Building on Spatial Mismatch: A New Review of Literature and An Example Case Study

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Abstract: Barriers to employment exist at different levels for minority groups, especially those that are residentially segregated. Many studies have examined these barriers, including a physical separation between the residential location and the available job opportunities since John Kain's 1968 Spatial Mismatch Hypothesis. However, recent studies of modal mismatch, racial mismatch, and skill or language mismatch, have been identified with significant impact on accessible employment without being including in a comprehensive review of mismatch literature. This research provides an updated literature review of Spatial Mismatch. It also includes a case study of a little studied region, Dallas – Fort Worth metropolitan area. The case study found that spatial accessibility is not significant to unemployment rates for the DFW area, however they are significant when reviewing Dallas county alone, implying a sensitivity directly to the chosen area of study. Where Spatial Mismatch may be unfounded for a larger area, inequities of access may exist for smaller divisions of area and in need of intervening policies or programs.

THESIS

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INTRODUCTION

Spatial Mismatch is a hypothesis that residential racial segregation displaces minority populations to the extent that physical separation from relevant job opportunities leads to lower economic outcomes. The concept itself can be related to skill mismatch or transportation mismatch as alternative focal barriers of access, however, the physical distance alone remains a significant area of focus in its own right as many minority communities still face residential segregation and comparatively poor economic outcomes. Any significant impact by each or all barriers contribute to the inequities observed today.

Since the beginning of Spatial Mismatch research, first hypothesized in 1968, continued improvements in data availability and computational methodologies have pushed the capabilities of understanding the dynamic to which physical separation of residentially segregated minorities from job opportunities are impacting economic outcomes for these individuals. Over the decades, research has found new ways of identifying and controlling for peripheral barring characteristics that might alter the measurement to which the physical distance alone impacts economic opportunities. This work has guided the understanding to which different barriers of access and physical distance have affected the employment opportunities of minorities. It is currently understood that barriers of skill, education, industry, transportation, and various forms of social racism exist for employment, and shall be addressed in this research.

There can be considered two main pillars for the original Spatial Mismatch Hypothesis, segregation and economic opportunity. The United States has a long history with residential segregation that have contributed to generational poverty and inequities. The question of why segregation exists in particular locations is left out of this research, but recognition of those that are residentially segregated is vitally important to studying the spatial impact on economic opportunities in accordance with the original Spatial Mismatch Hypothesis. As a foundational principle of the Spatial Mismatch Hypothesis, this research will consider highly the methodologies of literature where segregation is and is no evaluated, emphasizing research that appropriately measures the Spatial Mismatch of those minorities segregated.

Furthermore, works of literature on this topic have alternated between specific regions, cities, or simply provided measures the United States as a whole. While providing significant contribution, there are gaps in research for specific cities that may have been left out. However, each city's unique makeup and history provide an opportunity for a new understanding of Spatial Mismatch as the measures and inequitable access can vary greatly across areas (Ihlanfeldt & Sjoquist, 1998).

Lastly, recent years have produced more empirical analysis of traditional Spatial Mismatch research, however, there has not been a recently updated wholistic literature review on Spatial Mismatch. It appears that multiple literature reviews occurred during the early 1990s - 2000s (Holzer, 1991; Ihlanfeldt & Sjoquist, 1998; Blumenberg & Manville, 2004; Gobillon, Selod, & Zenou, 2007; Houston, 2005). Of the latest comprehensive reviews, literature was subject to the specific topic of research, such as reviewing planning policies' effect on alleviating Spatial Mismatch (Fan, 2012a).

Research Purpose and Design

The purpose of this research is to provide an updated review of Spatial Mismatch literature and contribute to a new empirical analysis of the Dallas - Fort Worth metropolitan area ("DFW"). It is for this purpose the research begins with an extensive review of Spatial Mismatch literature by bringing together recent works that have expanded the understanding and computational possibilities of measuring Spatial Mismatch. In doing so, the research exposes not only the gap since previous extensive literature reviews, but also contribute a geographical gap where unique regions of analysis have previously neglected. The review will provide further implications for the planning practice and suggest future areas of study.

In summary, the research topics are as follows:

1. Provide a current review of Spatial Mismatch literature bringing together decades of research since the original hypothesis
2. Provide a new empirical analysis of the Dallas – Fort Worth metropolitan area which has not been singularly reviewed
3. Discuss the implications on planning practice and expose areas for future research

The research is designed in a way to effectively illustrate the concept of Spatial Mismatch through a loose historical organization. As recognized by other researchers, the understanding and methodologies of Spatial Mismatch have greatly changed through the decades as continued research have exposed the significant extent to which different barriers impact employment and how they are controlled for within a methodology (Blumenberg & Manville, 2004). The primary focus of this research is primarily contained in the literature review. This literature review collects the prominent works of Spatial Mismatch since Kain's 1968 original hypothesis to present day research to illustrate the developing nature this topic. After a summary of the original hypothesis and the prominent critiques, the literature is organized by common characteristics and general shifts in the paradigm over the lifetime of its study by barriers of access. While the literature review remains focused on direct studies of Spatial Mismatch (once again, prioritize those where racial segregation is determined), adjacent studies are used in the research to better understand the general research focus of them time. The final significant contribution provides an empirical analysis of the DFW region to further highlight the necessary research for previously non-exclusively measured areas.

Literature Review

This section will review the literature of substantial contribution of Spatial Mismatch understanding. Table 1 in the appendix provides a summary and overview of primary Spatial Mismatch literature. While many articles exist, the chosen literature in the table presents direct measures or literature reviews of Spatial Mismatch.

Original Spatial Mismatch Hypothesis

Spatial Mismatch research concepts began with John F. Kain. In 1968, he published his analysis of connectivity between housing segregation and Black unemployment rates from the decentralization of employment, following White majority populations moving to suburban areas (Kain, 1968). As an economist, Kain sought to understand contributing factors for the disproportionately high unemployment rates amongst Black populations. At the time, prevailing literature focused on education and skills as an explanation, brought upon by years of racial segregation and unequal access to opportunities (Kain, 1968). As a divergent area of analysis, Kain is credited with first considering housing segregation and physical distances from decentralizing job opportunities as an overlooked contributing factor and began the Spatial Mismatch Hypothesis in three parts:

1. Racial segregation in the housing markets affects the distribution of Black employment
2. Racial segregation in the housing markets reduces Black job opportunities
3. Postwar suburbanization of employment has increased the disparity.

(Kain, 1968)

Kain's original study includes an analysis of physical distance from residentially segregated Blacks in Chicago and Detroit urban centers to employment, a per-industry analysis to understand the impact of skill or education, and a workplace Black residence ratio to represent racial bias in hiring (assuming jobs in predominantly White neighborhoods would not be available to Black individuals). With the combination of identified and available data, Kain built an index equation to model Black employment where a regression analysis would be used to determine significance of spatial distance (along with the other variables) on unemployment rates.

However, Kain's original hypothesis was constrained to limited data and methodological controls. First, the analysis of segregation uses a previous segregation index classification of central city blocks and metropolitan tracts conducted by another research. The control for racial biases in hiring is based on an assumption of near-workplace demographic makeup and there are no controls for transportation modes. Job accessibility is also generally categorized by being located within the central city and those located in the suburbs, as a way to understand decentralizing employment.

The study found that residential segregation clearly impacts the distribution of employment (Kain, 1968) signifying that those individuals must travel to separate and distinct opportunities. However, the effects on unemployment levels were determined to be more complex with additional analysis necessary (Kain, 1968). This study launched a multi-decade section of literature whereby inequities of

residential segregation were evaluated, and new data availability has changed the possibilities of understanding this dynamic situation.

Arguments Against Spatial Mismatch

While a majority of research in Spatial Mismatch has found supporting evidence that physical separation through residential segregation impacts economic opportunities, there are some instances where researchers have found no supporting evidence or simply conclude that space alone is not significantly contributing to lower economic outcomes for minorities. These studies often utilize a methodology that excludes a review of racial segregation, an appropriate control to understand and measure physical separation, or provide the results of only a specific location.

An important distinction is that Spatial Mismatch Hypothesis stipulates that physical separation through residential segregation for minority populations leads to lower economic opportunities and, originally, higher unemployment rates. A common instance that claims to be Spatial Mismatch research evaluates the residential location of groups by poverty classification (Hu, 2015; Guthrie, Burga, & Fan, 2018; Quillian, 2012; Ong & Miller, 2005). While significant contributions, they do not represent the original Spatial Mismatch Hypothesis original intent of understanding specifically how racial segregation contributes to worse economic outcomes. It is understood that there is often a clear correlation between poverty segregation and racial segregation (Quillian, 2012), however there are distinct differences. For instance, it was found that planner policies for vehicle ownership and increased housing choices specifically were more effective in areas of racial segregation rather than all areas of poverty concentration signifying a distinction not only in basic understanding, but in how planners also can interpret the empirical analysis of Spatial Mismatch (Fan, 2012a).

An analysis of residential segregation also combats a common critique of Spatial Mismatch research. As Holzer exhaustively points out in his 1991 literature review, Spatial Mismatch research is subject to an endogeneity, or rather a situation where two variables being evaluated are not mutually exclusive. In this case, it is the commonality that individuals choose to live based on their economic opportunity. Literature contradictory suggest both, that as an individual's economic ability increases, they choose to live in areas that increase their job access, as well as further away from job centers where they can purchase larger dwellings and more acres of land (Ihlanfeldt & Sjoquist, 1998; Liu & Painter, 2012). However, Holzer's critique is counter intuitive to the original Spatial Mismatch Hypothesis altogether. Endogeneity is accounted for by identification of residential segregated communities that have peripheral reasons for limited residential locations other than employment prospects (Farley, 1987). For example, social networks, particularly amongst Hispanic communities, also contribute to an individual's decision of residential location (Hellerstein, McInerney, & Neumark, 2011).

Furthermore, this supposed endogeneity is the purpose of studying Spatial Mismatch to begin with. Kain's original research was predicated on the preconceived idea that individuals would choose to live by simple cost – benefit analysis (Kain, 1968). It is precisely the fact that Black populations were heavily residentially segregated that he thought to investigate this spatial separation apart from other barriers of access. While it does not remove endogeneity altogether, concluding that

residential segregation exists is paramount to combat suggestions that Spatial Mismatch is irrelevant due to minority individuals choosing where to reside solely based on economic opportunity.

Second, a methodology must account for many peripheral characteristics in order to understand the effect of space alone on economic outcomes. As another common critique (Holzer, 1991; Ihlanfeldt & Sjoquist, 1998), and often cited by researchers, there are many barriers of access to employment and therefore difficult to address the impact of space alone (Kain, 1968; Farley, 1987). It has been through increased data accessibility and additional controls to economic opportunity that allow researchers to continue to gradually better understand the impact of space (Hellerstein, Neumark, & McInerney, 2008; Shen, 1998; Taylor & Ong, 1995).

In regard to the literature summarized, Taylor and Ong's (1995) use of analyzing commute times and how they changed of a period of time for different races and ethnicities in large cities by controlling only for mode of travel is not an adequate measure for Spatial Mismatch. Alone, it first requires individuals to even have a job for commute time measures. Additionally, the increase in Hispanic commute time is dismissed as White commutes also increased; this comparative approach is not conducive to the original hypothesis by Kain and can be caused by other factors not indicating a direct physical distance correlation (Kain, 1968). Even Ihlanfeldt and Sjoquist (1998) discredit this literature for not using suitable controls for job accessibility.

Hu (2015) and Ong and Miller (2005) both found no evidence supporting Spatial Mismatch in Los Angeles, however the results are contradictor. Hu, using only poverty classifications, found no evidence of Spatial Mismatch using a gravity model and job to worker ratios for inner city and suburban areas (Hu, 2015). Ong and Miller, on the other hand, suggest that poverty classification along with vehicular access were the strongest determinants for economic outcomes while researching the same area using a similar regression on employment ratios and job accessibility – perhaps the only differences being in the controls for transportation access (Ong & Miller, 2005).

Lastly, Boustan and Margo's (2008) research on the rate of USPS job employment for black populations found that employment for Black individuals rose while other employment opportunities moved to the suburbs. While this research is certainly an interesting finding but can hardly be conclusive to be generalized to all employment opportunities for all residentially segregated minorities (Boustan & Margo, 2008). This temporal study may have identified that Spatial Mismatch is less of an issue now (Boustan & Margo, 2008), but the methodology alone leaves room for judgement on residentially segregated minorities and a control for skill levels or transportation.

Finally, Spatial Mismatch can exist and not exist in separate areas as each city has their own history and present conditions of residential segregation and job decentralization. These distinctions are necessary when reviewing literature where no evidence of Spatial Mismatch was found as it does not conclusively relate to all cities or all forms of measurements – and vice versa. Understanding where Spatial Mismatch does not exist or the extent to where it generally does or does not exist is substantial contributions to the study alone.

Reviewing Barriers of Access

A wholistic calculation of economic opportunity is rather difficult to measure, as there is little data on job openings, future availability, or data to understand exactly the workforce qualified for the available positions (Holzer, 1991). However, over time, researchers have developed methods that statistically account for job accessibility, often using ratios of current jobs and current workers, along with peripheral demographic and circumstantial characteristics. Barriers of access generally include a diverse understanding of land-use, transport modes, temporal access, and individual limitations – and the relationship within and between components (Geurs & Wee, 2004). Specific to Spatial Mismatch, the interest is for characteristics that can be attributed to an individual not receiving a job or having the opportunity to receive a job.

Unfortunately, the data used or peripheral barriers to access often change between researchers and have not remain consistent over time. As the literature has progressed, the control barriers to economic opportunity and job access have gradually encompassed more characteristics (Blumenberg & Manville, 2004; Houston, 2005). Barriers of access to economic opportunity are used to filter *job access* to a more representative *applicable job access*. The following sections are organized by the commonly cited and measured barriers of access. These identified barriers to employment, while relevant to the solutions for and wellness of residentially segregated minorities, help guide an understanding to which physical distance alone contributes to economic outcomes for these segregated individuals. Over time and through many published works of literature, the barriers to access used as controls and peripheral characteristics make use of available data to the time and places being evaluated.

In the literature reviewed, there exists three of these categorizations for barriers that come from Kain's original hypothesis: industry, skills and education; distance and transportation access; and social racism. More often researchers attempt to control the industry, skills, education, and transportation in order to determine the significant impact of physical distance alone on economic outcomes. However, the barriers are not all inclusive and not always present in research. Over time, the barriers of accessibility that are focused on in studies has gradually changed or were given additional focus depending on the specific researcher and the area or research question.

Beginning with a rudimentary control for industry, education and individual skills, and later transportation modes, recent research has found methods for controlling social racism and biases in an organization's hiring process. Immediately after Kain's original hypothesis, literature focused much more on the economic outcome variation after accounting for industry, and education. Following this, focus shifts in the late twentieth century to account for more transport modes and the impact transportation has to job access. Lastly, a more social-conscious approach arises to account for social racism and networking in job accessibility.

The following sections will explore these divisions that give attention to accumulated barriers of economic opportunity that are used as controls to understand the impact of physical distance alone.

Skill, Education, and Industry

The first barrier includes work that has heavily focused on including the significant impact and controlling for barriers of industry and education to determine the extent physical separation impacts economic opportunity. Conclusions have leaned favorable to Spatial Mismatch, but without a general accepted consensus within the research community as to acceptable measurements and magnitude of impact of spatial separation alone. It is readily understood that education attainment and skill can provide barriers of employment whereby an individual without the required education simply cannot be expected to be hired in a position where they are unqualified. Methods have found ways to incorporate Census educational attainment as well as various forms of industry employment numbers to control the calculation of job accessibility to reasonable opportunities for the specific individuals of interest. Most often this includes measuring the spatial impact on low skill industries with low education workers (Kain, 1968; Farley, 1987; Holzer, 1991; Rogers, 1997; Immergluck, 1998). Therefore, the results are not skewed by calculations for a low education worker and a seemingly unachievable highly skilled job.

