and distance decay function work together to create a gradually changing map of bank access. Few tracts have sharp differences from their neighbors, and the two-step method shows the modest access levels in the urban periphery. By accounting for travel time and population, this metric captures the differing manifestation of physical distance in rural and urban areas. The concentration of banks also appears like isolines around the high access core in northern Fulton and DeKalb counties, which makes identifying the low access areas between that core and the moderate access periphery clear. For readers familiar with Atlanta's spatial demographics, the band of predominantly Black tracts between the affluent core and the far suburbs is echoed in a similar band of low-access tracts.

The map of alternative financial service access created by the two-step method looks considerably different from the map of bank access. The swath of tracts in the south metro with the lowest access to banks has some of the highest access to AFS. For example, the tracts in southern Fulton, southern DeKalb, and northern Clayton counties with the top 20% access to AFSs have some of the lowest access to conventional banks. Additionally, portions of Douglas and Henry counties that had low-to-moderate access to banks have top 40% access to AFS. While some areas like Downtown have high access to both types of services, the map of AFS access looks like the connecting puzzle piece to bank access; the tracts with modest access to conventional banks are relatively saturated with alternatives.

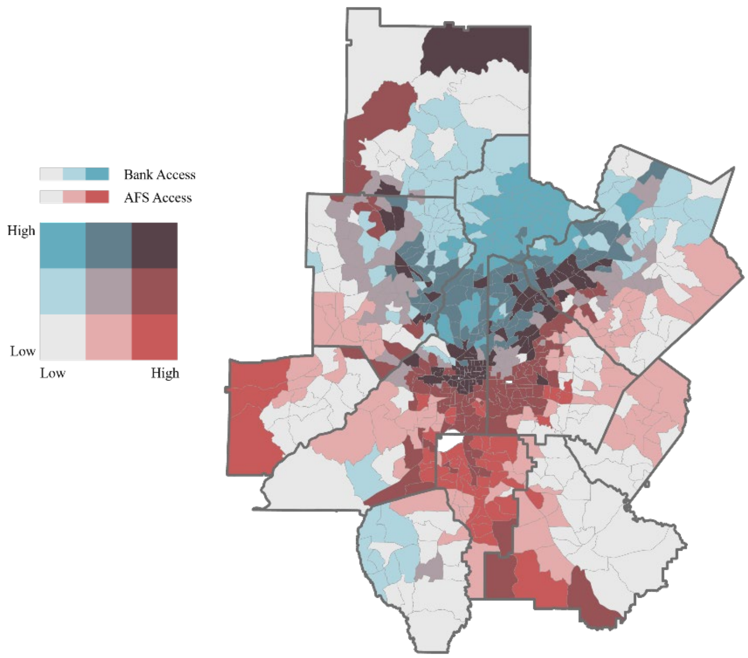

Figure 18: Two-Step Floating Catchment - Bank/AFS Access

Looking at them together on one map, the spatial disparities between conventional banks and alternative financial service access become more apparent than other methods. A few clusters of high access to both services appear around Downtown, in northern DeKalb and western Gwinnett counties, and in Cobb County. These areas are some of the largest commercial shopping districts in the Atlanta metro. Outside of these commercial areas, bank access is higher in the northern portions of the metro, while AFS access is high throughout the southern half of the metro. Towards the core, many tracts have high access to one service with moderate access to the other, but the north/south divide holds. Access becomes more polarized past the Atlanta city boundaries and the historic suburbs. Especially prominent is the concentration of AFS in the predominantly Black portions of Fulton, DeKalb, and Clayton counties and the inverse pattern of high bank concentration in the wealthy, white corridor between Downtown and northern Fulton and DeKalb counties.

The two-step floating catchment method creates the most interpretable and persuasive map of financial access and exclusion in the Atlanta metro, while also providing the most complex and comprehensive analysis of the spatial relationships that underlie financial access. The most gradual and smooth patterns of the two-step method make the differences between bank and AFS access more obvious than previous methods. By evening the difference in access between the core and peripheral tracts, this visualization draws attention to the starker differences in the urban core. Figure 19 also displays visual patterns similar to the maps of Atlanta's racial and income demographics, which draw a clear visual connection between financial service access and socio-economic demographics. Even without numerical comparison, banks display a clear preference for the metro's wealthier and whiter areas, while AFS locate themselves in predominantly Black and lower-income areas.

4.6 Odds Ratios

The visualizations in the previous section view tract-level financial access in quantiles, assigning an equal number of tracts to each of the color value categories. While this symbology provides a clear picture of relative access within each variable, it makes a direct comparison between bank access and AFS access difficult. Bi-variate choropleth maps, like Figure 18, allow readers to visually compare the relative abundance of banks alongside AFS, but it does not identify whether tracts are disproportionately served by one service type or another. Odds ratios provide an internally relative comparison that interprets whether a given tracts ratio is higher or lower than expected, given the study area's overall distribution of services. The ratio is calculated by comparing each tract's ratio of AFS to banks to the overall ratio within the metro, so tracts with an odds ratio of 1 have the same ratio as the population ratio, which is one AFS to every two banks. Visualizing the odds ratio in a choropleth map provides an alternate view of spatial disparities that prioritize the relative prevalence of banks or AFS over the absolute counts, so odds ratio maps represent a more relativistic visualization of spatial disparities.

