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Banks on a plane: The possibilities and limits of spatial accessibility measures for understanding geographies of financial exclusion

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Abstract

This paper examines how the underlying assumptions of geospatial accessibility metrics impact their representation of social and spatial relations and how these assumptions ultimately produce differing understandings of financial exclusion and its geographies. As increasing scholarly and public attention has been paid to the role of policy and institutions in (re)producing racial inequality in the United States, the role of the financial and banking system has taken on a particular importance. While conventional banking services offer the foundations of economic opportunity through savings and credit, these institutions have rarely been spatially uniform in their distribution or equally available to all classes of people. Instead, the growth of alternative financial services (or AFS) has sought to target those left out of the conventional banking system, offering higher interest and often predatory lines of credit to already marginalized people and communities. In order to examine financial exclusion and its geographies, this paper maps both banks and AFS in the Atlanta metropolitan region using five different methods for measuring spatial accessibility. Ultimately, while each of these five methods reveals a bifurcated pattern of financial exclusion across the metro where wealthier, whiter areas have higher access to banks and lower access to AFS and poorer, predominantly Black areas have relatively little access to banks and higher concentrations of AFS, each method produces a somewhat different picture of this process and its geography, calling attention to the role that such metrics play in shaping our collective understandings of racial inequality and how it to address it.

Keywords

Geographic methodology, financial exclusion, urban inequality, spatial accessibility, critical GIScience

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Introduction

As the public has become increasingly cognizant of the pervasiveness of racial inequality throughout American society, scholars and policymakers have been interested in understanding the different mechanisms by which racial inequality is (re)produced. One of these mechanisms that has drawn particular attention has been the role of the financial and banking system in shaping the US' racial wealth gap, which produces structural barriers to social mobility and economic security for people of color (Baradaran, 2015, 2017).

Despite the digitalization and pervasiveness of finance in nearly all aspects of social life, the importance of brick-and-mortar consumer bank branches has persisted, providing a fundamental way for individuals to access the capital needed to buy homes, start businesses or take on other significant expenses. However, the presence of these banks has never been spatially uniform, with the places where wealthier and whiter people live and work being much more saturated relative to poorer communities of colour. Even when banks are present in marginalized communities, evidence shows that consumers are still subjected to discrimination (Dedman, 1989; Friedline et al., 2022).

Into this vacuum has stepped a range of so-called 'alternative financial services' (hereafter, AFS), like check cashers, pawnshops, title loans and payday lenders, which have long existed but grown rapidly since the 1990s (Servon, 2017). These businesses offer types of credit that consumers cannot obtain from banks, usually in smaller amounts and with higher interest rates or fees. For many, these AFS serve as a lender of last resort, using loans to pay for necessities they could not otherwise afford (Charron-Chenier, 2018, 2020). This combination of necessary purchases, limited credit availability and debt cycles leads many scholars and consumer advocates to view AFS as predatory services that exploit financially and racially marginalized groups (Baradaran, 2015). Given that these AFS ultimately represent a means of *extracting* wealth from people rather than helping them build it, it might be said that rather than representing an opportunity for people to access capital, the spatial arrangement of AFS across the landscape represents a means by which predatory capital *accesses people*.

While various scholars, including geographers, have examined these unequal geographies of banks and AFS, the quantitative literature on financial exclusion has been partly hamstrung by the problem of inconsistent measurement. Even though most studies find *some* degree of inequality in access to financial services, the debate within the literature tends to focus on small differences in the econometric importance of various factors or debate the correct framing of differences in bank and AFS access. We argue that the empirical differences between papers stem more from the specific analytical strategies employed by various scholars than any substantive difference in the locational decisions of banks and AFS or the underlying processes that drive these spatial patterns. As such, the literature is replete with discussions that largely agree on the presence of racial and class-based financial exclusion but differ on its observed intensity and the correct way to measure it. This debate obscures the academic consensus on the spatial dimensions of our unjust and exploitative financial system. In order to address this consistent limitation, this paper takes a critical GIScience approach to explore five common spatial accessibility measures used in financial exclusion research, with the goal of explicating the importance of spatial theory and methodology in financialization research and human geographic research, more generally. Such an approach shifts our perspective from identifying a single 'optimal' method for measuring financial exclusion, instead focusing on the affordances and limitations of different metrics and their visualization.

In addition to using different metrics to determine which places are more-or-less accessible to either conventional or alternative financial services, we are also interested in how each of these measures embeds particular assumptions about social and spatial processes into their working, which in turn produces different understandings of financial exclusion. For example, some accessibility measures effectively reproduce the long-critiqued assumption of space as an isotropic plane with no variation in physical features and social characteristics (Tobler, 1993), which render invisible material barriers to financial services other than geometric distance. Extending this critical position, we also

take as a given contemporary theories of racial capitalism that suggest a fundamental intertwining between workings of capitalist exploitation and white supremacy, whereby racial difference is leveraged as a means of extracting ever more profit in new ways (Bledsoe and Wright, 2019; Melamed, 2015; Robinson, 1983). Thus, in addition to the aforementioned questions about the ways these different measurement approaches rely on and produce different understandings of the world, we are also particularly interested in the potential for (or failure of) these metrics to capture the underlying racial exclusion at the heart of contemporary finance, if not capitalism writ-large.

We examine these methods in the Atlanta, Georgia metropolitan area, one of the 10 largest metros in the country and one with a rich history of both Black middle-class ascension (Hobson, 2017) and persistent racial and class inequality (Keating, 2001; Immergluck, 2022). Indeed, despite being known as 'the Black Mecca', Atlanta has consistently been found to have the country's widest racial income gap (Berube, 2018), along with significant racial inequalities in home value appreciation (Markley et al., 2020), which represent the primary means of wealth-building within the United States. And while not limited to the Atlanta metro alone, the state of Georgia ranks second nationally in the total amount of fees extracted through predatory car title loans at nearly $68 million, behind only the state of Texas, which has a three-times larger population (Glottmann et al., 2023). The state even ranks eighth nationally for the combined fees extracted via payday loans and car title loans, even though Georgia effectively banned payday loans in 2004. Together, these features make Atlanta a prime example for examining the spatial distribution of financial services and how the location of these institutions reflects and reinforces broader geographies of racial inequality.