In some of the earliest works, Kain (1968) and Farley (1987) found support for their hypothesis that residential segregation and the decentralization of jobs has contributed to the high unemployment rates of Black (and Hispanic according to Farley) unemployment rates. Each study controlled for skill mismatch by using job data by industry classifications most likely to employ minority individuals. While each postulate that additional characteristics need to be analyzed to understand magnitudes of Spatial Mismatch, technological advancements and increased data availability, it is now more possible than during the 1900s. Lastly, Farley provides one of the earliest examples of a generalized Spatial Mismatch analysis of the entire United States (both Black and Hispanic populations) and concludes that support for the hypothesis exists. However, Farley sacrifices controlling for transportation modes, which could greatly skew the final results.

Holzer's (1991) review of early literature is relied upon heavily after examining the referenced literature and concluding similarly. The results of mid to late 20th century Spatial Mismatch found that general evidence support Spatial Mismatch on the conditions that residential segregation exists, populations are suburbanizing, jobs are decentralizing. As jobs decentralize, minority populations in city centers have gradual decreasing access to opportunities. Methods used in the research reviewed by Holzer included controls in job accessibility for those individuals by education attainment and job industries. As noted, other qualities that might lessen the demand for minority employment are "industrial shifts, technological change, declining relative quality of black education," presenting additional skill and education barriers for Black workers (Holzer, 1991).

Transportation

An individual's available transportation modes impact their ability to find and maintain employment with significant degree (Blumenberg & Manville, 2004). Furthermore, transportation policies have been proven to impact employment, whereby public car ownership programs providing assistance in vehicle access were seen to have a positive impact on employment outcomes (Goldberg, 2001). While reviewing literature to understand travel demand for immigrant populations, research found different races and ethnicities are likely to have different reliance on transportation modes (Chatman & Klein,

2009; Shin, 2016). Therefore, it is imperative to include controls and additional data that capture this understanding of transportation mode. Given the post-war decentralization of city residents, transportation became more and more significant to jobs that also decentralized (Ihlanfeldt & Sjoquist, 1998), and transportation mode availability became an economic class luxury that not every individual could afford. For obvious reasons, the decentralizing jobs presented an additional barrier to individuals that could not afford personal vehicles and did not have direct public transit access. Therefore, including transportation controls in job accessibilities found a strong following and significant impact in Spatial Mismatch research.

From the 1990s and onwards, the research community on Spatial Mismatch increasingly includes additional measures of transportation modes or measures of transportation access that Kain admits to erroneously leaving out of the original hypothesis in his later review of Spatial Mismatch Work. Early work in this time period were also quick to point out how transportation has previously been neglected in the literature (Sanchez, 2007).

Ihlanfeldt and Sjoquist provide a literature review and critical analysis of the 'new wave' of Spatial Mismatch literature. While highly critical of each methodology (seemingly finding no option adequate), the review in large part finds support for Spatial Mismatch existence. First that Spatial Mismatch exists, and furthermore that Spatial Mismatch can vary amongst Metropolitan Statistical Areas ("MSAs") (Ihlanfeldt & Sjoquist, 1998). The research considered transportation modes as included in the 'underlying premise' of barriers of access to job opportunity. Therefore, each article reviewed by Ihlanfeldt and Sjoquist includes an evaluation of the methodological controls used for transportation access. It is noted that "differences in mean commuting times" are alone not an adequate test of Spatial Mismatch (Ihlanfeldt & Sjoquist, 1998).

Rogers and Sanchez are two signature works that place transportation modes as predominant consideration in calculating job accessibility. Rogers' (1997) work contributes a specific and detailed account of laid off individuals and their unemployment duration with respect to commute times to jobs. There is an increase in attention placed on a worker's ability to access new work by their place of residency and mode of transportation. While contributing to the Spatial Mismatch literature, the work fails to provide a scalable methodology that is applicable across time and location (Rogers, 1997). Furthermore, Rogers lacks an equally detailed selection of residentially segregated individuals, which is principal to the Spatial Mismatch Hypothesis (Kain, 1968; Ihlanfeldt & Sjoquist, 1998). Sanchez, on the other hand, places focus on public transportation and finds significant positive correlation between public transit and number of weeks worked of non-White individuals. Nevertheless, racial residential segregation is once again lacking as an essential component of individual selection since all non-White populations are combined, even though Spatial Mismatch disparities can vary greatly amongst racial groups and sub populations (Easley, 2018; Stoll & Covington, 2010).

Along a similar paradigm, Immergluck presents supporting Spatial Mismatch literature that set a groundwork for emphasizing skill mismatch along with job accessibility through public transportation, placing a large emphasis on selecting jobs within an accessible range of residentially segregated neighborhoods (Immergluck, 1998). The research suggests that combination of skill mismatch with

accessibility controls for transportation access were necessary to address a residentially segregated individuals' economic opportunity to skill-wise acceptable jobs. While a significant contribution, the work details the limitations in job vacancy data as well as the possible biases in a gravity model for job accessibility.

RACISM

Not only should researchers consider the physical separation between residentially segregated minorities, but also refine jobs by transportation mode, skill and education, and furthermore, social forms of racism or networking for job accessibility. This is not a new concept, but rather an increase in focus on the social connections that enable economic opportunity. In fact, Kain's original research on Spatial Mismatch attempted to include a similar characteristic by determining that Black individuals would not be welcomed as employees in predominantly White residential areas (Kain, 1968). While a distinct pillar in his original research, subsequent research in Spatial Mismatch has not adequately address or improve upon this social aspect of job accessibility until only recently.

It is important that job accessibility measures take into account the racial biases apparent in hiring processes by identifying those employment areas where ethnic and racial minorities are already present. For instance, research of employment data of race and ethnicity by place of employment found a significant racial segregation amongst workplaces with language proficiency a key factor in Hispanic employment (Hellerstein & Neumark, 2008; Jin & Paulsen, 2018). Where possible, the research method should try to include the in-depth social aspects of Spatial Mismatch effect on all minority populations, racial biases in the workplace, and social network's impact on deciding residential location or available workplaces.

A defining author in this temporal division is Hellerstein et. al. Their work on racial biases in the workplace for Hispanic and Black populations provide a clear indication that minorities groups' employment opportunities are significantly impacted by social biases or social networks. Coined as "Racial Spatial Mismatch" these researchers contribute supporting evidence that social racism in the workplace must be an integral part of the Spatial Mismatch Hypothesis. Their findings can be summarized as: existing workplace presence for minority populations significantly contributes to the possibly and accessibility of ethnically or racially similar individuals to be considered for job openings (Hellerstein et. al. 2008, 2010, 2011). For Black and Hispanic minority populations, the extent to which residency impacts employment is greater for those with less education or skills.

However, the extent can even vary amongst sub-populations of minority groups. Easley's work on comparing the extent of Spatial Mismatch for Asian and Hispanic sub-populations depicts cultural differences in selecting housing or employment opportunities that lead some sub-population groups to move closer to opportunities at a quicker rate than others (Easley, 2018). This paints a more rounded picture of education, cultural, and social contributions to the Spatial Mismatch Hypothesis that has previously been left out of literature.

McManus (1990), while not directly related, presented a counter argument, even if not blatantly targeted to Spatial Mismatch. His contribution supports a positive economic outcome for Hispanic populations that live in English-deficient enclaves. Therefore, the interpretation of Hispanic segregation and economic outcomes that are often less severe compared to Black populations might find explanation in the marginal benefits of Hispanic enclaves (Holzer, 1991). Alone, this adds a peripheral contributing factor to Hispanic, and possibly other, minority individuals that may choose to live in segregated communities for a benefit of language and cultural cohesion, reducing endogeneity of housing solely on proximity to economic opportunity. A study of before and after economic outcomes for immigrant communities during the 2008 recession found that immigrants living in ethnic enclaves were more likely to return to work, which further backs up recent research that low skill and foreign-born immigrants are more satisfied, including with their economic circumstances whilst living in ethnic enclaves (Zhu, Liu, & Painter, 2014; Brazil, 2019). Additionally, a study of Hispanic youth found that neighborhood social networks and multi-lingual job opportunities increased likelihood of employment (Schuch, 2018).

Unique Studies in Spatial Mismatch

Outside of the barriers of access classifications, there exists contributing research in Spatial Mismatch that are unique amongst themselves. There are those that are unique from their data availability, methodology, locations, and population segmentation that are outside the majority Spatial Mismatch practices. These works can help fill the gaps and understanding of Spatial Mismatch even if not generally applicable or replicable for various locations. The following sections provide a review of such unique studies and their impacts on the Spatial Mismatch Hypothesis and Table 2 in the Appendix provides a summary of these unique studies.

Data Availability or Methodology

Liu and Painter (2012) and Zhu, Liu, and Painter (2014) provide an overtime analysis of Spatial Mismatch that is unique in that the component of time and the economic conditions therein are the crucial variables of themselves (Liu & Painter, 2012; Zhu, Liu, & Painter, 2014). It is the focus on the time periods of vast economic growth (2012) or time period of national recession (2014) the help understand these macroeconomic impacts on residentially segregated minorities. Other papers include time components, but the chosen time periods of themselves are not as an essential role as seen in these mentioned articles (Taylor & Ong, 1995).

Sugie and Lens (2017) have perhaps the most unique data used in Spatial Mismatch literature with real time GPS tracking of recent parolees. Tracking daytime travel behaviors and the duration of unemployment adds significant detail to the hypothesis that spatial proximity to jobs affects economic outcomes. While it does not directly point to residential and job spatial distance, it is contextually understood that proximity to jobs allows for individuals searching for jobs to be near and around the job openings more frequently. Nearly impossible to reproduce, this work provides a contextual element of Spatial Mismatch and a further understanding of how clusters of jobs might prove more accessible by the capability of spending time within the vicinity.

Further work aims at providing detailed analysis of job accessibility that factors in dimensions of time and space, a temporal component that is significant, but often left out due to the complex data and calculations necessary (Geurs & Wee, 2004). An example study used volumetric data for space-time evaluation in a gravity model to determine the economic outcomes by mapping places of work in Tampa, Florida (Hu & Downs, 2019). While fulfilling the research purpose of providing a detailed measurement of job accessibility, the calculates neglected to include racial based segregation analysis.

Alternate Countries

The United States has not been the only nation with decentralizing jobs or with residential isolation for individuals of specific minority or poverty groups. Articles relevant to Spatial Mismatch but with qualitative and quantitative research primarily of another nation are reviewed to provide addition global insight. In Sweden, Aslund et al. researched Spatial Mismatch over time using data from refugee resettlement programs. Endogeneity of housing selection could be completely controlled for as the government's placement program and selected housing options for refugees. The study found that those refugees placed further away from job opportunities had long term economic disadvantages (Åslund, Östh, & Zenou, 2010). In Brazil, Oliveira provides a comparative review of Brazil and the United States' policies and infrastructure changed that accommodate decentralizing jobs (Brazil, 2019; Oliveira, 2016). The review focus on the impact and adverse effects of housing policies that lead to the social and economic inequalities also observed by the Spatial Mismatch Hypothesis.

Poverty Status as Population Grouping

Lastly, a final unique study classification is on the focus and emphasis on poverty status classification in Spatial Mismatch. As Quillian (2012) suggests, there are three segregations, one of race, one of poverty, and one of poverty within a race. In their work, it is suggested that poverty classification add additional levels of analysis in understanding the disadvantages of spatial separation from opportunities. However, this work is not a direct measure of Spatial Mismatch nor does it attempt to be. It provides only a contextual component on segregations. Hu (2015) on the other hand, provides a typical Spatial Mismatch methodology using the gravity job accessibility model, on poverty classifications in LA. The research found that individuals in poverty in LA are spatially closer to job opportunities and therefore there must exist non-spatial barriers that limit more positive economic outcomes.

Fan is a prominent author, or co-author, whose work often considers bridging the gap between spatial mismatch literature and planning policies or actions. However, Fan consistently measures on poverty and low-wage residential concentrations rather than utilizing a racial or ethnic segregation (Fan, Guthrie, & Levinson, Impact of light-rail implementation on labor market accessibility: A transportation equity perspective, 2012b; Guthrie, Burga, & Fan, 2018). Therefore, her work reviewing policies impact on Spatial Mismatch acknowledges planners (specifically transportation planners) that work to improve accessibility between poverty areas and common low-wage workplaces. The team of researchers have produced policy recommendations to planners as well as evaluated effects of planning decisions on

alleviating inequities of Spatial Mismatch (Fan, 2012a). The conclusion found that car ownership and maintenance programs were the most effective. However, once again the evaluation is done considering Spatial Mismatch between poverty classifications rather than a social and racial segregation that is the basis for Kain's original hypothesis.

Literature Conclusion

Decades of Spatial Mismatch literature have revolved around finding methodologies and understanding the extent to which spatial separation of segregated minorities face barriers to employment. Since Kain's original Spatial Mismatch Hypothesis, literature from planning academics and economist have theorized and evaluated how this physical displacement has affected the economic opportunities and outcomes of individuals.

This review of literature has organized generations of work into foremost categories by barriers of access controlling job accessibility. Barriers of industry, education, and skills were prevalent throughout the work reviewed and utilized almost in every study by matching appropriate industries with worker opportunities. However, detailed accounts of transportation access and modality came through paradigm shifts, not only in Spatial Mismatch and after the early studies. Most recently, work reviewing specific controls for the effect of social racism and networking found ground in Spatial Mismatch to improve upon Kain's original method, which had largely been ignored. This review found that each incremental understanding of barriers to employment access have contributed significantly to understanding and evaluating the role that physical distance alone has on employment for residentially segregated minorities.

Support for all three research questions is found in the literature review. First, the last substantial literature review of Spatial Mismatch occurred in the early 2000s. Literature since that time have include more social aspects into the nuances of job accessibilities attributed to social racism and networking capabilities or the differences between minority groups capability to relocate for better economic opportunity. Second, the literature reviewed found many repeated locations such as Chicago and Los Angeles, with the majority of work reviewing many cities or MSAs across the entire nation. There exists a need to see more singular city or MSA evaluations to help determine possible differences in historical, political, or social characteristics that might separate cities and alter the magnitude of Spatial Mismatch. Lastly, apart from Fan's work to review planning policies impact on Spatial Mismatch, no other literature was found to provide insight into programs that might have successfully impacted the economic inequalities of residentially segregated minorities.

CASE STUDY: DALLAS – FORT WORTH

Dallas – Fort Worth was chosen as a case study for empirical analysis as it has been previously neglected for individual analysis and review of Spatial Mismatch. Most common locations are Chicago, Detroit, and Los Angeles, but DFW presents its own unique study. Each city has a distinctive history and demographic make-up. DFW and Los Angeles may share more demographic characteristics as having large Hispanic populations relative to other common cities in the Mid-West and East coast. However, politically and in terms of recent growth, DFW stands apart. While it has been reviewed in national Spatial Mismatch studies, a specific review of a single city or MSA provides unique insight that can help understand aspects of Spatial Mismatch, especially when compared with similar reviews of other MSAs or cities. The purpose of this case study is to illustrate a new empirical analysis of the Dallas – Fort Worth metropolitan area in order to contribute to further literature and understanding of Spatial Mismatch in the hopes that more individual regions will be evaluated apart from general national analysis.