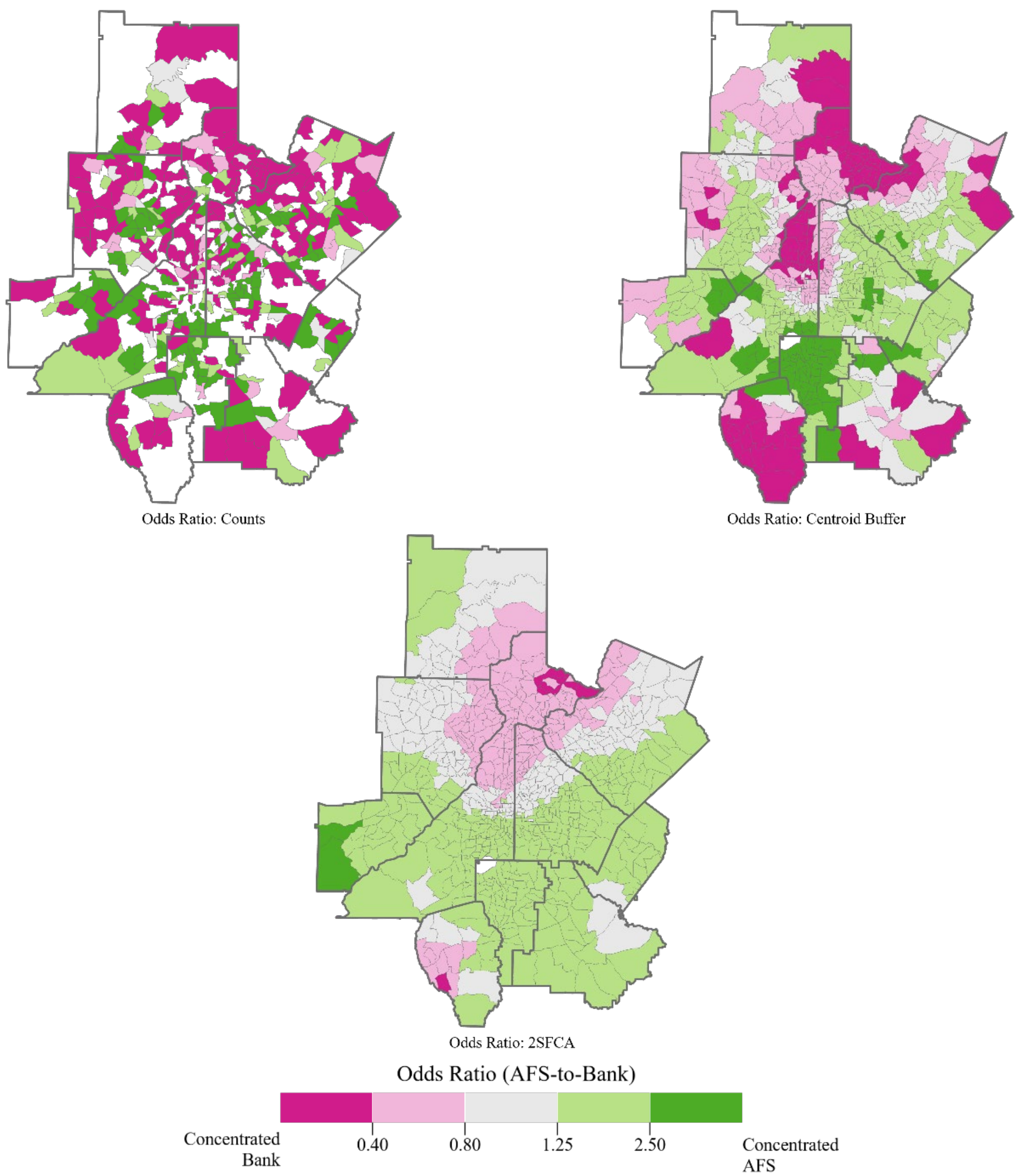

Figure 19: AFS-to-Bank Odds Ratio - Polygon Counts (Top Left) Centroid Counts (Top Right) and 2SFCA (Bottom Center)

Figure 19 revisualizes three access metrics in odds ratio maps. These maps share a unified classification scheme where areas in white have the expected ratio of AFS-to-bank. Areas in pink have an over-representation of banks, and those in green have an over-representation of AFS. The spatial patterns of AFS and bank concentration match the results seen in the previous choropleth visualizations. Predominantly white, affluent Census tracts in the northern portions of the metro have heavy concentrations of conventional banking services, and predominantly Black, lower-income tracts have heavy concentrations of AFS. Interestingly, the intensity of over-representation changes considerably between the three methods visualized above. In the “counts within polygons” method, most tract fall into the middle or the two extremes of the diverging classification, meaning they have either the expected ratio of services (or no services at all) or over two-and-a-half times the number of services in one category as the population ratio would suggest. Similarly to the other visualizations of this method, the odds ratio map has a patchwork nature where the value of one tract does not always reflect the value of its neighbors. The other two maps portray clear regions of bank and AFS concentration. The “centroid buffer” map has core areas of high bank concentration in the most white and highest income tracts in the metro and high AFS concentration in some of the most predominantly Black tracts. Border regions with the expected ratio of services separate bank and AFS regions. The two-step floating catchment odds ratio map contains very few tracts with a heavy concentration in either service, but it clearly communicates the connection between the geographies of financial services, race, and income in Atlanta.

Visualizing each tract’s bank and AFS access together as an odds ratio creates visuals based on an internally relative statistic that clearly portrays the bifurcated nature of spatial financial accessibility in Atlanta. Unlike the quantile classification schemes in Figures 10-19, the odds ratio uses the overall ratio of AFS to banks in the study area to compare the relative concentration of financial services within a tract. Visualizing the raw access metrics effectively communicates the distribution of spatial access across the metro, but the odds ratio map better communicates the relative nature of uneven urban development. The numerical difference between bank access and AFS access within a tract does not matter so much as how that difference compares to other tracts in the metro. When the ratio of access clusters in distinct areas, it becomes clear that financial opportunity falls unevenly across the metro.

4.7 The Big Picture

Comparing the visualizations of five accessibility estimates highlights the impact that quantitative and methodological decisions have on the spatial imaginaries created through GIS. While the underlying pattern of racialized financial access echoes throughout each map, the five different methods create noticeably distinct images of financial exclusion. The first two methods, the counts with polygons and counts within polygons buffers, show the uneven distribution of banks and AFS, even on a local level. They illustrate the peaks and valleys of urban development and provide the least abstract view of financial access. The third method, points within centroid buffers, improves the methodological rigor of accessibility estimation by using standardized buffers instead of tract boundaries. This uniform estimation clearly shows the density of banks and AFS in the core metro while still depicting a North/South bifurcation of bank and AFS concentration. The fourth method improves on the conceptual limitations of absolute distance estimations by shifting to a travel time buffer around centroids, and its results further highlight the centrality of access while providing the most starkly bifurcated image of AFS concentration in predominantly Black tracts and bank concentration in predominantly white tracts. Finally, the two-step floating catchment method provides the most sophisticated estimation of spatial accessibility, accounting for distance decay and inter-tract competition as well as travel times, and gives the smoothest visualization of financial accessibility.

When using quantitative methods to conduct progressive social research, how you record, measure, and present information matters a great deal to how your audience perceives the processes you research. Maps have an especially potent ability to shift how readers understand the material realities of the spaces that they depict. Explicitly walking through the visualizations created by five accessibility estimates illustrates the tensions present between progressive goals, methodological complexity, and transparency. For instance, the first two visualizations show the least abstracted or calculated visualization of financial access, but they have major methodological limitations and do not illustrate the racialized process of financial exclusion well. On the other hand, the travel time buffer method provides the clearest visualization of the AFS concentration in predominantly Black urban areas, drawing the strongest connection to financial exclusion and spatial segregation, but the method also systematically over-represents access in the urban core over the periphery. Fortunately for this project, the most spatially complex measure, the 2SFCA, also provides a clear visual connection between racial composition, median income, and financial access. In this case, the tension between critical theory and quantitative methodology is resolved by using most of the method that best adapts conventional GIS tool to represent the relational nature of financial access.

Beyond calculating access metrics, the methods used to visualize the resulting estimations impact the extent and severity of financial exclusion. The quantile classification scheme used in Figures 9-18 portrayed equal numbers of tracts in each class. This scheme provides the best visual of banks and AFS spatial distribution, but it makes the comparison of their relative concentrations difficult. Odds ratio maps seen in Figure 19 directly compared the ratio of AFS to banks in a manner that portrayed their relative abundance, which more clearly portrayed the areas of financial inclusion and exclusion. While these spatial visualizations point toward the relationship between local demographics and financial access, they do not directly measure it. For that, quantitative methodologies rely on numerical statistics.