Ultimately, our analysis shows that the utility of spatial accessibility measures for understanding financial exclusion very much depends on which measures are being used, a point that is doubly true when attempting to link patterns of financial exclusion to broader structures of racial capitalism. Across all the measures used, we find persistent racial and class inequalities in access to financial services; however, the visual apparentness of this connection varies considerably. 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. We also demonstrate that, in general, the more ontologically and computationally complex measurements not only perform better at producing coherent and intuitive visual representations of financial exclusion but also at producing representations that link the patterns of bank and AFS locations to longstanding patterns of racial segregation and exploitation, which provide the kind of compelling narrative necessary to effect change within these structures. Ultimately, our analysis points to the importance of conceptual and methodological approaches in shaping both the empirical results and broader spatial imaginaries produced by financial exclusion and spatial accessibility research.

Literature review

Finance plays a foundational role in producing contemporary social and spatial structures. While a plethora of practices fall under the broad banner of 'financialization' – or the increased prominence of financial markets in capitalist economies (Sawyer, 2013) – the growing body of work on this theme attests to its importance across a number of domains. Even though a cohesive literature on financial geography did not emerge until the 1990s (Aalbers, 2015), geographers have long recognized how finance shapes broader urban and economic geographies (Harvey, 1978), from the dynamics of home mortgage finance (Gotham, 2012; Leyshon et al., 2008; Wyly et al., 2009) to international flows of capital through tax evasion (Genschel and Schwarz, 2011; Griffith et al., 2010; Roberts, 1994).

However, much of this work has historically focused on macro-scale processes of financialization, neglecting how finance is embedded in our everyday lives and social spaces. Indeed, as stock price and shareholder return have become the guiding principles of modern corporate organization, what

happens on Wall Street has become ever more important to those on Main Street (Davis and Kim, 2015), changing both the practices and subjectivities of individuals. As individuals and families have found it difficult to disengage from the global financial system, they have been forced to go from passive to engaged actors in the financial sector (Hall, 2012; Loomis, 2018). Consumers must now engage with risk insurance mechanisms to secure their economic well-being (French and Kneale, 2009), fundamentally shifting the dynamics between place and political economy (Pike and 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 brick-and-mortar financial services and the ability of individuals to access them represent a key intermediary in translating these macro-scale global processes into local, individualized experiences, albeit in geographically uneven ways. Mapping inequalities in access to financial services provides a unique opportunity to view the material manifestations of usually abstract economic forces and, in effect, re-materializes financial geography in the context of the urban built and social environment.

Geographies of financial exclusion

Financial exclusion refers to 'those processes that prevent poor and disadvantaged social groups from gaining access to the financial system' (Leyshon and Thrift, 1995: 312). While these processes are numerous, of particular interest has been the role of location decisions by banks and AFS and the built environment's role in shaping individuals' ability to access them. Access to financial services is widely seen as empowering consumers to make informed decisions about their financial health. Unfortunately, access to financial services has historically differed across class, race and gender. Within the literature on financial exclusion, several competing theories have arisen to explain and call attention to the different dynamics shaping the geography of conventional and alternative financial institutions, namely the concepts of banking deserts, the spatial void and financial ecologies. While the evolution of these concepts has not progressed linearly over time, they represent different levels of complexity in not only their theoretical basis for explaining financial exclusion but also in the methods used to identify its spatial patterns in the first place.

Considerable work in the last two decades has documented widespread bank branch closures in post-industrial cities at the turn of the 21st century, leading to the emergence of so-called 'banking deserts' where banks are entirely absent (Hegerty, 2016, 2020). 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 have allowed commercial banking institutions to close branch locations without diminishing their market share, with closures more likely to occur in marginalized communities (Brennan et al., 2011; Leyshon et al., 2008). Beyond these sheer inequalities in access, communities without bank branches suffer additional harm by having higher interest rate spreads between borrowers and fewer mortgage originations (Ergungor, 2010). Branch closures in marginalized neighbourhoods 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.

But the wide-scale closures of conventional banks in recent decades have not occurred in a vacuum, despite being treated as such by banking desert researchers (Hegerty, 2020; Van Leuven et al., 2024). Instead, at the very same time, AFS have simultaneously become more geographically prevalent (Graves, 2003; Faber, 2018, 2019) and widely used (Baradaran, 2015; Servon, 2017), forming an increasingly crucial element of the financial system for many. This is not to say that alternatives to conventional banking have not been available for centuries. Though recent scholarly and journalistic attention to AFS has focused more on modern institutions like check cashers, payday lenders and car

title lenders (Friedline and Kepple, 2017; McKernan et al., 2013), pawnshops in Britain's North American colonies predate US independence by several decades (Caskey, 1994). All of 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 marginalized communities (Baradaran, 2015).

Empirical research has shown that AFS are indeed more common in the country's most racially segregated cities (Faber, 2018) and in neighbourhoods hit hardest by the 2007–2008 financial crisis (Faber, 2019), as well as being considerably 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). AFS can therefore be seen as a modern form of what Keeanga-Yamahtta Taylor (2019) calls 'predatory inclusion', providing necessary services to those already marginalized by the conventional banking system, albeit on terms that force those individuals into a cycle of extraction, exploitation, and further reliance.