METHODOLOGY

This research provides a quick summary of articles that reviewed Segregation and Job Accessibility measures. The Dissimilarity Index is the most common method for measuring and visualizing segregation while a Gravity Formula is most common for measuring accessibility. Each have their own weaknesses but make up for it with feasibility and simplistic concept. As there is little consensus for an appropriate Spatial Mismatch methodology, knowing the limitation and data availability for commonly accepted methods is crucial to continuing research (Holzer, 1991; Houston, 2005; Ihlanfeldt & Sjoquist, 1998). The majority of Spatial Mismatch research utilizes a job proximity equation, with is dependent on the researcher's chosen controls and data availability. It is simple to understand, and with the right tools and data, replicable across different areas and scalable to various geographic planes.

For a choice of methodology, it is also important to find the balance between practicality and theoretical accuracy (Geurs & Wee, 2004). The significant impact of evaluating specific cities is even greater if methodology can be replicated by further research to understand how the differences in demography and political history that might affect the outcome of the otherwise identical research. Furthermore, and as discussed in Implications, the research may be significant to planners that may find similar calculations or evaluations useful in practice.

As mentioned, Spatial Mismatch has two areas of significant calculation, most commonly followed by a regression on the dependent economic outcome variable of choice. To stay true to Kain's original Spatial Mismatch Hypothesis, first step is identifying residentially segregated minorities. Second is calculating job accessibility or economic opportunity. Lastly, researchers have favored a regression of the unemployment rate to understand the significant contribution of barriers (Ong & Miller, 2005; Zhu, Liu, & Painter, 2014; Jin & Paulsen, 2018; Easley, 2018; Immergluck, 1998; Farley, 1987; Kain, 1968).

DATA

The demographic data used in the case study came from IPUMS National Historical Geographic Information System (NHGIS)[1]. This data is a collection of 2017 American Community Survey 5 Year estimates for block group locations. Data included all demographic race and ethnicity totals, data for workers by residential location including drive time, poverty status, education, and modes of transportation. Manipulations occurred to distinguish non-Hispanic White individuals, non-Hispanic Black individuals etc. to provide an accurate total without double counting. Rates were calculated to determine the unemployment rates, poverty rates, limited English-speaking, Spanish-speaking households, education attainment rates, transportation rates, and commute time rates. Each of these variables are provided, where calculable, for the block group for analysis.

The DFW metropolitan area contains 4,158 block groups covering thirteen counties of the MSA. The statistics below provides a summary of the wholistic data for DFW.

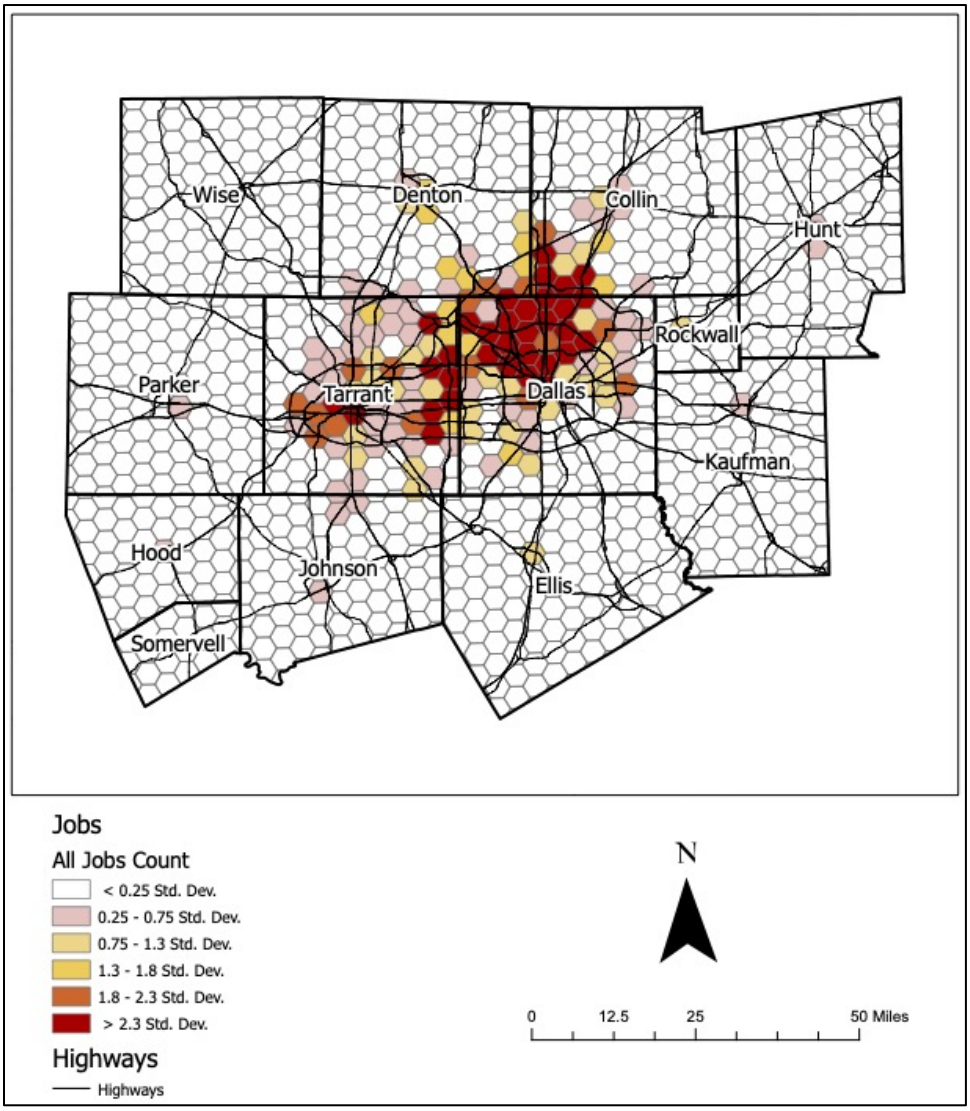
Total people	7,104,415
White	3,383,689
Black	1,073,234
Asian	445,094
Other	183,894
Hispanic	2,018,504
In the labor force	3,722,016
Drive to work	3,137,292

Job data is provided by Longitudinal Employer-Household Dynamics ("LEHD") Origin-Destination Employment Statistics ("LODES") through the OnTheMap virtual tool. Job data is downloaded by job location and enumerated by 2010 census blocks as a point file for all jobs in the state of Texas reported 2017. The data includes the number of jobs available in total, by industry, by race and other delimiters. Using ArcGIS software, job data was accumulated to 10 square mile hexagons to make calculations more feasible during the analysis. After accumulation, 1,582 hexagons were used to cover the thirteen counties of DFW along a 10-mile buffer outside of the county lines to account for jobs just outside as competition. See Map 1 below to view all job locations in DFW by the number of jobs.

Total jobs	3,580,116
Low skill industry jobs	1,642,528
Jobs employing People of Color	1,762,023

[1] (Manson, Schroeder, Riper, Kugler, & Ruggles, 2020)

MAP 1: LOCATION OF ALL JOBS



In the above map, it is easy to see the majority of jobs are found in the primary cities of Dallas, Arlington, Fort Worth, Plano and Irving. The largest concentration of jobs can be seen just north of Dallas. City centers of the surrounding cities also have a relatively higher concentration of jobs compared to the nearby rural areas.

SEGREGATION

Racial segregation is a cornerstone of Kain's original hypothesis. It is important that chosen minority groups during a Spatial Mismatch study are first identified as racially segregated, as it counters an argument of endogeneity. As previously mentioned, an instance of residential racial or ethnic segregation suggest individuals are limited from peripheral characteristics, imposed or elected, to live in specific communities and not solely based on job locations or economic opportunity.

A dissimilarity index is the most common method for calculating segregation (Stoll & Covington, 2010; Easley, 2018; Brazil, 2019; Reardon & Glenn, 2002). It provides a quick analysis that is easy to calculate and understand with readily available data. However, the dissimilarity index is highly criticized as a methodology as an accurate measure for more nuanced characteristics of segregation (Reardon & Glenn, 2002). While a simple approach, it lacks the sophistication perhaps necessary to isolate multigroup segregation.

To start with, the dissimilarity index is criticized as being only a measure of *evenness* but lacks the ability to measure three other dimensions of segregation: *concentration*, *centralization*, and *clustering* (Reardon & Glenn, 2002). And while the dissimilarity index method is the most common, Wilson (2011) provides a review and suggestion of the Theil's Entropy Index as a segregation measure. The benefit of using the Entropy Index or Diversity Index is that it controls for a geographical unit of space in a way that normalizes data and makes geographical units comparable. However, it does not determine which group is predominate, which could be identified separately, but does add additional calculation to select the chosen residential segregated areas. According to an analysis of Multigroup Segregation Measures, all measures except for the Entropy Index[2] cannot account for transfers, a measurement principle that if an individual moves from a unit that has a high measure of segregation to a unit that has a lower measure of segregation, the total measure of segregation should decrease (Reardon & Glenn, 2002).

This research utilizes the Entropy Index to identify segregation (see Equation 1 below). Block groups that are identified as less diversified and maintaining a majority presence of a minority group is considered to be segregated[3]. Of the 4,158 block groups, 470 block groups were identified as being segregated.

EQUATION 1: ENTROPY INDEX

$$h_i = -\sum_{j=1}^{k} p_{ij} \ln(p_{ij})$$

Where:

k	=number of ethnic groups ("ethnicities")
p_{ij}	=proportion of population of j^{th} ethnicity in tract i ($=n_{ij}/n_i$)
n_{ij}	=number of population of j^{th} ethnicity in tract i
n_i	=total number of population in tract i

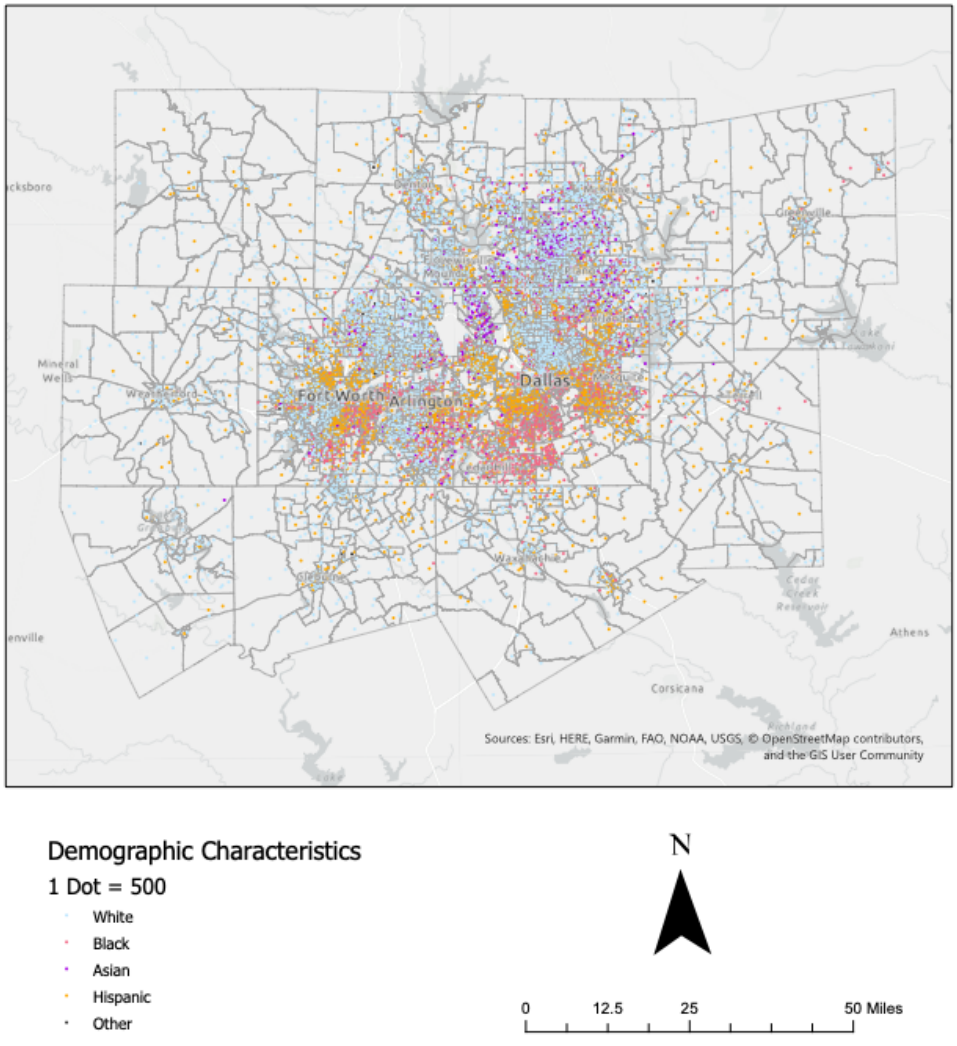
[2] Reardon & Glenn refer to the Entropy Index as Theil's Information Theory Index

[3] Less diversified block groups are those with entropy indices that are one or more standard deviations below the mean. In this case, it was those indices less than .7 where ln(5) ~ 1.6 is the maximum value.

(Forest, 2005)

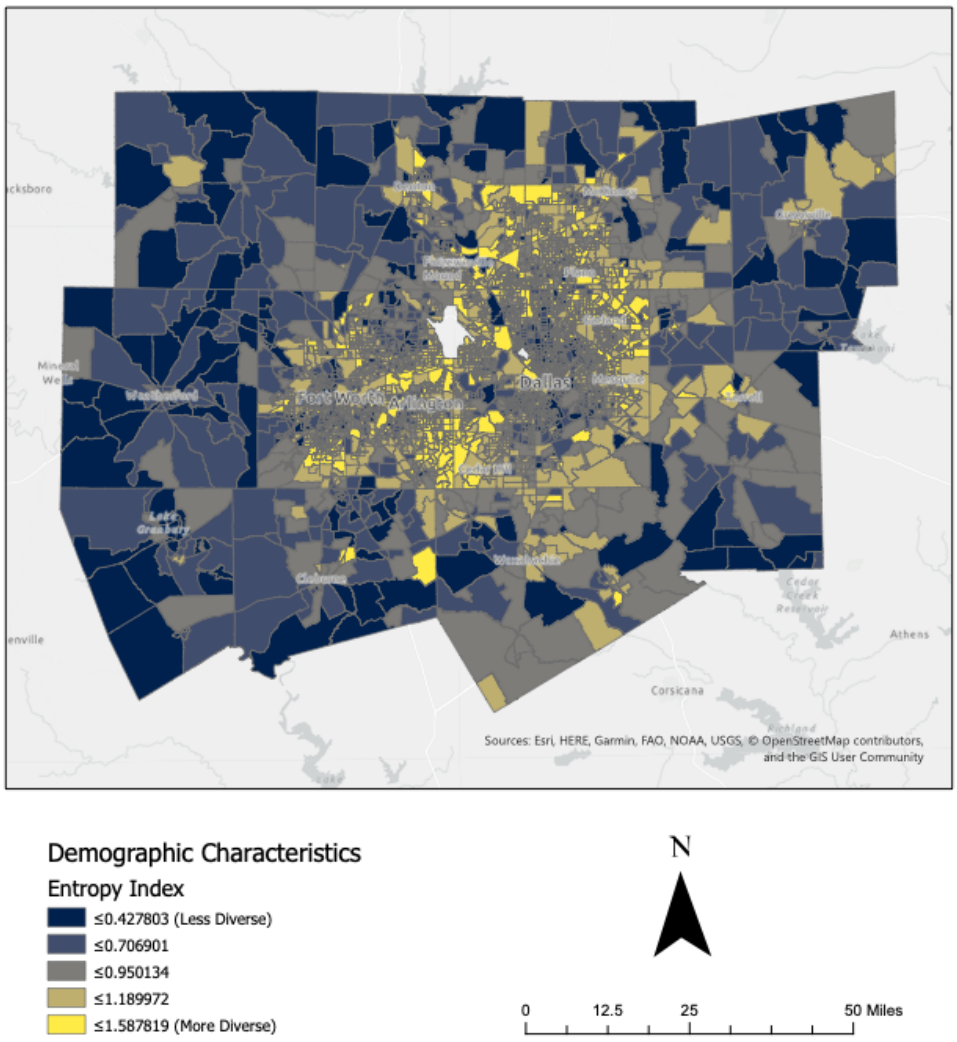
This index identifies areas of diversity on a logarithmic scale to allow greater comparison amongst other chosen geographical units of measurement. The Maps 2, 3, and 4 below show first the population of DFW by race, second the values of the Entropy Index across DFW, and lastly the block groups that are identified as containing segregated minorities. In Map 2, the concentrations of race and ethnicity are apparent in DFW. Visually, it would appear that Dallas has the clearest divide between population groups with the North being primarily White, East and West being Hispanic, and South Dallas being predominantly Black. Asian populations are more common far North and West of Dallas. Arlington and Fort Worth show similar divides with West being White, and East being mixtures of Hispanic and Black.