5 RUNNING THE NUMBERS: STATISTICAL ANALYSIS

Statistical analysis can quantify the spatial patterns seen in the previous visualizations of accessibility metrics in relation to income and racial composition. Basic summary statistics provide an aspatial lens through which to view the range of financial accessibility across the metro by articulating the numerical distribution of accessibility estimates. More importantly, relational statistics, like correlation coefficients and regressions, quantify the connection between demographics and accessibility that were visually identified in the previous section. Spatial statistics assign numerical support to the visual clusters seen above and improve the methodological complexity of regression analysis. While numerical quantification helps specify trends in data, the methods and specific results can obfuscate the underlying social and political processes that shape the data. Engaging in a critical quantitative practice calls for the reflexive evaluation of statistical assumptions and processes to parse how their results reflect critical social theory.

5.1 Summary Statistics

Summary statistics, like the mean, median, and standard deviation, provide the first glimpse into the numerical nature of the dataset. For this project, understanding the different distributions of each accessibility metric begins the process of comparing their statistical merit. Additionally, the basic statistical summary of Atlanta's demographics and housing characteristics contextualizes the later analysis of their connections to financial accessibility. From a methodological standpoint, evaluating summary statistics also allows the researcher and audience to confirm that data fulfill the assumptions of later statistical tests. The following aspatial statistics also open the final "view" of Atlanta's financial accessibility as seen through the statistical lens.

Table 2: Summary Statistics of Socioeconomic Characteristics and Access Estimates

Summary Statistics

Statistic	N	Mean	St. Dev.	Min	Pctl(25)	Pctl(75)	Max
Total Population	733	6,206.01	3,241.66	196	4,046	7,680	26,399
Population Density (per sq.mi.)	733	3,239.96	2,697.28	98.67	1,729.35	4,014.21	28,547.49
White Population	733	3,061.63	2,536.24	0	1,081	4,170	18,641
Black Population	733	2,519.71	2,409.27	30	927	3,439	19,341
% White Population	733	48.30	28.51	0.00	23.02	72.78	98.24
% Black Population	733	42.13	30.90	0.42	15.46	67.03	100.00
Median Household Income	733	74,285.11	35,480.31	12,485	48,146	90,586	236,149
Log(Median HHI)	733	11.11	0.48	9.43	10.78	11.41	12.37
% Vacant Housing Units	733	9.25	7.13	0.00	4.70	11.70	55.50
Bank Counts	733	1.32	2.03	0	0	2	14
AFS Counts	733	0.67	1.22	0	0	1	10
Bank Tract Buffer	733	3.20	3.87	0	0	4	26
AFS Tract Buffer	733	1.69	2.32	0	0	3	14
Bank Centroid Buffer	733	47.91	35.00	0	20	70	155
AFS Centroid Buffer	733	23.48	14.26	0	12	34	65
Bank Travel Buffer	733	348.67	154.62	0	211	483	660
AFS Travel Buffer	733	184.29	71.82	0	128	233	365
Bank 2SFCA	733	2.31	0.83	0.00	1.61	2.96	4.95
AFS 2SFCA	733	1.24	0.37	0.00	1.00	1.48	2.36

Table 2 provides the summary statistics for all of the variables in this project, starting with the Census tract characteristics and followed by the accessibility estimates. This table contains two Census variables not previously discussed in this project: population density and the percentage of vacant housing units. These are included in statistical analysis as ‘control’ variables for the built environment within tracts. Previous studies on the relationship between tract-level demographics and accessibility suggest that population density and vacant housing units can help explain some variation between tracts (Cover et al., 2011; Hegerty, 2016; Wheatley, 2010). Additionally, median household income was logarithmically transformed following a common-place practice to create a normally distributed measure of median income that performed better in the latter models. The specifics of each demographic variable’s statistics in Table 2 are used to note that all demographics and characteristics vary considerably across the metro.

The summary statistics for the accessibility metrics, on the other hand, provide a new, more informative view of the differences between estimates. First, the distribution for bank access is higher across every metric than the AFS access estimates. There are roughly twice as many banks as AFS in the study areas, and this has translated into generally higher levels of access to banks than AFS in the metro area, with the mean of a given bank access measure being roughly twice the corresponding AFS metric. This pattern accents the localized disparities present in areas with high relative concentrations of AFS since the raw counts in the study area are heavily present across the metro. This also highlights the importance of starting with geographic visualizations that reveal spatial disparities hidden by these summary statistics. Second, the differences in magnitude between metrics are considerable. The “count within polygons” and “tract buffer” methods have similar means and standard deviations, but the two buffer methods have much larger numerical estimates for access. The final 2SFCA method returns to similar values as the first two methods, but its interpretation has changed from a raw count of services to services per 10,000 residents. While these patterns in summary statistics are not incredibly insightful, they inform the importance of using visualization techniques with robust classification schemes in the initial exploration of spatial data.

Histograms visually represent the distribution of a variable by placing observations into equally sized “bins” that represent the density of values as vertical bars along a horizontal range of values. Figure 20 displays the histograms for the five spatial access metrics, with banks shown on the left and AFS on the right. The predominant pattern in the histograms is the progression from the heavily right-tailed distributions of the “counts within polygons” metric to the bell-curved distributions of the 2SFCA methods. Statistically, this means that the distributions of access metrics become more normal as the complexity of the estimate increases, making the