Regardless of the potentially harmful nature of AFS, their increased prevalence has changed the landscape of financial services and introduced an additional dimension through which financial exclusion can be viewed. As such, studies of financial exclusion have evolved to not only look at the presence or absence of banks but also analyse the relative mix of banks and AFS to determine a community's access to and integration into the financial system. Substantial empirical evidence points towards a dichotomous pattern in many American cities, where AFS are likely to be located in low-income, predominantly minority communities with relatively few banks. This pattern is commonly referred to in the literature as the 'spatial void' hypothesis (Smith et al., 2008), referencing the void that is left by an absence of conventional banks and subsequently filled by AFS. For instance, Graves (2003) has shown payday lenders in Chicago to be much more concentrated in minority communities with few bank branches, a pattern that's repeated across both urban and rural communities elsewhere across the US (Burkey and Simkins, 2004; Dunham, 2019; Wheatley, 2010). 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 remains robustly related to local demographics. The racial composition of neighbourhoods, often measured at the scale of Census tracts, seems to determine the types of financial services within it, even when controlling for factors like commercial density and income (Cover et al., 2011).

More recent work has sought to recover and reinvigorate the concept of 'financial ecologies' (Leyshon, 2020) as an abstraction that broadens the scope of financial exclusion beyond just the location of financial services. Drawing from earlier work by Leyshon (Leyshon et al., 2004, 2006), the idea of financial ecologies seeks to account for how the spatial availability of services interacts with other local socio-cultural conditions to define a community's interaction with financial markets and resources. While used more broadly (Lai, 2016; Langley and Leyshon, 2017; Green, 2023), this concept has recently been taken up in quantitative financial exclusion research by Dunham and Foster (2023) as a way to build on the basic insights of the spatial void hypothesis and better situate the mutually constitutive relationship between conventional banks and AFS in producing socio-spatial inequality. For these researchers, the prevalence of AFS and lack of conventional banks in poorer and Blacker neighbourhoods is important because it further exacerbates existing inequalities, with households in these areas being less likely to have savings accounts, thereby precluding them from even the most basic prerequisites for building intergenerational wealth (Friedline et al., 2019).

Regardless of one's spatial conceptualization of financial exclusion, however, studying the spatial extent and intensity of financial exclusion relies on one's ability to effectively estimate the local availability of banks and AFS. Methodological decisions about the object of analysis (conventional banks, AFS or a combination of the two), spatial scale/resolution, and use of accessibility measures impact the results and the relative importance of explanatory variables, which accounts for much of the disagreement within the financial exclusion literature. Although most research finds at least some

evidence of racialized disparities in financial services, conversations about the importance of those racial differences relative to other demographic and built environmental factors abound (Burkey and Simkins, 2004; Dunham, 2019; Graves, 2003; Hegerty, 2016; Prager, 2014; Wheatley, 2010). In many cases, disagreements about how financial access relates to other local characteristics are in some way related to differences in how financial access is measured. Yet the importance of these methodological decisions in producing not only different empirical results about, but also (and perhaps even more importantly) spatial imaginaries of, financial exclusion has gone relatively unremarked upon within the literature, with each study being confined to a single method of choice. Therefore, understanding these differences in how financial exclusion is quantified and measured is crucial for any critical examination of, and potential consensus on, the particulars of this phenomenon.

Critical perspectives on spatial accessibility

The local presence and extent of financial exclusion are most commonly measured by estimating the spatial accessibility of financial services. According to Aday and Andersen (1981), 'access' broadly refers to the ability to use services when and where they are needed, though the concept can be further broken into the five material and experiential components of (1) availability, (2) accessibility, (3) accommodation, (4) affordability and (5) acceptability (Penchansky and Thomas, 1981). In general, quantitative and spatial-analytical approaches to measuring access disparities focus primarily – if not exclusively – on the availability and accessibility dimensions of Penchansky and Thomas' five-part definition. While this paper, in some ways, perpetuates this limited focus on those elements most easily quantified, it also seeks to call attention to the elements of accessibility – and inequality more broadly – that cannot be so easily captured.

Initially developed by public health researchers, quantitative accessibility research sought to measure differences in the physical 'availability' of health services or the risk factors that might necessitate them. Throughout their history, however, studies of spatial accessibility have grappled with the limited ability to create theoretically complex estimations of spatial access within conventional GIScience frameworks, which inherently reduce the multidimensional experience of access into a series of objects on a flat, isotropic plane of quantified accessibility. Simple aggregation methods, like counting the number of services within a bounded area, tend to 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 services diminishes as the distance to them 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 and Wang, 2011; Luo and Wang, 2003). 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 accessibility (Auchincloss et al., 2012), which also holds in financial exclusion research.

Many, if not most, quantitative studies of financial exclusion use some form of an aggregated metric of bank and/or AFS locations 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 and Simkins, 2004; Cover et al., 2011; Faber, 2018; Friedline et al., 2019; Hegerty, 2016, 2020; Nguyen, 2019; Smith et al., 2008; Wheatley, 2010). Meanwhile, other studies bypass the need for GIS entirely by using pre-aggregated datasets provided by government agencies that report the number of financial services within a given tract or county (Faber, 2019; Fowler et al., 2014; Friedline et al., 2019). Therefore, they never even engage with the underlying location of services and the spatial relationships between them, as the spatial relationship was defined by the data source rather than the researcher.

Several studies, however, attempt to understand more complex social and 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). Similarly, accessibility scholars have sought to integrate into these metrics the growing importance of temporal context in understanding mobility patterns (Kwan and Weber, 2003; Kwan, 2013), especially when it comes to understanding the decision-making processes of schedule-constrained individuals, like women (Kwan, 1999) and parents (Schwanen and de Jong, 2008). This paper draws from these works by comparing the results for several methods of measuring spatial accessibility to financial services, showing how each approach's underlying logics and computational methods produce different results and understandings of the geographies of financial exclusion.