MAP 2: DEMOGRAPHIC POPULATION OF DFW



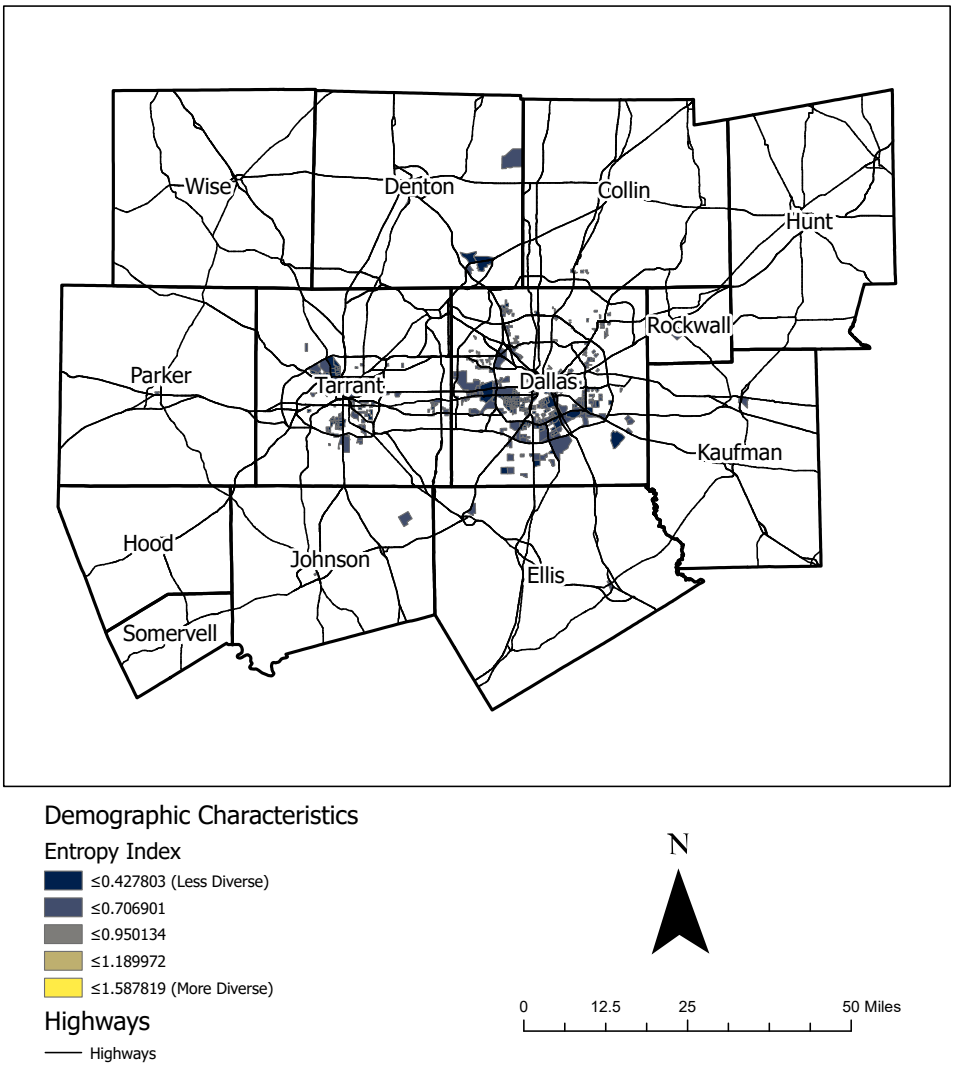
Map 3 and 4 below are showing the results of the Entropy Index, with those block groups identified as segregated shown alone in Map 4. In Map 3, notice that many of the outermost block groups contain very little diversity, however these areas are predominantly White making them non-areas of interest according to the research's definition of segregation.

MAP 3: ENTROPY INDEX OF DFW



Map 3 showing Entropy Index values shows high areas of diversity in East Arlington, South and East of Fort Worth, and far North of Dallas. The areas of low Entropy Index values of dark blue indicate less diversity. Map 4 below shows only block groups with Entropy Index values at or less than .7 with a predominant race or ethnicity that is non-White.

MAP 4: IDENTIFIED SEGREGATED BLOCK GROUPS



The final analysis of segregated areas that will be identified for analysis are shown in Map 4. The majority of segregated block groups are in East, West, and South Dallas. Fort Worth has the second most in the areas of North and East. Some of the surrounding cities will have a few segregated block groups, typically around the city center. This culmination of evaluation found that segregated areas do exist in Dallas – Fort Worth and there is a visual and mapped concentration within the primary cities.

EMPLOYMENT ACCESS

Standard to Spatial Mismatch research, there are four main categorizations of measurements – Commute times, earnings or economic outcomes, job proximity models, and detailed spatial experiments (Houston, 2005). Job proximity models are the most common with a gravity model being used. Generally, the job accessibility equation will factor in the various barriers of access used to control for a segregated

minorities true accessibility and conclude the effect of physical distance. A critical analysis of available methods is not necessary as there exists literature that has extensively reviewed current and previous methodologies. Like most methodologies, a primary limitation surrounds *operationalization*, or the ease of use and concept, along with the number of resources necessary (Geurs & Wee, 2004). The Table 3 below summarizes Houston's 2005 review of job accessibility methodologies by strengths and weaknesses.

TABLE 3: SUMMARY OF HOUSTON (2005) REVIEW OF SPATIAL MISMATCH METHODOLOGIES

Method	Weaknesses	Strengths
Commute Times	Selective biases on propensity to commute, cannot measure how space alone acts as barrier to employment	Comprehensive coverage, simple concept, measures cost/benefit of spatial barriers
Earnings	Does not model supply and demand of labor, does not measure how space acts as a barrier to employment, does not account for housing and commute costs	Could provide comprehensive coverage and with the right controls provide a location-based measure of supply and demand
Job Proximity	Does not naturally account for competition in labor, straight line distances, does not measure how space acts as a barrier to employment	Comprehensive coverage, conceptually transparent, and can measure directly the extent of spatial mismatch
Spatial Experiments	Difficult to generalize, subject to the current economic conditions, limited availability and time consumption	Can be built to control for all varying aspects and measure how space acts as a barrier to employment

Other researchers have also critically reviewed various methodologies to understand which amongst them are appropriate for valid research. The use of Commute Times alone often draws criticism as a weak measure of Spatial Mismatch as there are no controls for social aspects of employment accessibility, and rather relies on those individuals who already have jobs to represent what is possible (Ihlanfeldt & Sjoquist, 1998). The Gravity Model, identified and later revised by Shen (1998), provides a common method of calculating Job Proximity measures. While the most accurate measure would contain data specifically on job availability and current job seekers (Ihlanfeldt & Sjoquist, 1998), the revised Gravity Model has built in characteristics to account for supply and demand within the labor market of the research area (Shen, 1998). See Equation 2 below.

EQUATION 2: GRAVITY MODEL WITH SUPPLY AND DEMAND

$$A_i = \sum_j \frac{O_j \, \mathrm{f}(C_{ij})}{D_j}, \qquad D_j = \sum_k P_k \, \mathrm{f}(C_{kj})$$

Where

A_i is the accessibility index for location *i;*
O is the opportunities or jobs at location *j*
$f(C_{ij})$ is the impedance function on the distance between *i* and *j*
D_j is the competition of demand by workers in resident location *k* for job location *j*
P_k is the worker population at location *k*
$f(C_{kj})$ is the impedance function on the distance for workers residence (*k*) to jobs (*j*)

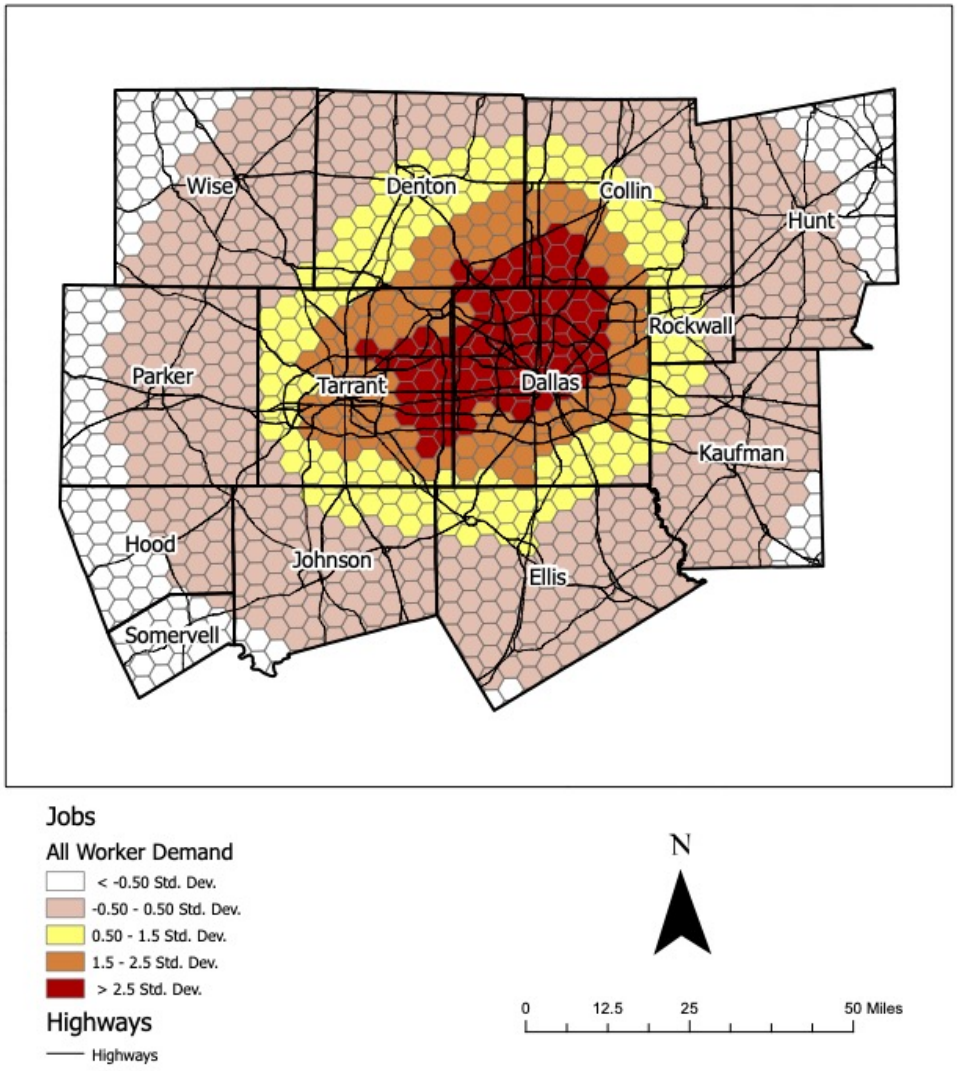
This measurement allows for worker competition to be included. Previous gravity models only reviewed opportunities with an impedance function but this was considered to be lacking a crucial understanding of job demand and competition for the number of jobs available (Shen, 1998).

Maps 5, 6, 7, 8 in the appendix show the results of the demand function by different classification of workers or possible workers[4]. Maps 9, 10, 11, 12 in the appendix show the results of the combined accessibility formula by the separate classifications and their respective job opportunities of interest to Spatial Mismatch research[5]. Map 5 and Map 9 are included below as examples of results as the evaluations prove visually similar across each paring. The formulas for calculating the worker demand and accessibility indices as Arcade functions in ArcGIS Pro are provided in the Appendix in Tables 4 and 5.

[4] Classifications include: (1) all individuals in the labor market (2) all low education individuals as having a high school degree or less (3) individuals who drive to work using a vehicle (4) all People of Color

[5] Pairing are done as (1) all individuals in the labor market to all jobs (2) all low education individuals to low skill industries (NAICS codes 01, 02, 03, 04, 05, 06, 07, 08, and 18) (3) individuals who drive to work using a vehicle to low skill industries and (4) People of Color to low skill industries

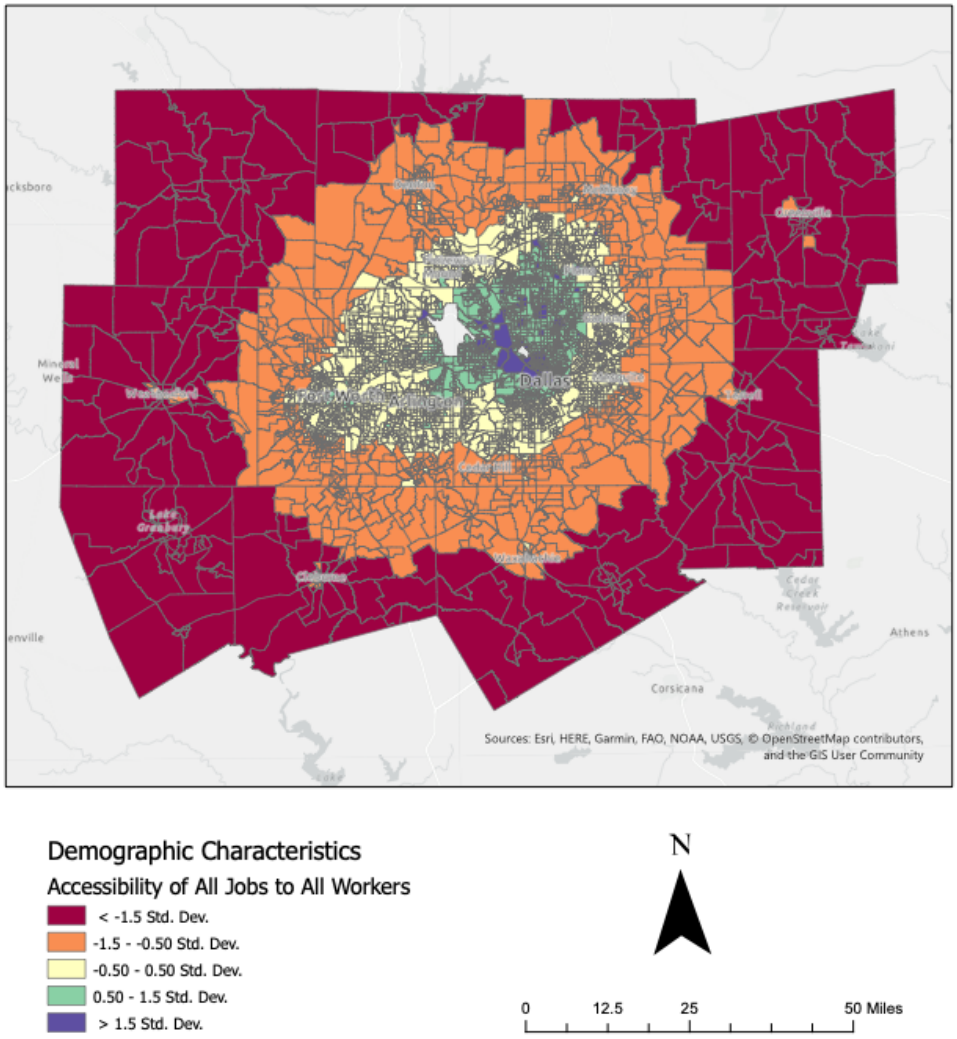
MAP 5: WORKER DEMAND FOR ALL JOBS



Map 5 above displays the worker demand for all jobs in Dallas – Fort Worth by calculating the number of total jobs compared to the number of surrounding labor force residents. This calculation is significant as if 10 jobs are in an area with 15 applicable workers, there is a job shortage for the single area. The calculation accounts for job demand by residents for the number of jobs that exist according to the revised Gravity Model (Shen, 1998).