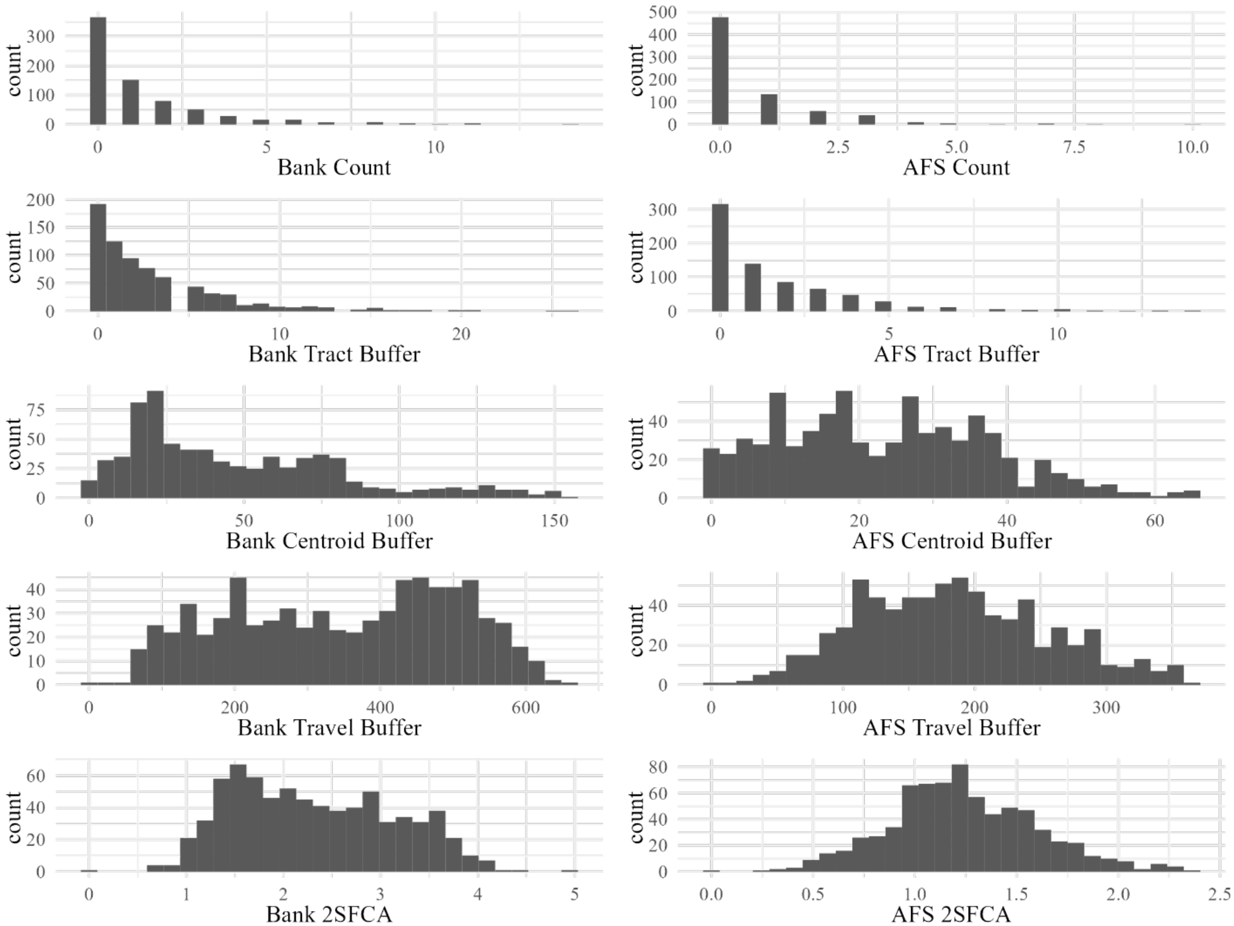

Figure 20: Histograms of Accessibility Metrics

metrics more ideal for conventional probabilistic statistics. From a more intuitive standpoint, the more spatially complex metrics, like the 2SFCA and travel time buffer, create a smoother surface of accessibility values where most tracts have values around the middle with few tracts in either the high or low extremes. On the other hand, the first two rows of histograms highlight how the majority of tracts do not have banks or AFS within or near their boundaries. This serves as a reminder that tract boundaries artificially enforce constraints on the interpretation of space and that financial services are heavily clustered across the metro. If services were evenly distributed, fewer tracts would have no services despite their arbitrary boundaries. Taken together, these summary statistics provide a numerical starting point for the subsequent analysis of the relationship between accessibility and tract characteristics.

5.2 Relational Statistics

The core research question of this project searches for the presence of inequalities in financial access. Previous mapping has shown clear spatial disparities within access to banks and AFS, which this section now expands upon with correlation and regression analysis. Correlations coefficients evaluate the degree to which two variables move with or against each; two variables with a high positive correlation closely move in the same direction, while two with a high negative correlation move in opposite directions. Ordinary Least Squares (OLS) regression analysis expands on correlation analysis by quantifying the relationship between two variables in their respective units, and it can evaluate the impact of several predictors on financial accessibility at once. This project is primarily concerned with this ability to look at how racial composition, median income, and other characteristics jointly explain differences in financial accessibility. The predicting power and specific interpretation of the resulting regression coefficients are largely ignored since this project focuses on evaluating disparities in financial access over creating models to forecast accessibility based on demographics.

Table 3: Correlation Coefficients between Demographics and Accessibility Estimates

Correlation Matrix

	% White Population	% Black Population	Log(Median HHI)	Pop Density	% Vacant
Bank Count	0.198	-0.237	0.158	-0.054	-0.049
AFS Count	-0.118	0.062	-0.253	-0.048	0.066
Bank Tract Buffer	0.288	-0.326	0.242	0.072	-0.026
AFS Tract Buffer	-0.175	0.076	-0.333	-0.011	0.082
Bank Centroid Buffer	0.327	-0.381	0.184	0.537	0.200
AFS Centroid Buffer	-0.226	0.106	-0.373	0.387	0.283
Bank Travel Buffer	0.122	-0.225	0.013	0.500	0.223
AFS Travel Buffer	-0.296	0.273	-0.308	0.553	0.496
Bank 2SFCA	0.332	-0.424	0.148	0.417	0.113
AFS 2SFCA	-0.452	0.444	-0.539	0.334	0.504

Table 3 displays the correlation coefficients between all ten accessibility metrics and five socioeconomic characteristics of census tracts. Hidden within this somewhat unwieldy table are confirmations of the patterns between income, racial composition, and financial access seen in the previous accessibility maps. First, the proportions of white and Black populations with a tract have mirrored correlations with accessibility. The white population within a tract is positively related to bank access and negatively related to AFS across all accessibility estimates, and vice versa for the Black population. Similarly, the median household income is positively associated with bank access and negatively with AFS access across most measures. The magnitude of the correlations between financial access, income, and racial composition changes significantly between estimation methods. In general, the coefficients become stronger as the complexity of the estimations increases, but the travel time buffer has distinctly lower coefficients than both the centroid buffer and 2SFCA methods. The relationships between financial service access and population density and vacant housing also change depending on the metric, though with a less distinct pattern. The correlation coefficients indicate a distinct and robust relationship between access and socioeconomic characteristics where whiter and more affluent areas have better access to banks and lower income, and more Black areas have higher access to AFS.