Crucially, this project adopts a critical GIScience perspective on these different accessibility measures in seeking to interrogate the utility of these metrics for understanding financial exclusion. On the one hand, we seek to leverage the power of maps and spatial data to demonstrate the realities of financial exclusion in Atlanta, repurposing computational algorithms towards the ends of critiquing the system that produces these inequalities in the first place (see, for example, Chambers, 2020; Robinson, et al., 2022 for similar efforts in different contexts). At the same time, we seek to examine the underlying theories of space that constitute and inform these different ways of measuring accessibility and how these conceptual underpinnings affect the results of such quantitative analysis, including the spatial imaginaries that are produced through such quantitative analysis. Although it has long been recognized that conventional GIS software reduces the rich tapestry of spatial processes recognized especially by critical human geographers into the over-simplified structure of points, lines and polygons (Bergmann and O'Sullivan, 2018; Poorthuis and Zook, 2020; Rundstrom, 1995; Sheppard, 1995), a number of geographers have recently attempted to take up this persistent challenge of representing non-Cartesian relational spaces within GIS (Bergmann and Lally, 2021; Lally, 2022; Shelton, 2018; Shelton et al., 2015). These critiques are especially relevant to spatial accessibility metrics that tend to flatten the concept of accessibility into a measure of proximity in absolute space or travel costs, which reflect dated understandings of urban dynamics and mobility. Even as it remains incredibly challenging to do GIS entirely outside the confines of Cartesian spatial ontologies, understanding the limitations imposed by these different methods and their assumptions is a crucial task for scholars who seek to leverage the social power afforded to maps and quantitative data toward progressive social ends (Wyly, 2009). So, while our own analysis here shows the uneven spatial patterns of banks and AFS across Atlanta, our interest is not primarily in relitigating whether these patterns exist. Rather, we are primarily interested in how well different geospatial methodologies are able to capture and depict these disparities given the ontological assumptions embedded in different methods. Our intervention is thus a call to pay greater attention to the spatial ontologies embedded within the data and methods used to model financial exclusion and similar social processes, as well as the spatial imaginaries that result from such research.

Methodology

Study area

This study is focused on the ten-county Atlanta region, as defined by the service area for the Atlanta Regional Commission (see Figure 1a). These ten counties represent the urban and suburban core of the wider metropolitan area and are assumed to have a categorically different financial landscape than the surrounding exurban and rural counties. Although the analysis was limited to the ten-county region, we also collected business locations and Census data (see below) for the 29 surrounding counties to ameliorate the systematic underestimation of spatial accessibility for the tracts at the edge of

the study area. Because tract boundaries are not barriers to access, including services in the surrounding counties better represents the range of options available at the edge of the primary study area.[1]

Data sources

The locations of banks and AFS used in this study were drawn from ReferenceUSA, a proprietary business and residential information database. North American Industry Classification System (NAICS) codes were used to identify banks and AFS within the Atlanta metro.[2] The ReferenceUSA business locations were collected in November 2021 and reflect the database's current listings at that time. Once downloaded from ReferenceUSA, these locations had to be cleaned and filtered to give an accurate list of services due to duplicate listings and misclassified businesses.[3] Ultimately, the core research area contains a total of 972 banks, with another 408 locations in the surrounding peripheral counties. AFS, despite including a wider range of institutions, are significantly less prevalent across the Atlanta metro, with 492 locations in the core study area and another 272 in the surrounding counties.

Tract-level Census data was used to compare these locations to socioeconomic variables, particularly median household income and the percentage of non-Hispanic white population, as seen in Figure 1b and c. We use 2015–2019 ACS 5-year estimates for these specific variables, as well as block group populations from the 2010 decennial census for calculating population-weighted centroids within tracts. We use Census tracts as the primary unit of analysis because they are a conventional proxy for neighbourhoods, are widely used in financial exclusion literature, and generate more interpretable maps for comparative analysis. Though the 2015–2019 five-year estimates are not the most recent vintage of data available from the ACS, due to systemic issues with the 2020 Census, we have opted to continue using this older data due to the likelihood of greater accuracy (Rothbaum et al., 2021). This cautionary use of 2015–2019 ACS data also accounts for the temporal mismatch between demographic data and the business location data, but this mismatch does not meaningfully impact our primary goal of comparing accessibility metrics and their corresponding spatialities.

Methods of analysis

As previously discussed, most financial exclusion research finds some evidence of racialized and class-based disparities in financial access, and the differences in the measurement of spatial accessibility likely account for much of the existing disagreement on the particulars of what's driving these patterns of financial exclusion. In order to illustrate the impact that these methodological choices have on research results and assess the 'true' state of financial exclusion in Atlanta, we use and compare five different spatial accessibility measures: (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 centre, (4) the number of services within a travel time of the tract's centre 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 accessibility of conventional and alternative financial services within the communities that tracts represent, though they vary considerably in their conceptual and computational complexity. Figure 2 summarizes the basic conceptual schema for each of these methods, which are explained in more detail below.

Method 1: Points within polygons. Counting points within polygons is the first tract-level estimate of physical access to financial services, providing the least complex and most intuitive estimate. It is a computationally and conceptually straightforward method since it simply aggregates the service locations within the tract boundaries and is arguably the most common method used in the financial exclusion literature (Brennan et al., 2011; Burkey and Simkins, 2004; Cover et al., 2011; Faber, 2018, 2019;

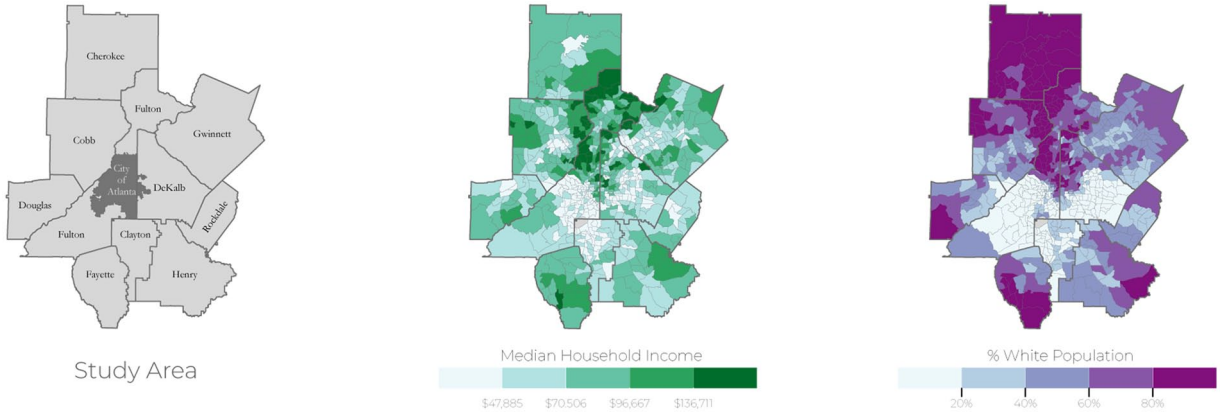

Figure 1. (a) Study area , (b) Median Household Income, and (c) Percent White Population.