Map 9 below shows the accessibility of jobs by residential location for all jobs and all workers. As expected, accessibility increases as residential locations move towards the center of Dallas – Fort Worth, with the highest levels of accessibility in Northwest Dallas. Downtown Fort Worth and Arlington present high levels of accessibility with medium values present throughout these three primary cities. Areas in North Dallas have both high and the highest levels of accessibility, dependent on the exact number of adjacent jobs and worker demands. Outer cities can be seen to have increased levels of accessibility near the city center, but for the most part are the lowest levels of access.

MAP 9: ACCESSIBILITY FOR ALL JOBS TO ALL WORKERS



Visually comparing the residential locations of minorities and segregated block groups from Map 3 and 4 above, it can be observed that minority races in South Dallas are at a greater disadvantage to job access. However, given that the comparison of White residents to racial and ethnic minorities, the outermost block groups and their low levels of accessibilities might skew the results for the entire Dallas – Fort Worth evaluations. Maps were created for each group paring previously detail and are available in the appendix. Visually the worker demand and accessibility maps for each paring are similar with few variations, but not significant by just a visual review.

Regression Results

The following results are calculated by an Ordinary Least Squares (OLS) Regression on the variables with unemployment rates[6] as the dependent variable. The purpose of this regression is to understand the significance of physical distance, by accessibility index, on residentially segregated minorities in DFW while also identifying other significant variables of access. The variables are listed below:

[6] Unemployment rate calculated by the number of civilian unemployed individuals in the labor market divided by the total number of civilians in the labor market

TABLE 6: REGRESSION VARIABLES

Variable Names	Measurements	Hypothesis
Dependent Variable:		
Unemployment rate	Rate of unemployed persons in labor market	
Independent Variables:		
White Non-Hispanic	Count of individuals	
Black Non-Hispanic	Count of individuals	
Asian Non-Hispanic	Count of individuals	
Hispanic	Count of individuals	
Other Non-Hispanic	Count of individuals	
Labor force participants	Count of individuals	-
Jobs by Race	Count of jobs by the race and ethnicity of job holder	
Jobs by Industry	Count of jobs by the NAICS industry	
Entropy Index*	See Equation 1	-
Accessibility[7]*	See Equation 2	-
Low education	Rate of individuals with below highschool education	+
Medium education	Rate of individuals with high school to some college education	-
High education	Rate of individuals with bachelors or higher education	-
English-speaking residents	Rate of individuals with low English skills, speaking Spanish	+
Drive to work	Rate of individuals driving to work	
Public transit to work	Rate of individuals using transit for commute	
Commute times	Average commute times	+
50% below poverty	Rate at or below 50% poverty	+
200% above poverty	Rate at or above 200% poverty	-

*calculated

First, the regression was performed for each worker and job pairing for all block groups in DFW. The results found that in all instances the spatial distance measured by the accessibility index had an inverse effect on the unemployment rate, where accessibility increased, unemployment decreased. However, the variable was not found significant. The significant variables, again for each instance, were

[7] Accessibility measure captures physical distance through the Gravity Model

below poverty rate (direct), 200% above poverty rate (inverse), limited English skills in a Spanish speaking household (inverse), higher education (inverse), and public transit or drive time variables (direct). These findings are consistent with other research that similarly finds the same characteristics as significantly affecting unemployment rates. Results for all workers and all jobs are proved in Table 7 below. Results for other worker and job pairings are available in the appendix.

TABEL 7: ALL WORKER AND ALL JOBS IN DFW

Variable Name	Coefficient	Std. Error	t-statistics	Probability
Entropy Index	.004	.003	1.54	.124
50% under poverty rate	.079	.009	8.62	.0000*
200% over poverty rate	-.040	.007	-5.55	.0000*
Spanish-speaking skill	-.047	.010	-4.55	.0000*
Low education	-.015	.010	-1.54	.123
Medium education	-.012	.011	-1.10	.271
High education	-.032	.008	-3.82	.0001*
Personal car	-.012	.012	-.915	.360
Public transit	.048	.024	2.01	.044*
Drive under 30 minutes	.077	.030	2.58	.010*
Drive over 30 minutes	.073	.030	2.41	.0159*
Accessibility of All Jobs	-.005	.003	-1.81	.0702
Adjusted R^2	.158			

*Significant ($p < 0.01$)

To summarize the findings for the first analysis in Table 2, the Dallas – Fort Worth metropolitan area as a whole exhibits a correlation between income and unemployment. Areas that have high poverty rates (*underpovertyrate), and inversely with areas containing wealthy residents (*200overpoverty), have a significant probability of containing higher unemployment rates. Furthermore, neighborhoods that have skill mismatch, such as a lack of English-speaking skills (*spanishlimitedenglishrate), or inversely those with higher education (*higheredrate), also correlate significantly with unemployment. These results are commonplace and expected based on other literature.

Second, a regression is performed specifically on block groups intersecting with Dallas County. The results for all jobs and all workers are below in Table 8.

TABLE 8: ALL WORKERS AND ALL JOBS IN DALLAS COUNTY

Variable Name	Coefficient	Std. Error	t-statistics	Probability
Entropy Index	.003	.004	.480	.631
50% under poverty rate	.083	.016	5.09	.0000*
200% over poverty rate	-.060	.013	-4.56	.0000*
Spanish-speaking skill	-.034	.017	-1.99	.0463*
Personal car	-.027	.021	1.27	.204
Public transit	.040	.036	1.08	.279
Accessibility of All Jobs	-.010	.006	-1.79	.0743**
Adjusted R^2	-.165			

*Significant ($p < 0.01$)

**Significant Robust Pr

Dallas county visually presented the largest degree of mismatch between minorities and economic opportunity and therefore was reviewed separately. In the regression analysis, it was found that similar to DFW as a whole, income and English-speaking skills were significant indicators of unemployment rates. However, job accessibility was also considered significant for all instances and even more so for low education workers to low skill industries, workers that driver to low skill industries, and for People of Color accessing low skill industries. Each job accessibility coefficient indicates an inverse relationship where accessibility increases, unemployment rates decrease.

Implications for Planning

In 2009 there existed a panel discussion with prominent planners and inequality issues facing America. The documented discussion did include some acknowledgment of racial segregation impacting economic outcomes (Soureli & Youn, 2009). While a simple recognition, this is the only present crossover between Spatial Mismatch literature and direct planning practice found in the unique category. However, this is not surprising as difficult and complex methodologies, as well as rarely available data, are not often a suitable choice for public staff.

Planners around the United States of varying cities are, or rather should, be concerned with equitable access and economic opportunity. Through land use decisions, transportation planning, and all facets of urban planning is the innate responsibility to serve the individual citizens that live in, visit, or otherwise are affected by a city's design and policy choices. Continuously exposed by planning literature is the general inequitable access of minorities and racial and ethnic residential segregation. The two afflictions are often examined and reported on within cities, exposed by the United States Department of Housing and Urban Development (HUD), or areas of contention during local elections. Policies and programs often target the barriers separately: segregation with housing policy, skill and industry diversity with land use and economic development, and transportation with car ownership and public transit. While these singularly targeted programs can be effective, there is little evidence reviewed in literature that evaluate specifically the spatial distance between *residentially segregated minorities and employment opportunities* are simultaneously confronted (Fan, 2012a). In pursuant of the third research purpose, this is perhaps where the greatest implications of Spatial Mismatch literature exist.

There exists a gap between planning theory and planning practitioners where knowledge, applications, and evaluations are being lost without providing a direct benefit to the cities that are researched (Brooks, 2002). Inequities in economic opportunity for *residentially segregated minorities* has continued for many decades now as planners continue to struggle with holistically resolving these patterns. Programs and policies targeting the specific barriers similar to those of Spatial Mismatch are common as well as addressing employment opportunities for areas of concentrated poverty, however, literature suggest that programs targeting simultaneously economic opportunity and racial segregation might be most impactful.

In order to *bridge the gap*, this research has provided an extensive literature review of Spatial Mismatch, a case study of Dallas – Fort Worth and will go further to summarize the implications for planning by common solutions to specific facets of Spatial Mismatch. The case study provides evidence that Spatial Mismatch is subject to the areas of study and therefore solutions for different areas may need to be implemented by regions, county, or local bodies to produce effective results. At large, solutions to improve economic outcomes have been found to not be effective for minority populations, except for transportation solutions. These two areas of implications are expanded upon for further review.

Review of Implications from DFW and Dallas Case Study

The previous case study found that spatial accessibility is significant for workers in Dallas County, while simultaneously not significant for Dallas-Fort Worth as a whole. Other locations or studied regions might find similar patterns for their most segregated areas as Spatial Mismatch measures are subject to the area of study. Therefore, planners and policy makers must be aware on multiple dimensions where strategic programs will be most effective. This will also determine the likely governing body that is concerned with the solutions, either as a regional plan, county plan, or even down to city or neighborhood solutions. Specific to resolving inequitable access for segregated minorities, blanketed solutions should not be applied to entire areas if the significant impact is concentrated to specific locations.

Review of Solutions

Housing Solutions

Housing solutions that target racial segregation have been used since the civil rights movement, often by the guidance and direction of the U.S. Department of Housing and Urban Development through finance programs and grants that allow for more housing mobility and choices of living. The programs for housing supply through affordable options and housing demand through finance assistance often focus on undoing the concentration of those in poverty as well as by racial and ethnic enclaves. A review of housing program's ability to impact economic outcomes found that housing programs have little significant impact at effecting employment outcomes (Fan, 2012a). However, a conclusion of previous reviews on planner's impact on public housing programs found that, in order to be more effective, the programs should "ensure the areas where program participants move have suitable job opportunities in addition to having low poverty and less minority concentration" (Fan, 2012a).

Land Use Solutions

Planners often work to target the industry, education, and skill mismatch by land use controls or economic development to allow for varied work opportunities primarily near socioeconomic disadvantaged neighborhoods. It is common practice for planning and public staff to incentivize or specifically allow industries that might improve the employment outcomes for residents of their area. However, a review of planning practices that might mitigate Spatial Mismatch found that "there are no specific studies examining the effectiveness of land-use policies in addressing spatial mismatch" (Fan, 2012a). In regard to economic development, it was found that "economic development programs have little ability to create jobs or benefit disadvantaged zone residents" along with the finding that economic development zones target specifically areas of poverty and high unemployment, rather than addressing residentially segregated areas (Fan, 2012a).

While professional planners have worked to address the specific barriers of industry and education by policies diversifying employment opportunities, this research found no evidence in literature that reviews programs that target specifically residentially segregated minorities to improve economic opportunity.

Transportation Solutions

Barriers of transportation access have been effectively targeted by public transit, subsidized transit, and car ownership programs. This area of planning presents a strong possibility to mitigate Spatial Mismatch as minority race and ethnic groups are more likely to depend on carpooling and public transit (Shin, 2016; Chatman & Klein, 2009). Furthermore, jobs continue to decentralize leading to greater distances between concentrated job opportunities (Farley, 1987; Holzer, 1991).

However, a review of planning programs that are meant to increase transportation access and mobility found a reliance on poverty concentrations and other economic and nonracial demographic characteristics to review the impact of programs. Studies that have reviewed transit access found an ability to significantly increase in job accessibility, such as a new light-rail line built in the Twin Cities between areas of poverty and employment. It was found to increase employment opportunities for all workers by wage categories (Fan, Guthrie, & Levinson, 2012b). While car ownership programs meant for increasing private vehicle ownership are the most effective for improved economic outcomes for individual participants (Fan, 2012a; Goldberg, 2001; Sanchez, 2007), those evaluated were largely based on poverty status. Two studies were found to review car ownership programs by race, which found an increase in weeks worked and employment ratios for minority groups (Sanchez, 2007; Raphael & Stoll, 2001). Only Raphael and Stoll's (2001) work reviewed car ownership programs specifically for residentially segregated minorities and found that the greatest magnitude of positive impact were for individuals that were residentially segregated.

Areas for Future Research

Two areas of future research stand out from this research above others. First is the need for new empirical analysis of cities or metropolitan areas that are typically left out of literature. The more geographical areas that are independently studied, the more researchers will be able to understand the implications and results of national studies. Unique histories and demographic characteristics may alter how Spatial Mismatch impacts separate geographies. Understanding these differences will help in providing a more national, and perhaps global, insight in inequities for minority populations. Furthermore, and more simplistically, additional case studies of new regions allow the planners of the area to benefit from the research and propose new solutions, leading into the second area of future research.

Apart from Fan's work to identify the effects planning programs and policies have had on alleviating Spatial Mismatch, there is little research extensively reviewing practicing planner's ability to impact these specific spatial inequities. More research in identifying solutions that have specifically targeted the economic opportunity of residentially segregated minorities would not only contribute greatly to the understanding of Spatial Mismatch but impact the very lives of the individuals experiencing this injustice.