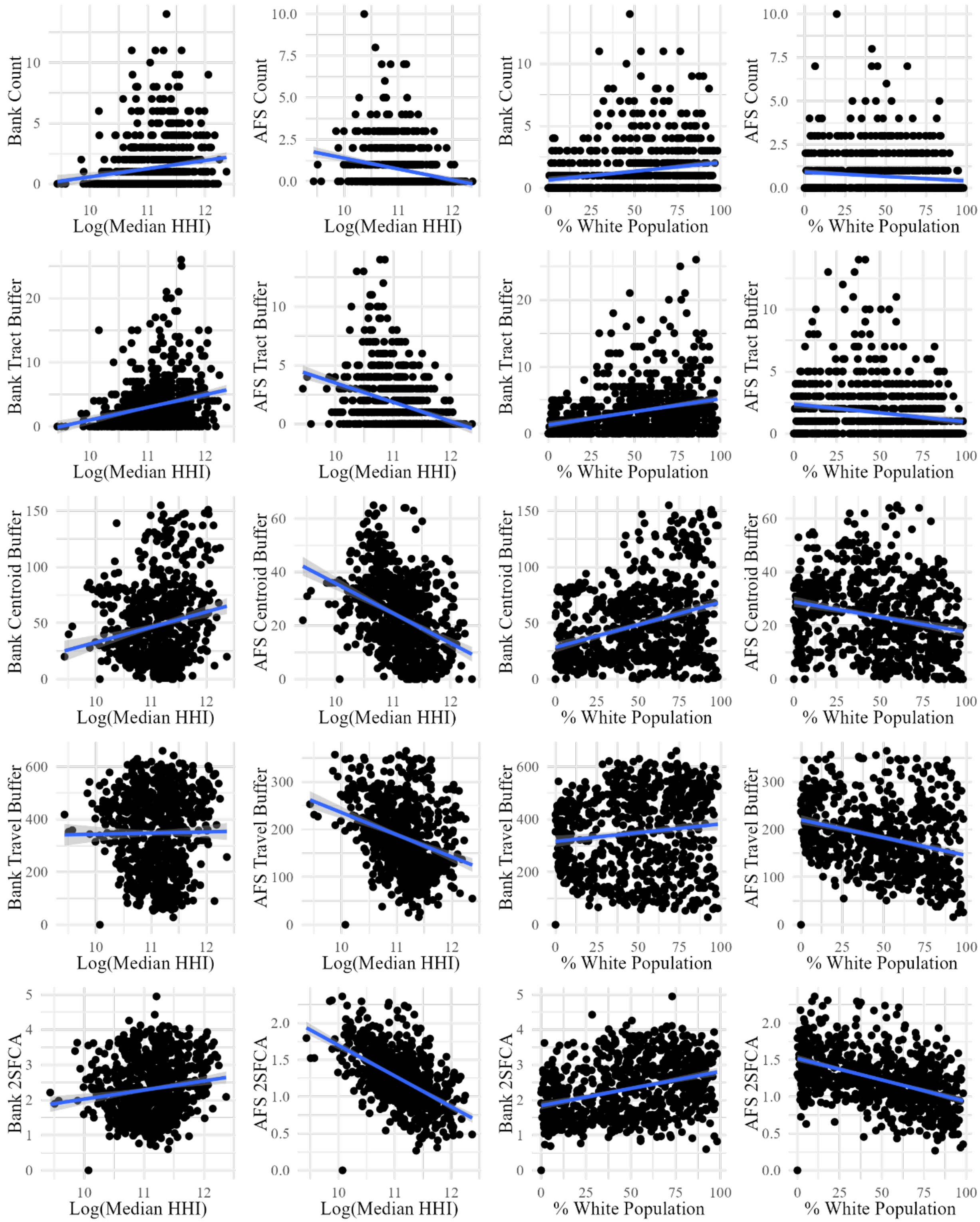

Figure 21: Scatterplots of Access by Median Income and Race

Figure 21 visualizes the correlation coefficients by race and income and financial accessibility in scatterplots with lines of best fit. The scatterplots bring home the consistent relationship that racial composition and median income have with banking and AFS access while more clearly displaying how more sophisticated metrics of accessibility have stronger statistical results. The positive relationship between median income, white population, and bank access is evident from the first row of scatterplots depicting "the counts within polygons" method, as is their negative relationship with AFS access. Still, the scatterplots become more precise and the relationship stronger as you read down the rows of increasingly complex accessibility metrics. Especially in the 2SFCA, the distribution of points becomes a tighter cluster around the line of best fit. The scatterplots convey the same information as the correlation coefficients, but they more clearly communicate the increased statistical power that comes with more spatially complex measures of accessibility. However, these correlations only measure the relationship between socioeconomic characteristics and accessibility one variable at a time.

OLS regressions of financial access by race and income, shown in Table 4, confirm the pattern in bank access but complicate the narrative around AFS access. Bank access increases with the proportion of the population that identifies as white across all accessibility measures. That relationship is also statistically significant across measures, and the magnitude of the relationship increases as the accessibility metrics become more complicated, except for the travel time buffer. Median income, on the other hand, does not have a significant relationship with bank access in the first two estimation methods. Still, it does have a significant negative association with the other three accessibility metrics that becomes stronger as the estimates become more complex. AFS access has a strong and significant negative relationship with median income across all estimates of accessibility, which confirms the relationships seen in maps and earlier statistics.

Table 4: OLS Regression of Bank and AFS Access by Median Income and White Population

Bank Access Regressions

	Bank Access				
	Count	Trct Buffer	Cntrd Buffer	Trvl Buffer	2SFCA
	(1)	(2)	(3)	(4)	(5)
Log(Median HHI)	0.020	0.059	-0.143***	-0.180***	-0.236***
	(0.055)	(0.054)	(0.053)	(0.055)	(0.052)
% White Population	0.183***	0.244***	0.435***	0.258***	0.510***
	(0.055)	(0.054)	(0.053)	(0.055)	(0.052)
Constant	0.000	0.000	-0.000	0.000	-0.000
	(0.036)	(0.035)	(0.035)	(0.036)	(0.034)
Observations	733	733	733	733	733
R^2	0.039	0.084	0.116	0.029	0.135
Adjusted R^2	0.037	0.082	0.113	0.026	0.132
Residual Std. Error (df = 730)	0.981	0.958	0.942	0.987	0.932
F Statistic (df = 2; 730)	14.989***	33.657***	47.858***	10.876***	56.740***
Note:					*p<0.1;* ***p<0.05;*** p<0.01
					Regression was run on standardized data

AFS Models

	AFS Access				
	Count	Trct Buffer	Cntrd Buffer	Trvl Buffer	2SFCA
	(1)	(2)	(3)	(4)	(5)
Log(Median HHI)	-0.379***	-0.465***	-0.469***	-0.196***	-0.459***
	(0.054)	(0.053)	(0.052)	(0.053)	(0.047)
% White Population	0.167***	0.175***	0.127**	-0.149***	-0.107**
	(0.054)	(0.053)	(0.052)	(0.053)	(0.047)
Constant	0.000	-0.000	0.000	0.000	-0.000
	(0.036)	(0.035)	(0.034)	(0.035)	(0.031)
Observations	733	733	733	733	733
R^2	0.076	0.124	0.146	0.104	0.296
Adjusted R^2	0.074	0.122	0.144	0.102	0.294
Residual Std. Error (df = 730)	0.962	0.937	0.925	0.948	0.840
F Statistic (df = 2; 730)	30.100***	51.883***	62.612***	42.591***	153.461***
Note:					*p<0.1;* ***p<0.05;*** p<0.01
					Regression was run on standardized data

The regression results raise interesting questions about the relationship between racial composition and AFS access. In the first three access metrics, the white population has a small but positive relationship with access to alternative services. This suggests that, for tracts with similar median incomes, the one with the higher percentage of white residents will have higher access to alternative financial services. This pattern contradicts the racialized placement of AFS seen in other studies and this project's maps. However, this might be partially explained by the increased likelihood of all types of businesses to locate in whiter areas. Furthermore, although statistical methods attempt to isolate the effects of median income and racial composition, social theories of racial capitalism and inequality more generally remind us that income and race are inherently tied. Predominantly Black tracts consistently have lower median incomes than similar white communities because of historic and ongoing systematic social and economic discrimination. Particularly in Atlanta, tract-level income and racial composition are heavily connected statistically and geographically[4], so the ability of an OLS regression model to separate those effects is severely limited. While these statistical results provide an intriguing pattern, they should not be interpreted as being contrary to theories of racialized financial exclusion. Instead, they should be viewed as an example of the limits of conventional statistics to capture multi-dimensional social processes.