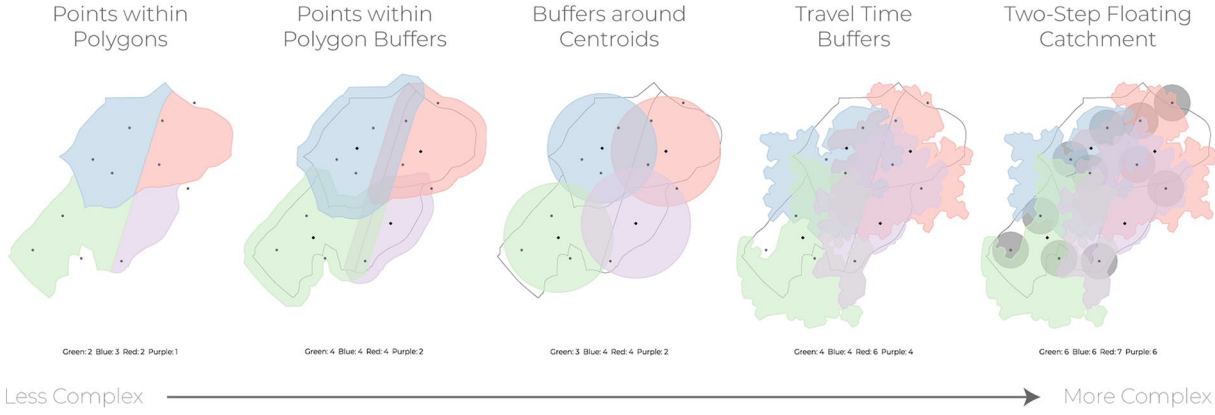

Figure 2. Conceptual diagrams for each spatial accessibility metric.
Figure 2 provides a basic, idealized sketch of the spatial relationship for each spatial accessibility method. The small grey dots represent financial services, either banks or AFS in this study. The larger black dots in the last four methods are the centres of each tract, which are population weighted centroids in this study. Lastly, the shaded areas around with tract or centroid represent the 'accessibility' area that tract-level access is being assigned from. In the final graphic, the dark grey shaded region around each service site represents the additional 'first' catchment in the 2SFCA method.

Fowler et al., 2014; Friedline et al., 2019; Graves, 2003; Hegerty, 2020; Nguyen, 2019; Wheatley, 2010). However, in its straightforwardness, this method also relies on an oversimplified understanding of spatial relationships, treating the boundaries of statistical units as meaningful social or spatial barriers where a neighbour on one side of a tract boundary would have an entirely different experience than a neighbour just across the street in a different tract.

Method 2: Points within polygon buffers. The second method makes the slight adjustment of counting within a buffer around each tract, softening the rigidity of tract boundaries by using a quarter-mile buffer around each tract's borders. This small buffer captures 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 particularly effective in this case because major roadways where banks and AFS are located often serve as boundaries between tracts, so the buffer helps capture many services that sit on the dividing line between tracts. By counting services in neighbouring 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, and actual residents are likely clustered in particular places throughout a given tract.

Method 3: Buffers around centroids. The third method we employ is arguably the second-most commonly used in the literature on financial exclusion (Dunham, 2019; Ergungor, 2010; Hegerty, 2016, 2020; Smith et al., 2008) and evolves from the previous methods by counting services within a uniform catchment around each tract's centre. 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. Here, we utilize a five-mile buffer, chosen due to the extant research about consumers' willingness to travel for banking services (Brevoort and Wolken, 2008). 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 centre of each tract. This centre accounts for the relative density of the population within each tract and significantly shifts the centroid in the study area's larger tracts.

Method 4: Travel time buffers. The fourth method replaces the absolute distance used to calculate previous buffers with a travel time buffer around population-weighted centroids. 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 temporally defined catchments better estimate 'distance' as it is actually experienced and perceived by residents, the access measure still fails to account for potential consumer preferences for nearer services over farther ones, that is, distance decay, and competition for the limited capacity of each service site. Both considerations influence the level of service residents receive from financial services.

Method 5: Two-step floating catchment area. 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' comes from looking at the catchments of service sites in addition to population centres. '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 centre 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. While the two-step floating catchment measure provides the most substantive insights thanks to its additional computational steps and conceptual complexity, its methodology requires a more in-depth explanation.

The first floating catchment calculation centres 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, we 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 consistently account for diminished geographic connections over space. After applying the weights, we 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.

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 each service site provides. The reciprocal of the first calculation gives the fraction of each service site available to local customers; we 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.

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

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):

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

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. $d_{kj} \leq d_0$), and d_{kj} is the travel time between k and j.

1. 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.

In the following section, we present the results of these five methods of estimating financial access in the Atlanta metropolitan area using four different visualization methods to illustrate how different geospatial methodologies create different spatialities of financial exclusion. Through the way it relates financial services to Census tracts, each method employs its own implicit definition of accessibility. Visual comparison of the results across multiple series of maps allows us to visualize the dramatically

different understandings of financial exclusion and socio-spatial inequality, more generally, created by each metric. For the first two visualizations, we apply each metric to the bank and AFS datasets, respectively, visualized as choropleth maps. Each map is classified using quintiles to allow for a consistent visual representation when the underlying values are inconsistent due to differences in the computational methods. Next, we visualize these two separate datasets together on a single map as a bivariate choropleth, allowing for a comparison of where the combinations of high and low concentrations of each variable are co-located. Finally, the fourth visualization uses an odds ratio to compare the concentrations of banks and AFS in particular locations relative to metro-wide figures, allowing for an understanding of the unique clusters where conventional or alternative financial services dominate. Each composite figure, therefore, allows for a comparison of how the same phenomena would be represented across each of the five methods we have used, going from the least complex methods on the lefthand side of the figure to the most complex on the righthand side.