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APPENDIX GUIDE

Tables

Maps

TABLE 1: SUMMARY OF PRIMARY LITERATURE WORKS IN SPATIAL MISMATCH

Citation	Data and Location	Summary
Kain, 1968	Chicago and Detroit Metropolitan Areas 1950 and 1960 Census data Detroit Area Traffic Study (1952) Chicago Area Traffic Study (1956)	There exists distribution impact, but too complex for evaluating unemployment contribution
Farley, 1987	All SMSAs of the 1980 census US Census	Support for hypothesis that segregated Black and Hispanic unemployment is impacted by job decentralization
Holzer, 1991	Literature review (US)	Majority of literature agrees that populations and jobs are decentralizing, Black populations are becoming less segregated but at a slower rate than other minorities, Black workers have less access to suburbanized jobs. However, the extent of impact physical distance alone has is disputed.
Taylor & Ong, 1995	Metropolitan samples of American housing Survey (1977-78 and 1985) Boston, Dallas, Detroit, Fort-Worth, Los Angeles, Minneapolis, Philadelphia, Phoenix, San Francisco, and D.C.	White commuters had longer average commute distances Longer commute times for minority workers were largely because of slow public transit Commute times and distance did not increase relative to white commuters during the study period Controlling for education and income, the average commute distance for minority workers did not vary from those of white workers Commuters in predominantly minority areas had lower commute times and distances Average commute time for black and Hispanic workers living in predominantly minority areas decreased during the study period Minority individuals with the same residence over the study period decreased commute times both absolute and relative to white commuters

Rogers,1997	Pittsburg Metropolitan Area	Individuals further away by commute are more likely to have longer unemployment durations. This is especially more significant for less educated groups.
Shen, 1998	Boston	Application for new demand/supply gravity model of accessibility resulted in low-wage workers have closer access to jobs, however, auto ownership is the most important determinant.
Ihlanfeldt & Sjoquist,1998	Literature review (US)	Spatial Mismatch can vary considerably within MAs, and a majority of new literature supports Spatial Mismatch.
Immergluck,1998a	1990 Journey-to-work census data Chicago MA	Occupational levels, and skill mismatch are significant contributors, along with job, labor ratios, and race in determining employment rates.
Sanchez,1999	1990 US Census	Public transit access is a significant factor in predicting weeks worked
Blumenberg & Manville,2004	Literature review with much of the literature used focused on Southern California and specific to welfare programs	Transportation policies are effective at improving employment opportunities
Hellerstein, Neumark, & McInerney,2008	US MSAs 2000 Census (SEDF with residential location and place of work)	Black employment is higher in areas with more jobs per resident -- particularly true for low-skilled jobs. Black job density most influences black employment whereas white job density has little influence on employment of blacks.
Grengs, 2010	Detroit Metropolitan Area 2000 Census (CTPP) Southeast Michigan Council of Governments (travel times)	Inner-city populations of Detroit are physically closer to job opportunities; however, they are still car dependent.
Hellerstein, McInerney, & Neumark,2010	US MSAs 2000 Census (SEDF with residential location and place of work)	Only local density of jobs held by Hispanic are significant determinants for Hispanic employment, and even more significant for poor English skills. Density of jobs held by Hispanic poor English speakers is the most important for the employment of less-skilled Hispanics than other Hispanics

Stoll & Covington, 2010	US MSAs 1990 and 2000 Census 1994 and 1999 Economic Census and Zip Code Business Patterns	Racial segregation in housing markets is the most important factor. Job sprawl is also an important factor especially between Latinos and white populations. Spatial Mismatch does exist, but the causes are still unclear. Black population groups are more affected than Latinos.
Fan,2012	Literature review (US)	Car ownership/maintenance programs are the most effective at overcoming disadvantaged individual's spatial mismatch.
Easley,2017	2010 Zip Code Business Patterns -- all MSAs 2010 Census Summary File 1 ACS 2007-2011 file 2010 ACS IPUMS	Spatial mismatch between sub-populations of Asian and Hispanic groups can differ significantly.
Jin & Paulsen,2017	Chicago Metropolitan Area 2000-2010 US Census ESRI's employment / job data	Job accessibility is significant to unemployment rates and household income
Chacon-Hurtado, Kumar, Gkritza, & Fricker, 2019	92 Counties Indiana 2005-2007 US Census LEHD Origin-Destination-Employment Statistics (Census Bureau's OnTheMap)	Significant differences in the accessibility ratio between high-, middle-, and low-income groups. In some counties, high income individuals travel farther and have more opportunity than the other income groups -- however, the reverse is true for other counties.

TABLE 2: SUMMARY OF UNIQUE STUDIES IN SPATIAL MISMATCH

Citation	Uniqueness	Data and Location	Summary
Soureli & Youn,2009	Data Availability	Symposium of planners	Segregation and enclaves as a socio-spatial patterns causing rising levels of economic inequality (Margrit Mayer). Planning practices contribute to the cause and allowance of segregation and inequality.

Liu & Painter, 2011	Over time analysis	60 MSAs US. 1980-2000 1980 and 2000 Census	Immigrants are more spatially mismatched than White, but less than Black populations. However, Immigrant residential patterns shift to employment opportunities over time. Most job growth occurred closer to White populations.
Zhu, Liu, & Painter,2013	Data Availability	2000 IPUMS 2008-2010 ACS County Business Patterns Atlanta, D.C., Chicago, LA	Being in an ethnic community after the recession increases the likelihood of working, but with longer commutes.
Sugie & Lens,2017	Data Availability	Newark, NJ (2012 - 2013) NSRP (location data of recently released prisoners) Census data Surveys	Daytime travel patterns most significantly impact the time until employment. Residential proximity to job locations are significant indicators as well, as it impacts the ability to travel to job-rich centers
Hu & Downs, 2019	Data Availability	Tampa Bay, FL Mapping of job locations Volumetric model for space-time accessibility	Provides a detail understanding of job accessibility utilizing advance modeling and geostatistical analysis.
Aslund, Osth, & Zenou,2009	Location	Sweden (1990-1991, 1999)	Refugees placed in a location surrounded by few jobs during 1990-1991 had employment disadvantages that remained in 1999.
Oliveira,2016	Location	Literature Review concerned with both the U.S. and Brazil	Specific to the US: post-war decentralization, infrastructure development, and New Deal home finance policies lead to the unique urban spatial issues experienced in the U.S with concentrated areas of lower access or advantages

Quillian,2012	Poverty Classification	US Tracts 1980,1990, and 2000 Census Decomposition Model	Black populations in metropolitan areas with high Black poverty rates see middle class Black individuals still segregated with low in come Black individuals. In Hispanic populations, low-income Hispanics tend to have more non-Hispanic low-income neighbors Income status can compound racial and ethnic segregation, requiring policies that target both racial / ethnic discrimination as well as diverse range of housing options for incomes
Fan,2012	Poverty Classification	Literature Review concerned with both the U.S.	Car ownership/maintenance programs are the most effective at overcoming disadvantaged individual's spatial mismatch.
Fan, Guthrie, and Levinson, 2012	Poverty Classification	Twin Cities US Census	New light rail implementation in Twin Cities provides increased access for low wage workers in high poverty areas.
Hu,2015	Poverty Classification	Census data (1990, 2000, 2007-2011 ACS)(IPUMS) SCAG (travel time data) Cali. EDD (employment data by industry) Orange, Riverside, San Bernardino, Ventura counties	Spatial mismatch (for poverty groups) does not exist in Los Angeles due to the high concentration of jobs in the inner city -- there exists nonspatial barriers.
Guthrie, Burga, & Fan, 2018	Poverty Classification	Twin Cities Interviews	Interview of practicing planners' regard of Spatial Mismatch and collaboration efforts between transportation planners and workforce professionals, resulting in recommended policies and collaboration efforts, specific to low wage workers and commute efforts.

TABLE 4: WORKER DEMAND FUNCTIONS FOR JOB LOCATIONS

Population	Arcade Function

All workers	var workerDemand = 0;
	var allPeople = FeatureSetByName($datastore,'DFW_DemoVariables')
	var origin = Centroid($feature)
	var dest = 0;
	var dist = 0;
	var calc = 0;
	var people = 0;
	
	for (var feature in allPeople){
	  dest = Centroid(feature)
	  dist = Distance(origin,dest,'Miles')
	  people = feature.DemoVariables_laborForce
	  calc = people*Pow(dist,-1)
	  workerDemand += calc
	}
	
	return workerDemand

Low education population	var workerDemand = 0;
	var allPeople = FeatureSetByName($datastore,'DFW_DemoVariables')
	var origin = Centroid($feature)
	var dest = 0;
	var dist = 0;
	var calc = 0;
	var people = 0;
	
	for (var feature in allPeople){
	  dest = Centroid(feature)
	  dist = Distance(origin,dest,'Miles')
	  people = feature.DemoVariables_lowEducationIndividuals
	  calc = people*Pow(dist,-1)
	  workerDemand += calc
	}
	
	return workerDemand

Driving workers	var workerDemand = 0;
	var allPeople = FeatureSetByName($datastore,'DFW_DemoVariables')
	var origin = Centroid($feature)
	var dest = 0;
	var dist = 0;
	var calc = 0;
	var people = 0;
	
	for (var feature in allPeople){
	  dest = Centroid(feature)
	  dist = Distance(origin,dest,'Miles')

	people = feature.DemoVariables_driveCar calc = people*Pow(dist,-1) workerDemand += calc } return workerDemand

People of Color population	var workerDemand = 0;
	var allPeople = FeatureSetByName($datastore,'DFW_DemoVariables')
	var origin = Centroid($feature)
	var dest = 0;
	var dist = 0;
	var calc = 0;
	var people = 0;
	
	for (var feature in allPeople){
	dest = Centroid(feature)
	dist = Distance(origin,dest,'Miles')
	people = feature.DemoVariables_Black + feature.DemoVariables_Hispanic + feature.DemoVariables_Asian + feature.DemoVariables_Other
	calc = people*Pow(dist,-1)
	workerDemand += calc
	}
	
	return workerDemand

TABLE 5: ACCESSIBILITY FUNCTIONS FOR RESIDENTIAL LOCATIONS

Worker and Job Pairing	Function

All jobs with all labor force participants	var basicGravity = 0;
	var alljobs = FeatureSetByName($datastore,'JobsHex')
	var origin = Centroid($feature)
	var dest = 0;
	var dist = 0;
	var calc = 0;
	var demand = 0;
	var jobs = 0;
	
	for (var feature in alljobs){
	dest = Centroid(feature)
	dist = Distance(origin,dest,'Miles')
	demand = feature.allWorkersDemand
	jobs = feature.SUM_c000
	calc = jobs*Pow(dist,-1)
	basicGravity += (calc/demand)
	}
	
	return basicGravity

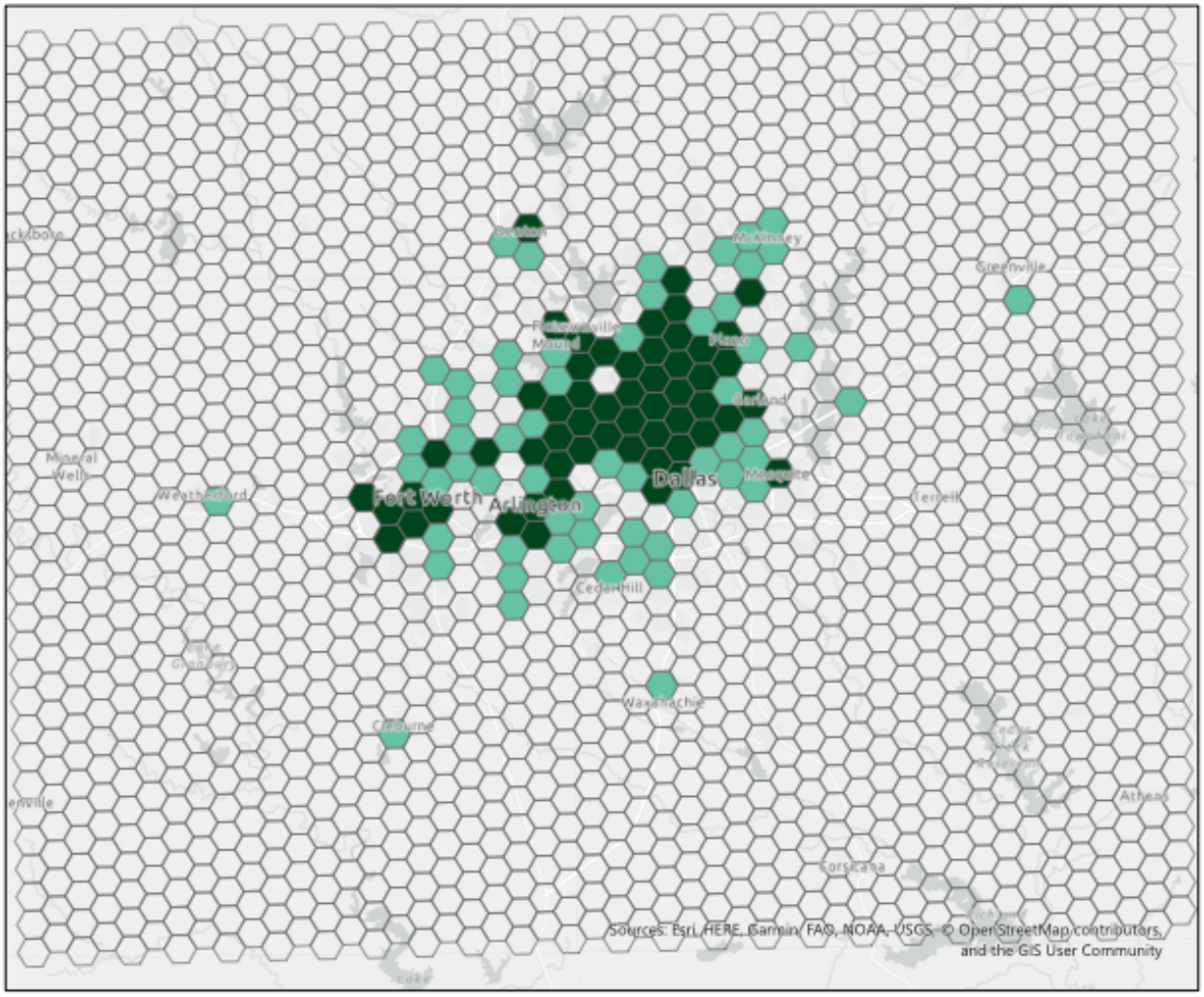
Low skill jobs by industry with low education population	var basicGravity = 0;
	var alljobs = FeatureSetByName($datastore,'JobsHex')
	var origin = Centroid($feature)
	var dest = 0;
	var dist = 0;
	var calc = 0;
	var demand = 0;
	var jobs = 0;
	
	for (var feature in alljobs){
	dest = Centroid(feature)
	dist = Distance(origin,dest,'Miles')
	demand = feature.allLowEdDemand
	jobs = feature.SUM_cns0X
	calc = jobs*Pow(dist,-1)
	basicGravity += (calc/demand)
	}
	
	return basicGravity

Low skill jobs by industry with People of Color	var basicGravity = 0;
	var alljobs = FeatureSetByName($datastore,'JobsHex')
	var origin = Centroid($feature)
	var dest = 0;
	var dist = 0;
	var calc = 0;
	var demand = 0;

	var jobs = 0;
	
	for (var feature in alljobs){
	  dest = Centroid(feature)
	  dist = Distance(origin,dest,'Miles')
	  demand = feature.allPOCDemand
	  jobs = feature.SUM_cns0X
	  calc = jobs*Pow(dist,-1)
	  basicGravity += (calc/demand)
	}
	
	return basicGravity

Low skill jobs by industry with people that drive to work	var basicGravity = 0;
	var alljobs = FeatureSetByName($datastore,'JobsHex')
	var origin = Centroid($feature)
	var dest = 0;
	var dist = 0;
	var calc = 0;
	var demand = 0;
	var jobs = 0;
	
	for (var feature in alljobs){
	  dest = Centroid(feature)
	  dist = Distance(origin,dest,'Miles')
	  demand = feature.allDriversDemand
	  jobs = feature.SUM_cns0X
	  calc = jobs*Pow(dist,-1)
	  basicGravity += (calc/demand)
	}
	