The bivariate regressions in Table 4 simultaneously measure the impact of racial composition and median income on financial accessibility. However, several spatial modeling studies have found variables about the built environment to be significant predictors of accessibility (Cover et al., 2011; Hegerty, 2016; Wheatley, 2010). To address those research designs, Table 5 includes regressions on "counts within polygons" and 2SFCA estimates of access by race, income, population density, and housing unit vacancy rate. Population density and vacancy rate come directly from Hegerty's (2016) analysis of banking deserts, and they act as high-level descriptors of an area's built environment. Population density broadly acts as a measure of urban versus suburban environments, and the vacancy rate serves as a sort of

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[4] However, Variance Inflation Indexes (VIF) in the range of 1.5 to 2.5 for all models and coefficients suggest only small concerns about multicollinearity between the predictor variables.

thermometer for the economic well-being of a Census tract. Comparisons between the bivariate and four-variable models in Table 5 show that the inclusion of population density and the vacancy rate does not dramatically change the relationship between race and financial accessibility. In the 2SFCA regression for bank and AFS access, the new variables reduce the importance of median income in understanding financial access, with income losing significance in the bank model and having a considerably lower coefficient in the AFS model. Population density and vacancy rate have a positive relationship with bank and AFS access in the 2SFCA models. Given the context of metro Atlanta, this means that denser, thus more ‘urban’ and central, areas like the city of Atlanta have higher access to financial services than relatively more suburban areas. On the whole, the inclusion of built environment variables increases the strength of the statistical models, but it changes the illustrated connection between income and access.

That being said, the inclusion of two additional variables alongside race and income isn’t merely an expansion of the OLS regression models. Indeed, it has profound ontological implications for the model and how we interpret it. OLS regression assigns predictive weight to an independent variable based on the relation of its variance to the dependent variable’s variance; it does not and cannot account for any theoretical connections between variables. By placing population density and the vacancy rate in the model, those variables are interpreted to be ontologically equivalent to race and income in explaining financial access. Geographic research on urban development and racial capitalism holds that the racial and class composition of an area defines its connection to larger processes, like financial access, and its physical characteristics, like population density. So although the four-variable regression offers statistical improvements to the bivariate model, it does so with a model that contradicts the underlying theoretical relationship between race, class, and the built environment that motivates this research in the first place.

Table 5: Extended Regression Models

Extended Bank Regressions

	Bank Access			
	Counts		Two-step Floating Catchment	
	(1)	(2)	(3)	(4)
Log(Median HHI)	0.020	0.029	-0.236^{***}	-0.011
	(0.055)	(0.059)	(0.052)	(0.049)
% White Population	0.183^{***}	0.197^{***}	0.510^{***}	0.451^{***}
	(0.055)	(0.056)	(0.052)	(0.046)
Pop Density (per sq. mi.)		-0.049		0.398^{***}
		(0.038)		(0.031)
% Vacant		0.057		0.210^{***}
		(0.042)		(0.035)
Constant	0.000	0.000	-0.000	-0.000
	(0.036)	(0.036)	(0.034)	(0.030)
Observations	733	733	733	733
R^2	0.039	0.043	0.135	0.338
Adjusted R^2	0.037	0.038	0.132	0.334
Residual Std. Error	0.981 (df = 730)	0.981 (df = 728)	0.932 (df = 730)	0.816 (df = 728)
F Statistic	14.989^{***} (df = 2; 730)	8.272^{***} (df = 4; 728)	56.740^{***} (df = 2; 730)	92.882^{***} (df = 4; 728)
Note:				*p<0.1; **p<0.05;*** p<0.01
				Regression was run on standardized data

Extended Alt Regressions

	AFS Access			
	Counts		Two-step Floating Catchment	
	(1)	(2)	(3)	(4)
Log(Median HHI)	-0.379^{***}	-0.440^{***}	-0.459^{***}	-0.266^{***}
	(0.054)	(0.057)	(0.047)	(0.046)
% White Population	0.167^{***}	0.183^{***}	-0.107^{**}	-0.127^{***}
	(0.054)	(0.054)	(0.047)	(0.044)
Pop Density (per sq. mi.)		-0.108^{***}		0.219^{***}
		(0.037)		(0.030)
% Vacant		-0.058		0.271^{***}
		(0.041)		(0.033)
Constant	0.000	0.000	-0.000	-0.000
	(0.036)	(0.035)	(0.031)	(0.028)
Observations	733	733	733	733
R^2	0.076	0.091	0.296	0.411
Adjusted R^2	0.074	0.086	0.294	0.408
Residual Std. Error	0.962 (df = 730)	0.956 (df = 728)	0.840 (df = 730)	0.770 (df = 728)
F Statistic	30.100^{***} (df = 2; 730)	18.281^{***} (df = 4; 728)	153.461^{***} (df = 2; 730)	126.900^{***} (df = 4; 728)
Note:				*p<0.1; **p<0.05;*** p<0.01
				Regression was run on standardized data

5.3 Spatial Statistics

This statistical analysis has thus far focused on aspatial statistics. Taking an aspatial approach focuses on the relationship between tract characteristics and access, but it abandons the inherent spatial connections between places, summarized in Tobler's famous first law of geography. With this in mind, this section quantifies spatially-minded patterns in financial access, first by verifying the spatial clustering of bank and AFS access with Moran's I coefficients and, second, using spatial lag models that improve upon the previous regression models by accounting for the similarity of spatially-proximate tracts. These more analytical statistics validate the visual pattern seen in the accessibility maps, and they facilitate a conversation on the methodological benefit of spatial statistics in identifying urban inequalities.

Table 6: Moran's I Coefficients

	Moran's I Coefficients	
	Banks	AFS
Counts within Polygon	0.1656807706	0.1286875321
Tracts Buffers	0.4084494406	0.3717408779
Centroid Buffer	0.9364109907	0.8835283153
Travel Time Buffer	0.9249190724	0.8996336828
2SFCA	0.8064990470	0.7015057681

All coefficients are significant at the p<0.0001 level

Table 6 contains Moran's I coefficients for all five access metrics for banks and AFS. Importantly, this statistic evaluates the tendency for one tract's access to be similar to their neighbor's; it measures the clustering of access metrics, not the underlying location of banks or AFS. According to this statistic, each access metric was significantly clustered, with the latter three methods considerably more clustered than the first two methods. Those three methods use the tract centroid with a uniform buffer instead of the Census boundaries. Their increasing clustering confirms that shifting to a standardizing method meaningfully impacts the vision of financial access. The consistently significant clustering also confirms that financial access is not uniformly or randomly distributed across the metro; there are significant spatial disparities in access. The Moran's I statistic helpfully confirms the visual concentrations seen earlier, but it says nothing about how spatial proximity informs the relationship between access, class, and race.

The spatial lag models, shown in Table 7, modify the four-variable regression seen in Table 5 with a spatial lag component that adjusts for the similarity of proximate tracts. Traditional OLS regressions run on spatial data contain a statistical issue called "spatial autocorrelation" in their residuals, which means that the model over- or under-predicts values in spatially concentrated patterns. This generally happens with observations, tracts in this case, that have a spatial similarity that is not captured in the model's independent variables. A spatial lag model corrects for spatial autocorrelation by incorporating the characteristics of the tract's neighbors alongside its own when generating its predicted value in a regression[5]. This practice incorporates the spatial similarity of tracts into the conventional OLS framework.