Analysis and results

The first two sets of maps (Figures 3 and 4) treat conventional banks and AFS separately and provide perhaps the most apparent insights into how the changes from method to method influence the results of the analysis. While the leftmost maps representing the 'points in polygons' technique produce a disjointed, patchwork-style result with no obvious spatial clustering, we can attribute it to this method's treatment of Census tracts as isolated, mutually exclusive, and hermetically sealed spatial units. Here, almost every tract with little or no access to either service – shaded as grey in each of the maps – is neighboured by a tract containing at least one, if not many, of the financial services. While this map clearly communicates where services actually are, it fails to capture the perceived access of individuals living or working within these tracts and does a poor job of parsing the underlying logic that goes into the geographic unevenness of financial services. Even as the maps from the second method begin to smooth out some of the disjointed spatial patterns from the first method by introducing small buffers around each tract, the results still fail to produce an intuitive picture of the clustering and inequality in banks and AFS across the Atlanta metro.

It is only with the third method utilizing a uniform distance buffer around tract centroids that clearer spatial clusters of accessibility become visible. Neighbouring tracts share similar access levels, making it easier to distinguish large-scale patterns across the metro. Notably, this third method creates two clusters of more banks in the wealthier and whiter northern portions of the metro and a trio of AFS clusters scattered across the metro, with one in east Cobb County, one in northern DeKalb and northwest Gwinnett counties along the Buford Highway corridor, and then one in south Fulton and Clayton counties. The fourth method, which switches from an absolute distance buffer to a travel time buffer based on the road network, ends up collapsing those distinct clusters into a single tighter cluster for both banks and AFS, with clearer geographic patterns emerging, which are made even more apparent when overlaying these two maps on top of each other, as in the bivariate choropleth below. Even as the bifurcated pattern seen in the fourth method is particularly useful when mapped onto the geographies of racial inequality in Atlanta, the travel time buffer's primary limitation comes in its consistent over-estimation of accessibility in the central core of Atlanta due to this method's privileging of road network connectivity over other factors.

By integrating travel times and a distance decay function, the 2SFCA best captures the experiential and relational spatial dynamics associated with accessibility, recognizing that access is not determined solely by the presence or absence of a bank in a given bounded area like a Census tract. 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 neighbours, and the 2SFCA shows modest access levels in the urban periphery. The 2SFCA creates the most interpretable and persuasive map of financial access and exclusion in the Atlanta metro while providing the most complex

and comprehensive analysis of the spatial relationships underlying financial access. The 2SFCA's more gradual and smooth patterns 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. With the most complex accessibility measure comes the most robust mapping of financial exclusion and its connections to underlying processes of racial capitalism.

Overlaying the distinct patterns of bank and AFS access in one bivariate choropleth, as in Figure 5, helps to make these patterns all the more apparent, especially their evolution from method to method. As we shift from left to right, we go from introducing a general, but still scattered, picture of high bank and low AFS access in the northern parts of the metro alongside high AFS and low bank access in the southern parts of the metro, to one that captures the distinct spatial clusters of activity. In the third and fourth methods, the bivariate choropleths are especially useful for identifying the places with high access estimates for both banks and AFS, which exist in some combination of the most accessible parts of the urban core and major commercial corridors that extend through parts of the Atlanta suburbs, such as Buford Highway corridor running to the northeast of the city proper, which is known as the major hub for immigrant businesses and residential settlement within the metro. However, again, it is only with the 2SFCA estimation that we see the full extent of the social and spatial bifurcation of the financial system in metro Atlanta, with much smaller areas of high access to both types of services and a reasonably clear north/south spatial divide that is far more spatially extensive and more closely mirrors the full extent of metro Atlanta's Black/white racial divide.

Up to this point, the visualizations in Figures 3–5 have shown tract-level financial access using a quantile classification scheme, assigning an equal number of tracts to each colour value category to allow for comparison across each metric. However, by using an odds ratio metric, as in Figure 6, we can produce a more analytical visualization that compares the prevalence of banks and AFS in a given tract relative to the overall distribution of services across the study area. In other words, the series of maps in Figure 6 shows the relative saturation of each type of financial service and more directly visualizes the bifurcated financial system of banks/AFS as established in the financial exclusion literature.

Each of these constituent maps shares a unified classification scheme where areas in white have more-or-less the expected ratio of AFS-to-banks, while 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. While each of the five maps tends to reiterate what was seen in the previous visualizations for each method, the intensity of over-representation changes considerably between methods. In the first method, most tracts 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, essentially reproducing the patchwork spatial pattern seen previously. Moreover, the more complex the access measures get, the more spatially clustered access becomes, with the third method producing another set of clear clusters of high disparities, albeit in slightly different locations than the simpler visualizations. The travel time and 2SFCA maps, however, almost entirely eliminate the extremes of access from either end of the spectrum but with even clearer spatial clusters for either bank or AFS access.