	return basicGravity

Map 1: All Jobs Available



Jobs Hexagon

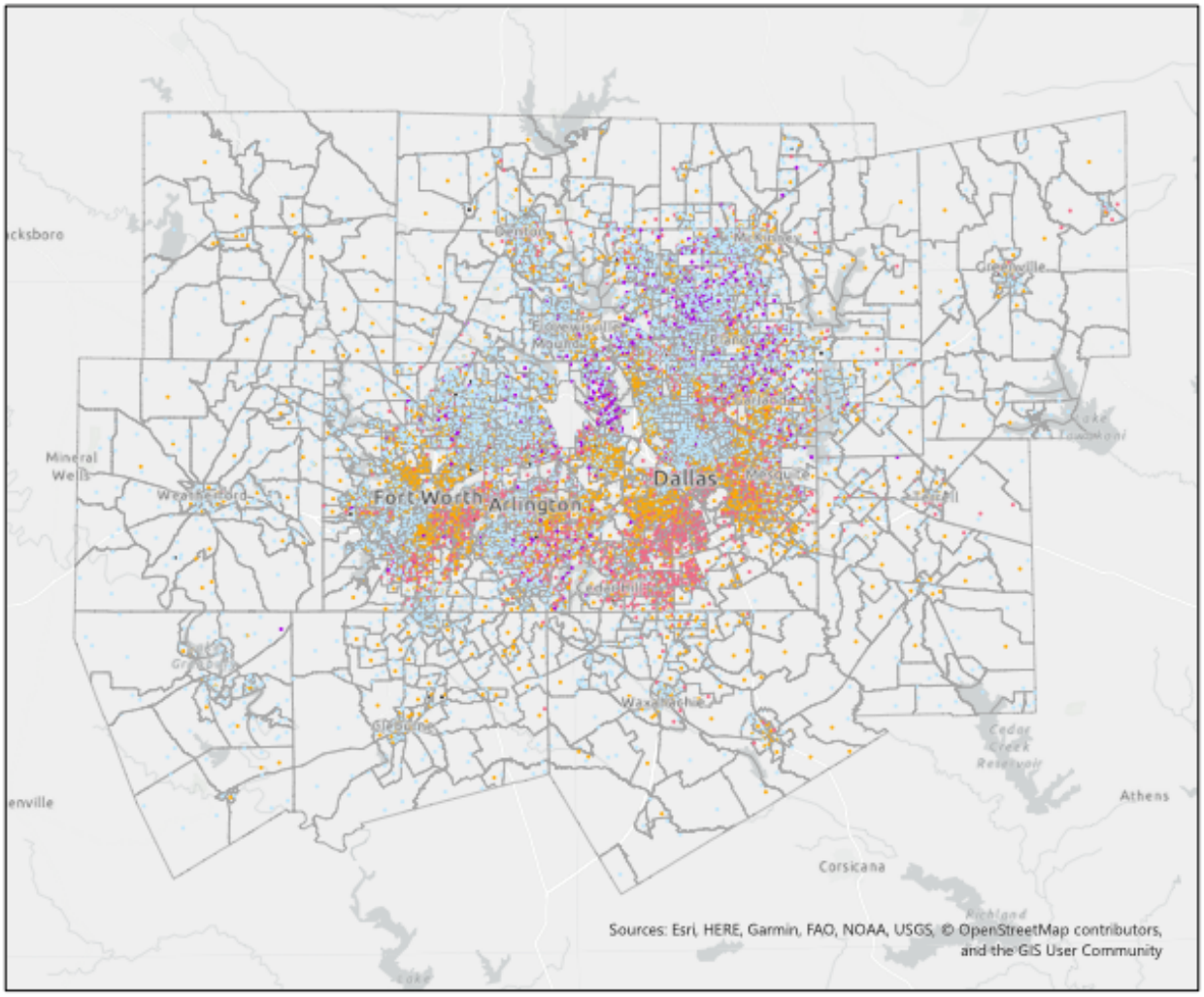
All Jobs

- < 0.50 Std. Dev.
- 0.50 - 1.5 Std. Dev.
- > 1.5 Std. Dev.

N

0 12.5 25 50 Miles

Map 2: Dallas - Fort Worth Population



Demographic Characteristics

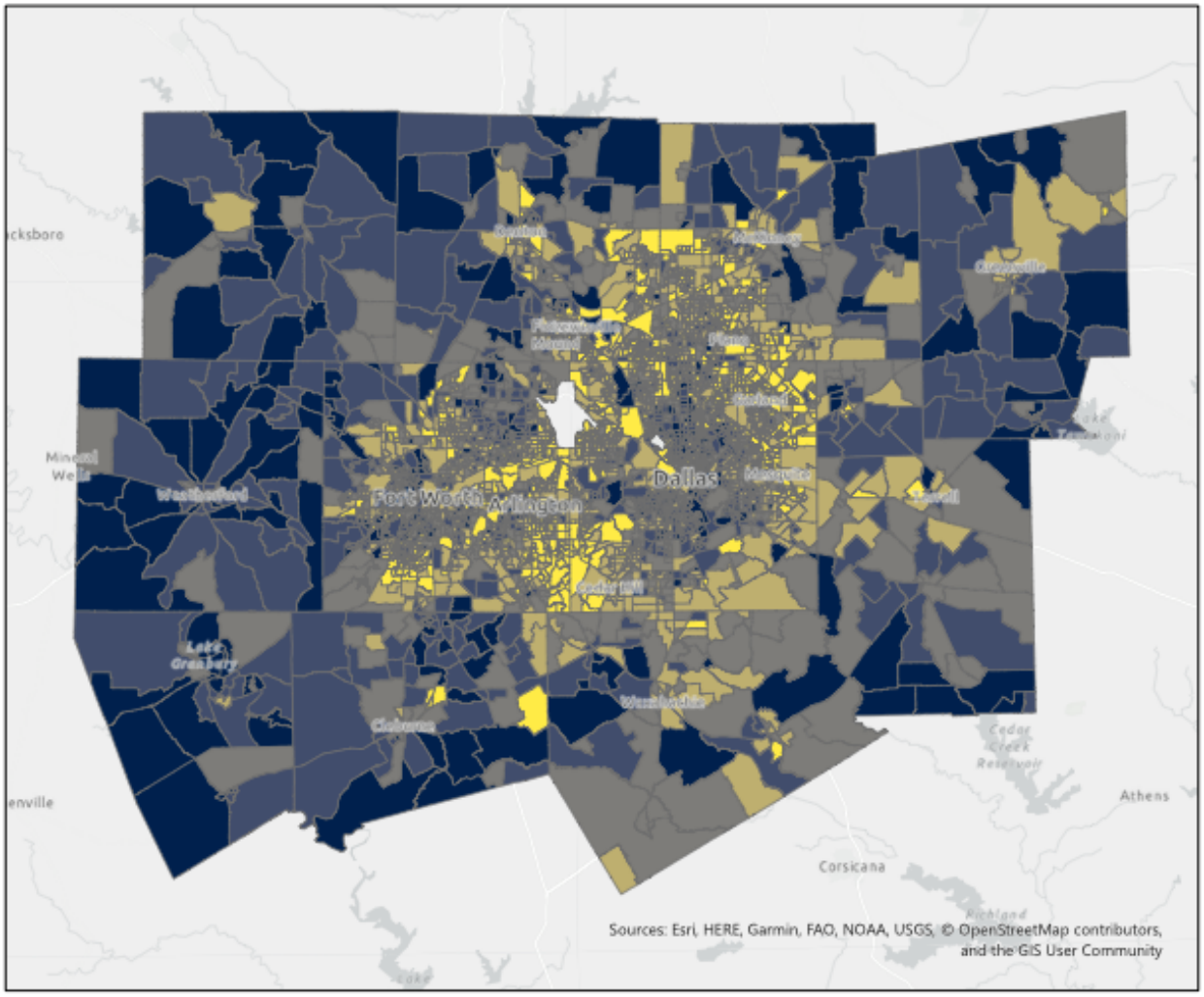
1 Dot = 500

- White
- Black
- Asian
- Hispanic
- Other

N

0 12.5 25 50 Miles

Map 3: Entropy Index



Demographic Characteristics

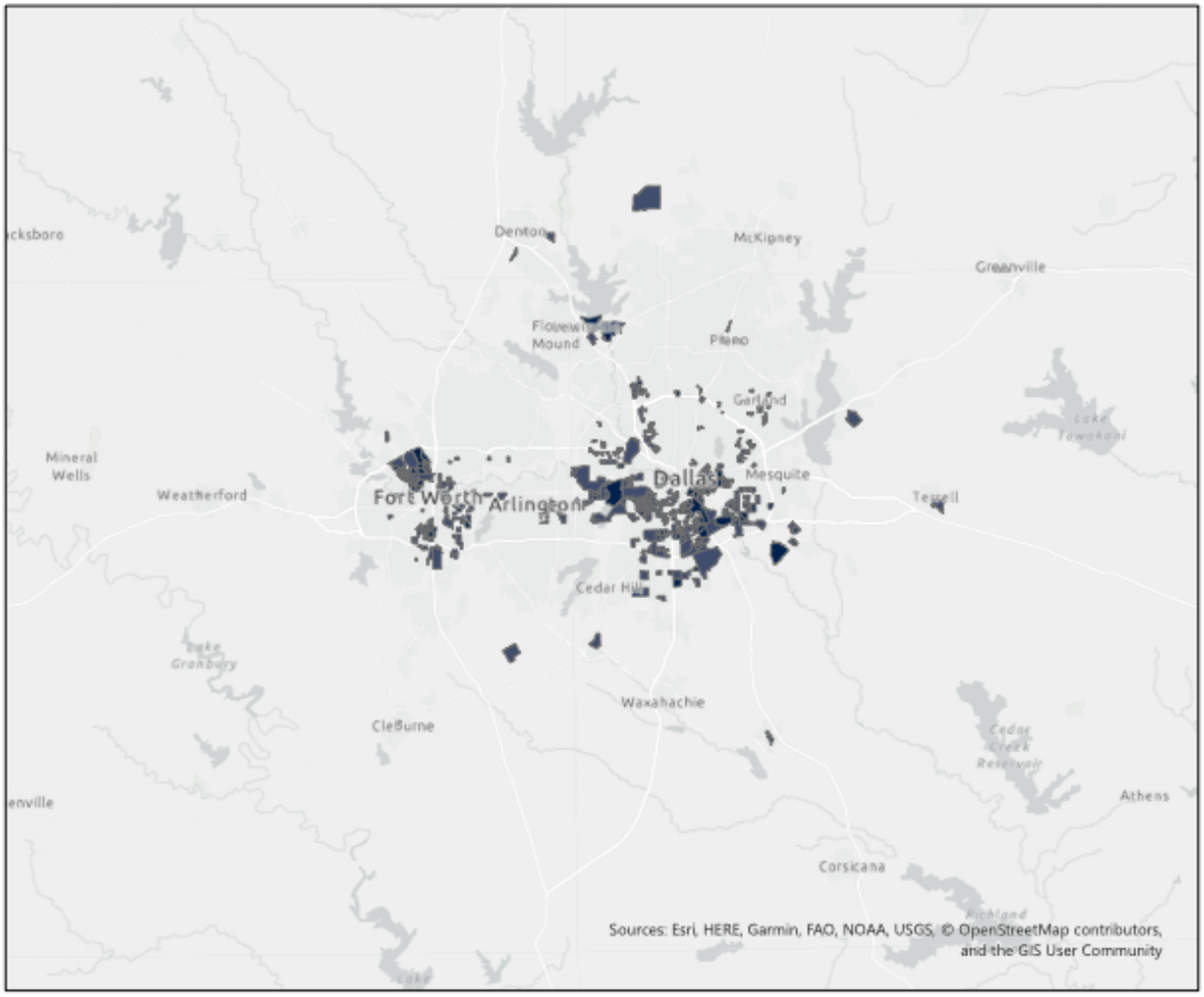
Entropy Index

- ≤0.427803 (Less Diverse)
- ≤0.706901
- ≤0.950134
- ≤1.189972
- ≤1.587819 (More Diverse)

N

0 12.5 25 50 Miles

Map 4: Segregated Block Groups



Demographic Characteristics

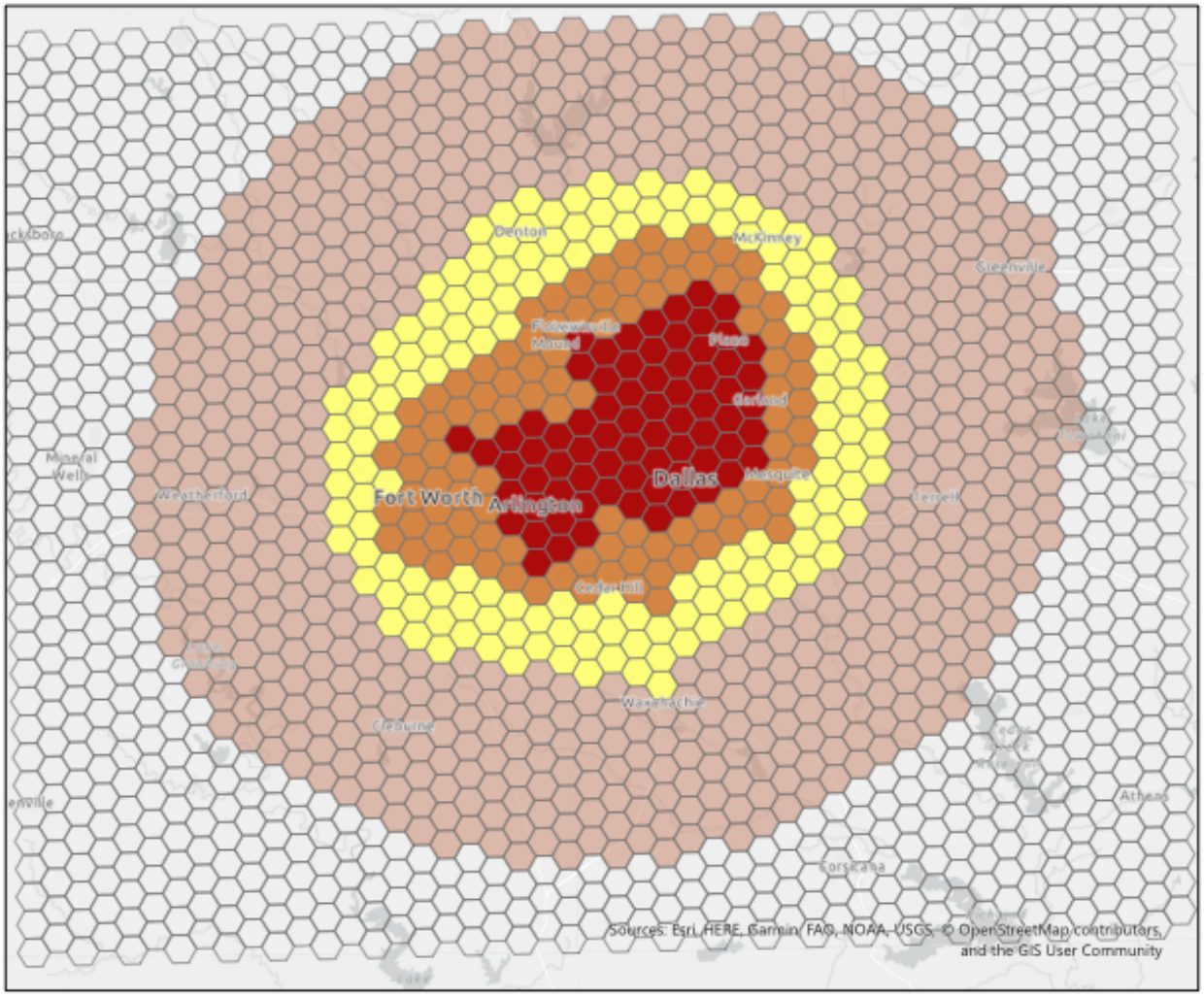
Entropy Index

- ≤0.427803 (Less Diverse)
- ≤0.706901
- ≤0.950134
- ≤1.189972
- ≤1.587819 (More Diverse)