A comparison of the OLS models and spatial lag models in Table 7 shows that the spatial lag model contains a significant spatial effect and reduces the impact of the four predictor variables on financial access. The significant Wald Test and LR Test values under the spatial autoregressive models communicate that the spatial lag models both significantly improve the predictive power of the OLS models and correct significant spatial autocorrelation. From a purely statistical standpoint, this suggests that the lag models are "better" than the conventional OLS models. The significant spatial connection in the lag models explains the diminished coefficients and significance of the explanatory variables, but it similarly raises interesting questions about the ontological and epistemological implications of the model. From an ontological perspective, the spatial lag model incorporates a spatial awareness that should make

[5] The following model specifically uses inverse distance weights, and it corrects the spatial autocorrelation of residuals found in the previous aspatial regressions.

it more "geographic." On the other hand, the cost of that spatial awareness is the statistical impact of median income and race in predicting financial access. Since both broader theories and empirical mapping have already shown that financial access is spatially concentrated, the epistemological value of regression models comes from their ability to quantify numerical relationships across multiple variables. The spatial lag model, while being the most statistically "valid" quantification, confirms existing knowledge at the cost of obfuscating the project's focus on the connections between financial access, class, and race.

Table 7: Comparison of OLS Models to Spatial Lag Models

Spatial Regressions

	2SFCA Access			
	Bank		AFS	
	OLS	*spatial autoregressive*	*OLS*	*spatial autoregressive*
	(1)	(2)	(3)	(4)
Log(Median HHI)	-0.011	-0.043	-0.266***	-0.114***
	(0.049)	(0.027)	(0.046)	(0.034)
% White Population	0.451***	0.107***	-0.127***	-0.001
	(0.046)	(0.027)	(0.044)	(0.032)
Pop Density (per sq. mi.)	0.398***	0.063***	0.219***	0.054**
	(0.031)	(0.018)	(0.030)	(0.022)
% Vacant	0.210***	0.061***	0.271***	0.110***
	(0.035)	(0.020)	(0.033)	(0.025)
Constant	-0.000	-0.013	-0.000	-0.011
	(0.030)	(0.017)	(0.028)	(0.021)
Observations	733	733	733	733
R^2	0.338		0.411	
Adjusted R^2	0.334		0.408	
Log Likelihood		-527.179		-651.760
$sigma^2$		0.207		0.308
Akaike Inf. Crit.		1,068.358		1,317.519
Residual Std. Error (df = 728)	0.816		0.770	
F Statistic (df = 4; 728)	92.882***		126.900***	
Wald Test (df = 1)		1,419.142***		593.175***
LR Test (df = 1)		722.564***		387.879***
Note:				*p<0.1; **p<0.05;** p<0.01
				Regression was run on standardized data

5.4 Final Tally

Altogether, the statistical analysis performed here confirms the racialized and class-based disparities in financial access seen in the previous visual analysis, but while it provided methodological robustness, the analysis added few new insights about the relationship between neighborhood characteristics and financial exclusion. The vacancy rate and population density improve the predictive power of statistical models, but they obfuscate the relationship between income, race, and financial access, which is at the core of this project. Additionally, placing them on the same ontological level as racial composition and median income undermines the theoretical prominence of racial capitalism in shaping material landscapes, like the location of financial services. Geographically aware statistics, like the spatial lag model, further improve the statistical robustness of predictive models but also further complicate the view of the underlying processes in a capitalist system. Conventional statistical analysis, like the one performed here, carries much weight in circles that prefer a probabilistic and positivist epistemology, but their value in a critical quantitative and mapping project is somewhat questionable when social theory already predicts the processes forming space and inequalities.

6 CONCLUSION

This project has aimed to explore how commonly used spatial access estimates shape the perception of financial accessibility. Although their specific visualizations changed considerably, comparing the access metrics consistently shows a bifurcated financial landscape where banks concentrated in whiter higher-income areas and AFS concentrated in lower-income and predominantly Black areas. Statistical analysis confirms the relationship between race, income, and financial access, but spatial statistics complicate the project's narrative with theory on underlying processes of racial capitalism. Finally, a discussion of the limitations of quantitative methods and mapping shows that a reflexive awareness of the limits of GIS and statistical methods can yield meaningful insight into the landscapes created by capitalistic processes.

6.1 Summarizing and Pulling Together

This project has engaged in a critical quantitative analysis of financial access in the Atlanta Metro. To quantify accessibility, it estimates the physical access to financial services, both banks and alternative financial services, using five GIS methods that modeled the spatial relationship between Census tracts and financial services. Visual comparison of those five accessibility metrics reveals consistent disparities in financial access across all methods, with more spatially complex methods illustrating an increasingly bifurcated geography of financial services. Banks are overly concentrated in the higher-income, predominantly white portions of the metro, while the AFS are concentrated in lower-income and predominantly Black communities. More diverse and commercialized areas, like Buford Highway and Smyrna, offer informative middle grounds with a balanced mix of both services. The comparison of maps shows this racialized pattern through readers' interpreted connections between accessibility maps, demographics, and social theory; those intuitive correlations are confirmed with conventional statistics.

The statistical analysis utilizes correlation and regression analysis to support the racialized and class-based disparities in financial access seen through comparative mapping. Consistently, banking access is positively related to median income and the percentage of white residents in a Census tract, while AFS access is negatively related to both. Like the spatial visualizations, the statistical evidence becomes more potent as the accessibility estimates model more complex relationships between Census tracts and financial services. The statistical method used to evaluate the relationship between race, income, and financial access also significantly impacts the interpretation of their connection. Correlations provide the first hint of a positive or negative association, while regression analysis can isolate multiple variables' effects on financial access. To that end, including the vacancy rate and population density of the Census tract as control variables increased the regression models' statistical power but diminished the apparent impact of racial composition and median income. Similarly, spatial lag regressions account for the inherent spatial connections between tracts and make better statistical models, but their resulting coefficients also obscure the underlying processes that shape financial access. While the statistics add empirical rigor to the analysis, they also complicate the narrative that ties quantified accessibility to critical social theory.

This project shows that conceptually complex methods can better mobilize quantitative research for critical and politically progressive research. The statistics and comparative mapping results illustrate the importance of rigor and theoretically complex methods when engaging in critical quantitative research on social issues. As accessibility metrics became more relational than absolute in their conceptualization of space, their views of financial exclusion became more evident and their statistics more significant. Ultimately, the two-step floating catchment area (2SFCA) method models spatial connections with travel times, distance decay, and competition which focuses more on the connections between tracts and financial services than the absolute distance between them. Its resulting graphics provide the most intuitive topography of physical financial access, and its statistics have the strongest coefficients and most explanatory models out of the five accessibility estimates. The time, data, and expertise needed to create 2SFCA estimates serve to enhance the methodological rigor of the analysis and the progressive goals of the research questions.