In addition to comparing the five accessibility measures, this analysis has also provided further empirical evidence of a bifurcated financial service landscape in Atlanta, both in terms of absolute access to banks and AFS and their relative concentration. 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. With the ratio of access clustering in distinct areas, it becomes clear that financial opportunity falls unevenly across the metro, with wealthier and whiter neighbourhoods continuing to have substantially greater access to capital through conventional banks, while capital maintains

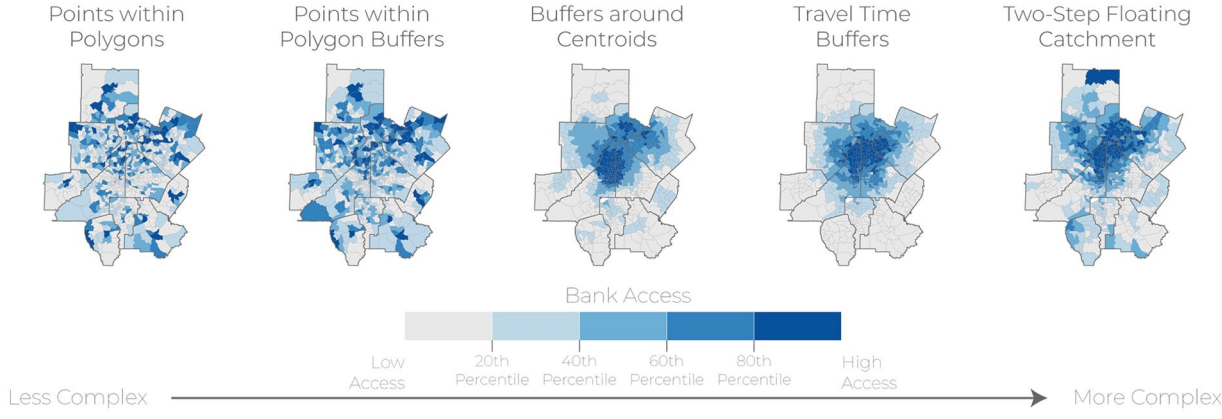

Figure 3. Accessibility to conventional banks according to five different spatial accessibility metrics.

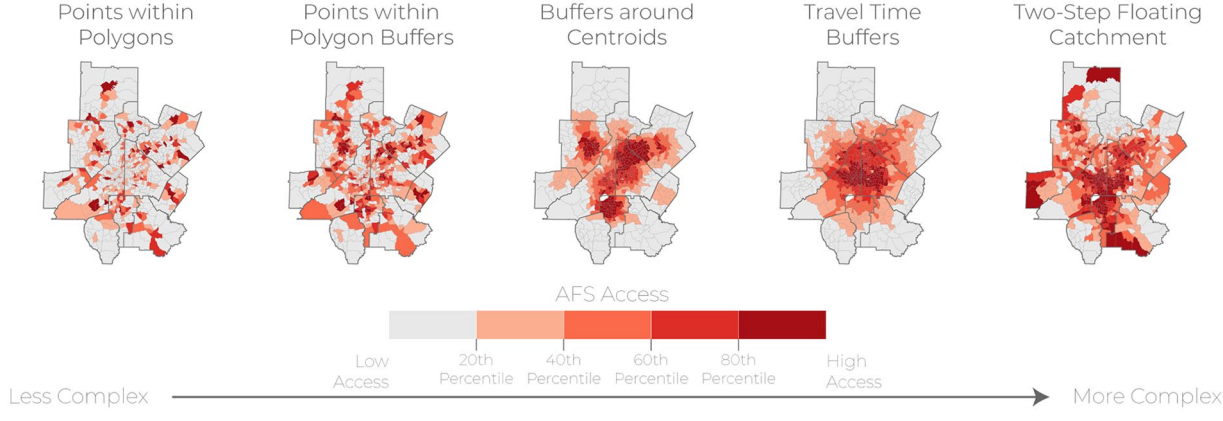

Figure 4. Accessibility to alternative financial services according to five different spatial accessibility metrics.

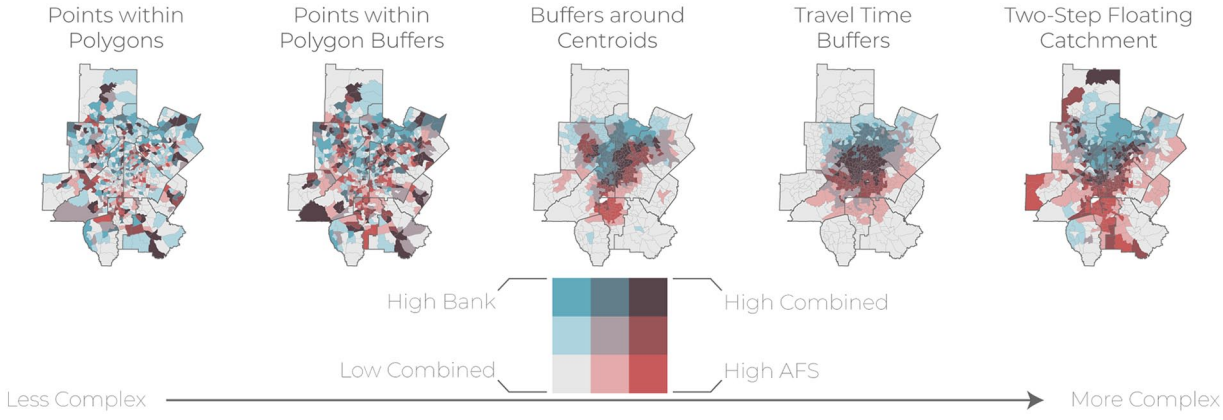

Figure 5. Bivariate choropleths of bank and AFS accessibility according to five different metrics.

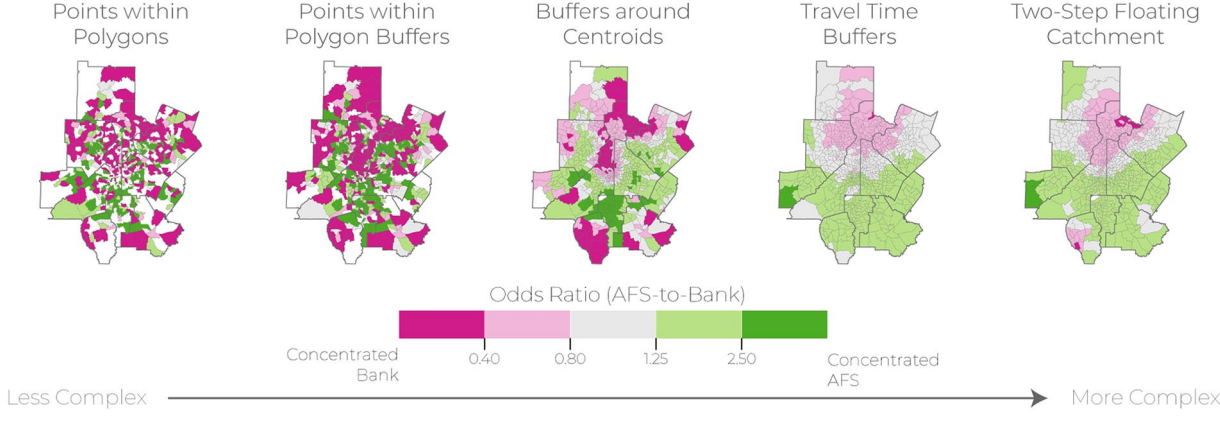

Figure 6. Bank and AFS accessibility compared via an odds ratio measure across five accessibility metrics.

greater accessibility to poorer and Blacker communities in the southern parts of metro Atlanta where AFS tend to be more prevalent than banks relative to what one would expect. Beyond these empirical findings, however, our research has contributed to a discussion of how the spatial imaginaries produced by different accessibility measures have the potential to shape broader imaginaries of financial exclusion and socio-spatial inequality, more generally. Across each set of visualizations, as the accessibility metrics become more complex (moving from left to right across each figure), so too do the uneven geographies of financial access become more apparent and more evidently connected to Atlanta's geographies of race and class.

Discussion and conclusion

Across each of the accessibility measures and visualization methods shown above, our analysis has demonstrated the existence of a bifurcated financial landscape in metropolitan Atlanta, with high access to banks disproportionately concentrated in higher-income white areas and high access to AFS concentrated in lower-income and predominantly Black areas. That said, the degree or magnitude of these inequalities depends on the measure of accessibility employed, with each metric's underlying spatial ontologies significantly impacting the way complex socio-spatial processes are distilled down into a single quantitative indicator. Comparing the visualizations of five accessibility estimates highlights the impact of quantitative and methodological decisions 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 ranging from disjointed hop-scotch patterns in the simplest method to smoother, continuous patterns in the more complex methods.

When using quantitative methods to conduct critical geographic research, it is essential to remember that how one records, measures and presents this information matters a great deal to how the audience perceives the processes in question. Adopting a critical perspective requires an acknowledgement that the results do not speak for themselves; the researcher, their methods and the assumptions embedded within them are the conduit by which quantitative data produces meaningful insight into the world and its people. This creates an imperative to intentionally engage with how theoretical assumptions inherent to a given method impact its results and to explore how alternative methodologies or metrics create competing and/or complementary findings. The resolution of that imperative is contingent on the particular questions being asked and the researcher seeking its answer. In this way, the goal of this paper is not to argue that any one spatial accessibility measure is universally better than all others, but rather, to provide an illustrative example of the insights that come from comparing results across multiple metrics and encourage similar engagement with the spatialities created in future financial exclusion research, as well as quantitative research into socio-spatial inequality more broadly.

To that end, this paper has explored the tensions present between the broader social goals of the research, its methodological complexity, and its legibility to readers. 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 well illustrate financial exclusion's connections to other spatial patterns of racialized and class-based uneven development. 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. However, the method also systematically over-represents access in the urban core over the suburban 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, which are intrinsically connected in racial capitalist societies. In this case, the tension between critical theory and quantitative methodology is resolved by using the method that best adapts conventional GIS tools to

represent the relational nature of financial accessibility and exclusion across space. Nevertheless, this method still requires a narrowed view of accessibility, as it cannot simultaneously take into account the variety of ways that individuals may have to access financial services (e.g. the 30-minute travel time estimates are for personal automobiles rather than those who are limited to walking or taking public transit, which would result in quite different accessibility estimates).

Like all GIS-based accessibility studies, however, this study is limited by only measuring the physical availability and accessibility components of access. The physical accessibility portrayed in most accessibility studies tends to be one of absolute space defined by presence or absence within a given bounded area or buffered distances. Geographers understand, however, that people perceive and make decisions based on space and 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 centre of one's neighbourhood. While the ability to integrate travel times into these accessibility measures can begin to move towards this more relational conceptualization of space, they still rely on the residential-to-service location paradigm. Furthermore, quantitative spatial accessibility metrics cannot measure the social, political, economic, cultural and psychological barriers that keep individuals from getting to conventional financial services and being able to make full use of them when present. Historically, social and political processes like redlining or even interpersonal discrimination have driven financial exclusion even more than the mere physical distribution of financial services across the urban landscape (Baradaran, 2017; Rothstein, 2017).

Ultimately, this paper has shown that using spatial accessibility measures *can* provide meaningful insights into the geographies of financial exclusion and their imbrications with broader processes of uneven development under racial capitalism. Across each of the five metrics explored in this paper, the Atlanta metropolitan area demonstrates a bifurcated system of financial access where wealthier and whiter neighbourhoods have greater access to capital through higher access to conventional banks. In comparison, capital has greater access to poorer and Blacker neighbourhoods, which offer a captive market for predatory financial services due to their exclusion from more conventional services. At the same time, the paper has demonstrated that some methods of measuring accessibility are preferable to others, not only because they produce more 'realistic' and contextually grounded understandings of accessibility but also because, in doing so, they also better capture the underlying spatial processes that drive unequal accessibility and align with broader conceptions of space and social inequality within critical human geography.

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Notes

1. 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 the following subsection.

2. NAICS code 52211002-Commercial Banking was used for identifying conventional banks, while the following NAICS codes were used to identify a variety of different types of alternative financial services: 52232003-Check Casher, 52229111-Payday Loans, 52229813-Pawnbroker, 52229815-Pawn Tickets Bought, 52222002-Automobile Title Loan, and 52229109-Title Loans.
3. To validate the locations of these establishments, we collected a random sample of 25 businesses from each dataset and searched for the addresses in Google Maps. All fifty locations matched their description from ReferenceUSA, and so we are fairly confident that this process generates an accurate accounting of financial service locations across the Atlanta metro.

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