While this quantitative research has pursued critical goals, its methods are not free from critique. Like all GIS-based accessibility studies, this project only measures the physical availability component of access. This methodology cannot measure the political, cultural, and social barriers that keep consumers from getting to services and using them entirely once they are at the location. Historically, social and political processes, like redlining, or even interpersonal discrimination have driven financial exclusion more than the physical distribution of financial services. The current distribution of banks and AFS is equally a material consequence of those processes and a driver of continued exclusion. Similarly, social barriers to access have their own geographies and spatial distributions that impact which people are excluded from which services. Without incorporating those additional geographies and social processes, spatial accessibility studies have a limited ability to analyze where consumers experience financial exclusion.

Furthermore, the physical accessibility portrayed in accessibility studies reflects a complete conceptualization of space that focuses on the physical distance, measured in meters and miles, between locations. Geographers understand that people perceive and make decisions based on distance in more relational terms. For instance, the location of a service relative to one's commute is more important than the physical distance from the center of one's neighborhood. While the travel time tools begin to create more relational spatial imageries, they still rely on that residential-to-service location paradigm, and this project only uses road networks that assume access to private car transportation. Therefore, people reliant on public transportation have lower access to financial services than predicted by this project. Relational distances change based on the position of the person perceiving the distance, like how car owners see road networks differently from bus riders, but conventional accessibility studies like this project cannot model those individualized differences. Intentionally acknowledging these critiques situates the spatial views of financial accessibility with their limitations and allows mindful researchers to draw informed conclusions despite them.

6.2 The Value of Statistics in "Situated Mapping"/Critical GIS

The spatial and aspatial analysis performed above confirms the pattern identified in the preceding mapping exploration without generating new insights other than population density and vacancy rates. It confirms the pattern of increased bank access in whiter, higher-income areas and increased AFS access in less white, lower-income areas. The differences in specific interpretation across access estimations also reiterate the importance of grappling with spatial abstracts created by different methods. Just as the maps became progressively clearer, the statistics of more complex accessibility metrics show stronger connections to access, income, and race than more straightforward methods. While this validation nicely fills out this thesis, the largely confirmatory results question the value of conventional statistics in a mapping project informed by theory and local context.

Answering that question requires distinguishing between quantitative and conventional statistical analysis. While the two terms are often used interchangeably, quantitative analysis includes any analysis that organization information through numbers and categories. Statistical analysis, specifically probabilistic statistics, takes quantified information and assigned probabilities to the likelihood of specific hypotheses given the patterns in the data. Statistical analysis conventionally accompanies a positivist epistemology that derives “truth” from statistical probabilities. This project’s mapping analysis requires quantified data to calculate access and display socioeconomic characteristics. Its visual narrative rests on a great deal of quantification, but that narrative exists separately from the statistical analysis that follows it.

Back to the question of statistic’s value in critical GIS, the role of conventional statistical analysis in performing critical GIS depends on each analysis’s audience. In an academic setting of positivist researchers, the validation generated by coefficients and p-values will provide rigor and authority to spatial analysis. Elvin Wyly’s (2009) call for “strategic positivism” expressly calls for using positivist methods, like conventional statistics, to add weight to progressive social research under the regime of neoliberal logic. However, contextualized mapping research can exist without direct reference to probabilistic significance. Taylor Shelton’s (2022) “situated mapping” framework adapts Wyly’s strategic positivism by internalizing the limitations of mapping and spatial statistics to reflect complex social processes. In this situated context, the disparities in financial accessibility shown in the initial maps are limited by their inability to convey the experiences of people living within the map space; correlations and regressions will not improve those methodological inadequacies.

The value of statistics in performing critical GIS ultimately comes from the goal and audience of a particular project, which can only be identified through reflexive evaluation.

Statistical analysis is heavily featured in this project to highlight its redundancy in a situated mapping of Atlanta's financial landscape. It would also serve the research well in an audience of economists and quantitative geographers, but the statistics could alienate and gatekeep a general audience that informative maps and contextualizing narratives would better serve. Removed from positivist epistemology, statistical analysis provides another method to portray patterns in quantified data. Engaging in critical GIS and critical quantitative geography should involve using quantitative tools to most effectively highlight the unequal realities created by the systematic discriminatory processes that shape our societies and landscapes.

6.3 Looking Forward: Future Research on Financial Accessibility

This project has effectively mapped the physical landscape of financial services and tract-level access to those services. It has shown that landscape to be racialized and bifurcated, with predominantly Black Census tracts having an over-concentration of predatory alternative services while conventional banks concentrate in predominantly white tracts. While these insights are an essential contribution to the literature documenting the material inequalities under racial capitalism, the critiques of conventional spatial accessibility studies highlight the limited view they create of financial exclusion. They rely on absolute definitions of space that do not capture the relational nature of distance and space, and these quantitative and mapping methods do not reflect the real experiences of people experiencing financial exclusion. Alternate methods and mappings could address the blind spots of the current project.

Qualitative methodologies can expand the ability of accessibility studies to incorporate the financial experiences of individuals and communities. Participant research would provide information on the other dimensions of accessibility that quantitative GIS studies cannot provide. Feedback from participant communities could validate or "ground truth" the landscapes of financial exclusion represented by the accessibility estimates. Forming such research relationships with communities would also present opportunities to collect alternative spatial information from participants. Travel journals or diaries could document the spatial flows of participants (Kwan, 2002), which could be used to assess the financial landscape within their daily lives or build new models for catchments in larger studies. Discursive methods and surveys could also evaluate the local usage of banks and AFS to better understand use patterns in specific locations and evaluate spatial estimates' representativeness. In-depth participant research would necessitate smaller study areas, but those insights could be used to evaluate the ability of quantitative methods to make more generalized insights.

Alternate mapping methods could also be used to better illustrate the spatial relationships within the financial market. The current spatial accessibility maps summarize the tract level access as numeric values that are then represented as choropleth maps; new mapping methods could visually represent the connections between tracts and financial services. For instance, charting lines between tracts and their connected services could visually compare the relative prominence and proximity of different financial services to individual tracts. The size or width of those lines could vary based on the revenue of specific service locations, highlighting the differentiated characteristics between service locations. Other maps could represent the interregional flows of capital involved in financial markets. Connecting specific financial service locations to their national headquarters would show where the profits of financial transactions flow, potentially highlighting disparities in the local circularity of financial markets. Capital transactions and flow have inherent geographies that could reveal new information about the spatial extent of capital accumulation and extraction. Maps that show those flows would add more dynamic and spatially specific context to landscapes of financial exclusion.

Understanding financial exclusion will inform research on racialized inequalities in wealth and economic opportunity. Combating centuries of exclusion and ongoing discriminatory discrimination requires a comprehensive view of the multifaceted material geographies created by capitalistic accumulation and development. The analysis and critiques in this project are the first steps towards understanding the racialized geographies of financial exclusion in Atlanta, but the experiences of financial exclusion are more important than the location of banks and AFS. Participant research and more relational mappings could expand the analytical depth of this research to better reflect actual financial experiences. Conventional quantitative and GIS methods cannot inform more equitable and just futures alone. Creating better futures requires creative and critical approaches to measuring, visualizing, and analyzing our current geographies.

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