N

0 12.5 25 50 Miles

Map 5: All Worker Demand



Jobs Hexagon

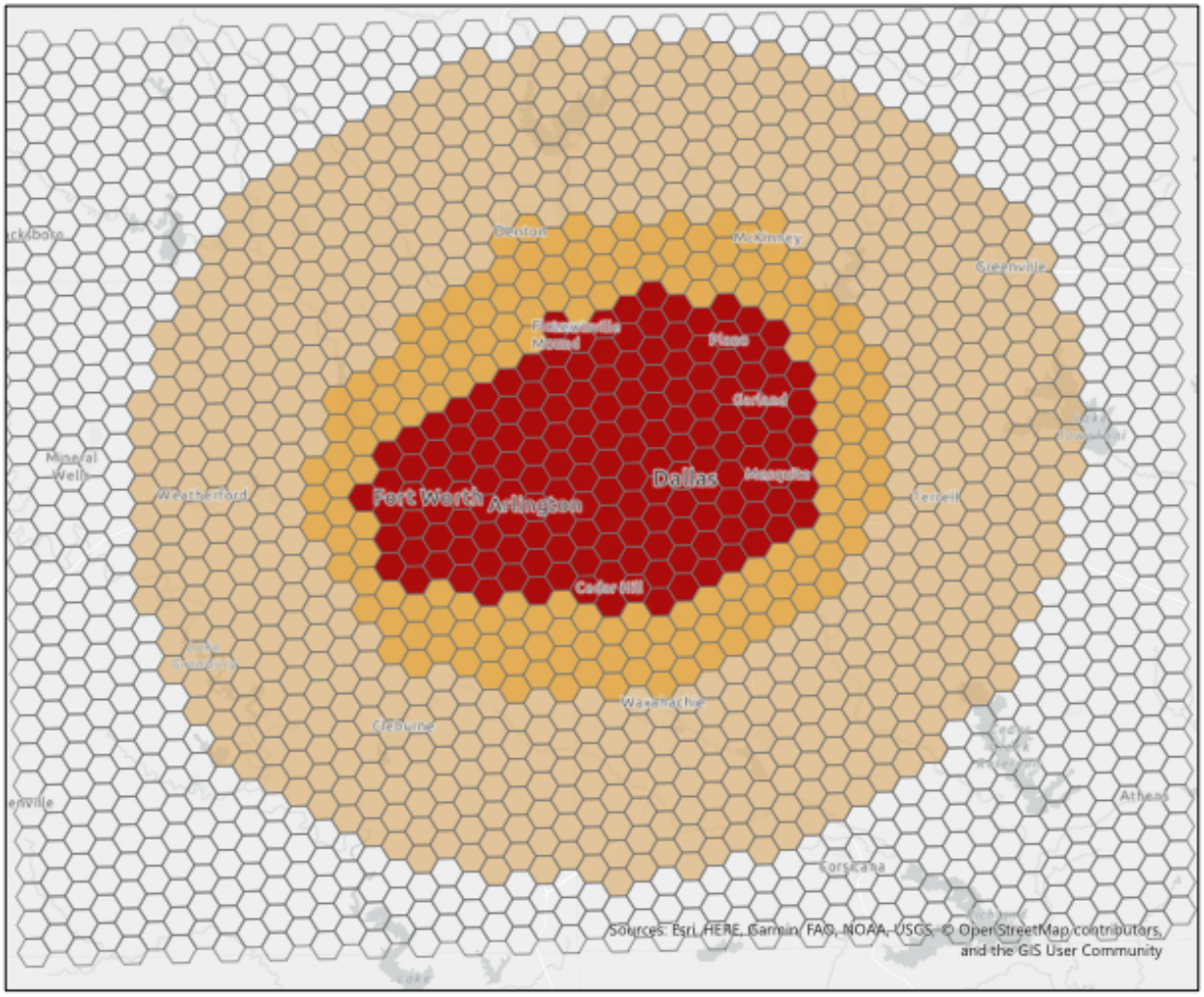
All Worker Demand

- < -0.50 Std. Dev.
- -0.50 - 0.50 Std. Dev.
- 0.50 - 1.5 Std. Dev.
- 1.5 - 2.5 Std. Dev.
- > 2.5 Std. Dev.

N

0 12.5 25 50 Miles

Map 6: Low Education Worker Demand



Jobs Hexagon

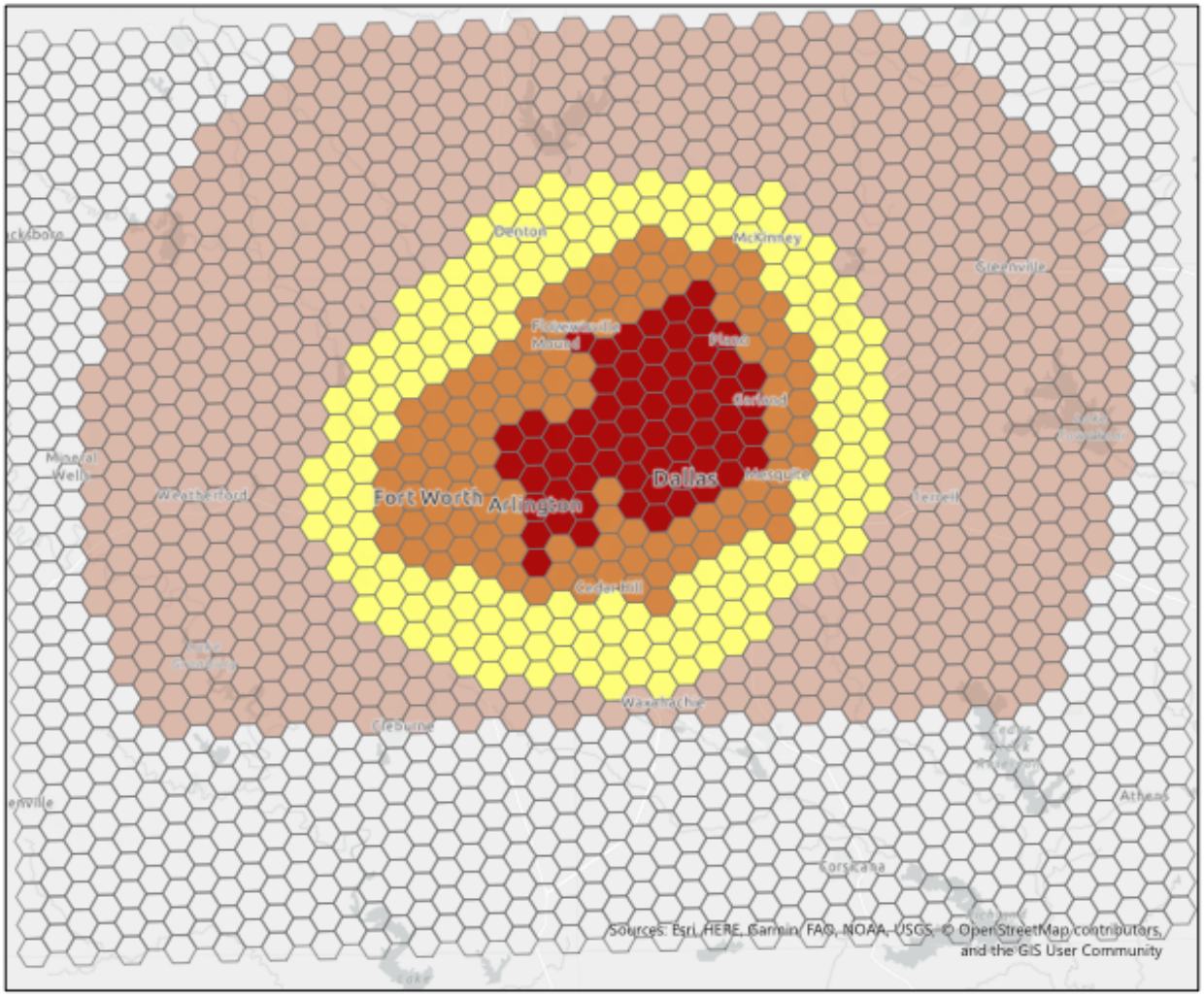
Low Education Worker Demand

- < -0.50 Std. Dev.
- -0.50 - 0.50 Std. Dev.
- 0.50 - 1.5 Std. Dev.
- > 1.5 Std. Dev.

N

0 12.5 25 50 Miles

Map 7: Driver Worker Demand



Jobs Hexagon

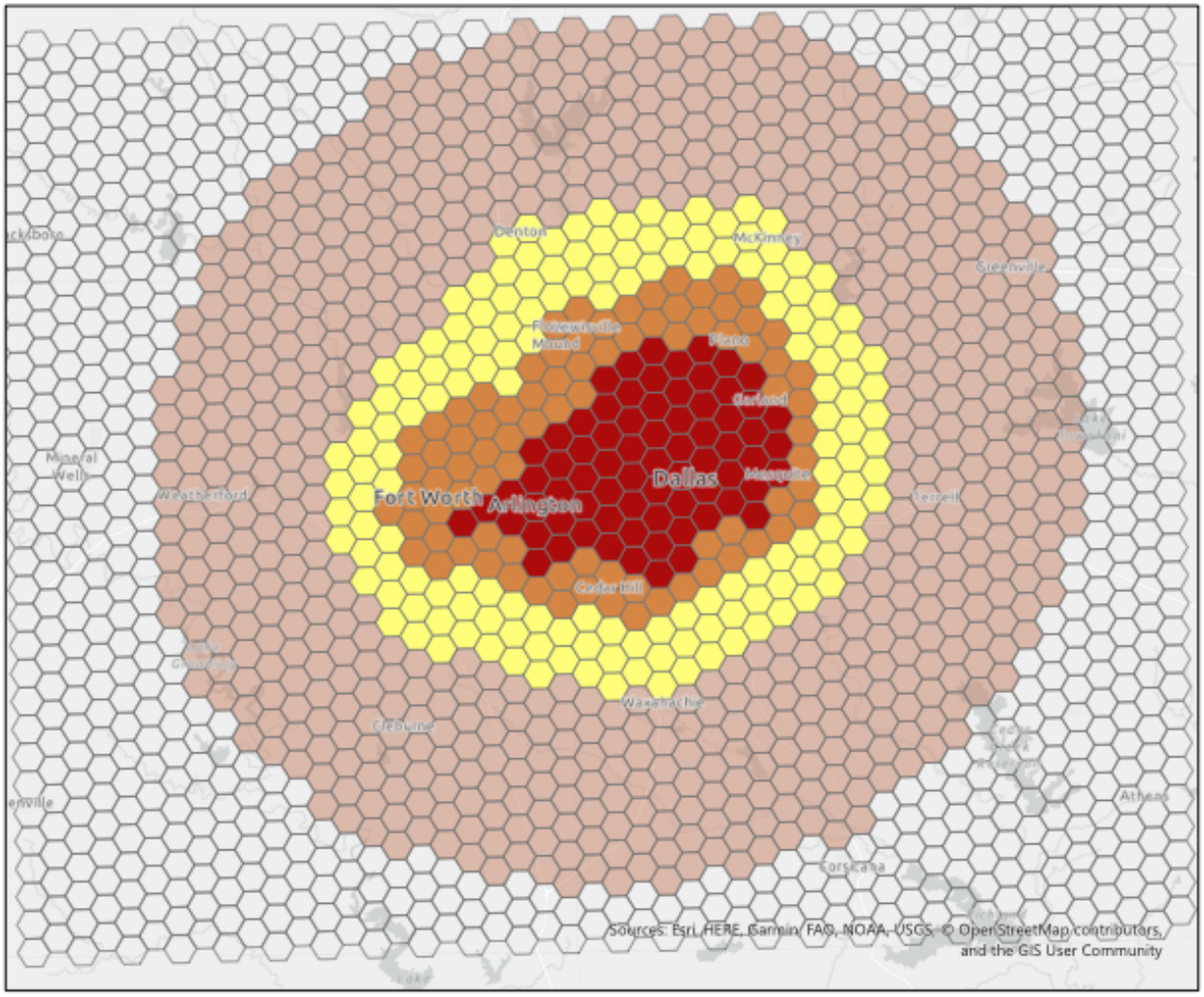
Driver Worker Demand

- < -0.50 Std. Dev.
- -0.50 - 0.50 Std. Dev.
- 0.50 - 1.5 Std. Dev.
- 1.5 - 2.5 Std. Dev.
- > 2.5 Std. Dev.

N

0 12.5 25 50 Miles

Map 8: People of Color Job Demand



Jobs Hexagon

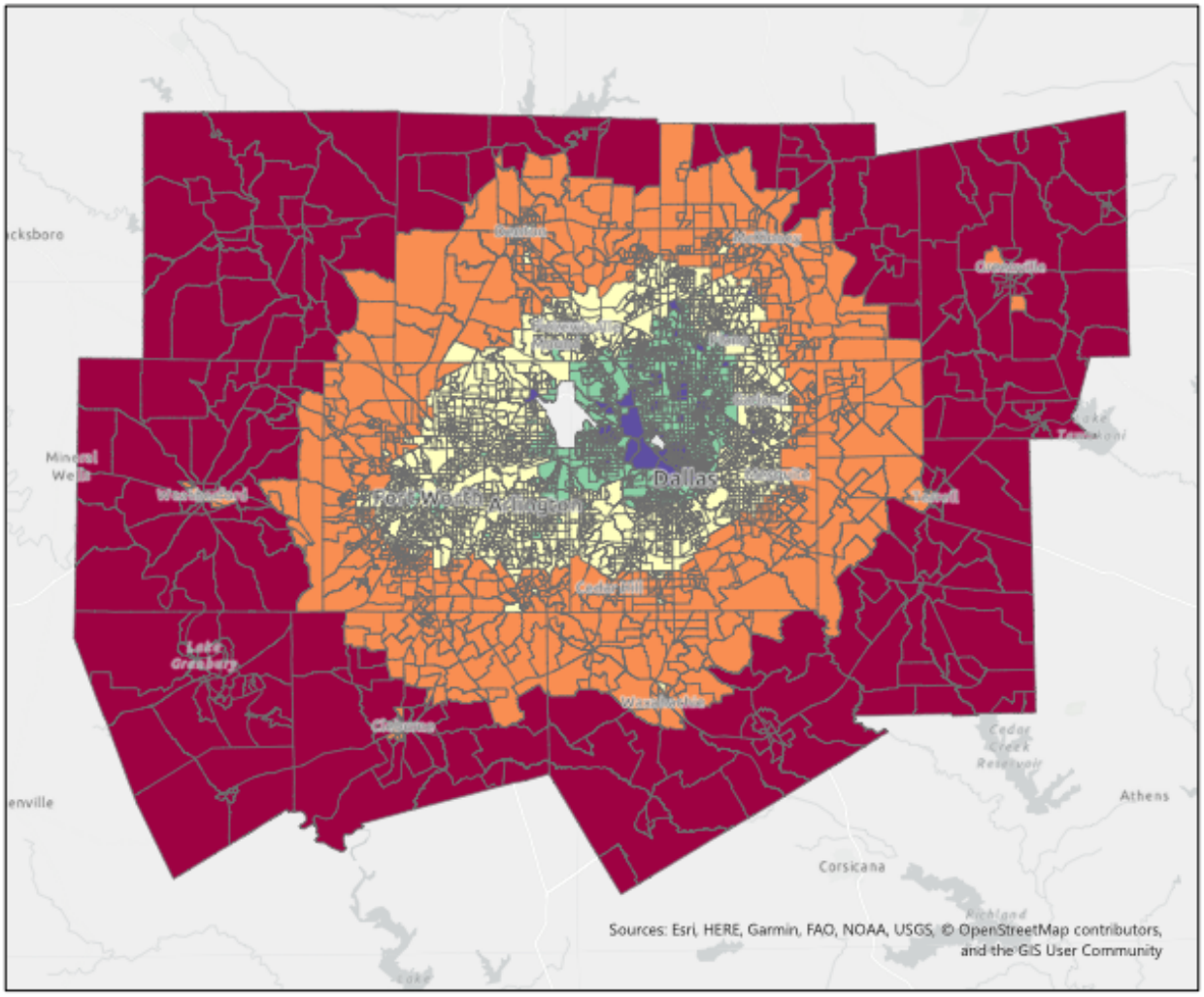
People of Color Job Demand

- < -0.50 Std. Dev.
- -0.50 - 0.50 Std. Dev.
- 0.50 - 1.5 Std. Dev.
- 1.5 - 2.5 Std. Dev.
- > 2.5 Std. Dev.

N

0 12.5 25 50 Miles

Map 9: Accessibility of All Jobs to All Workers



Demographic Characteristics

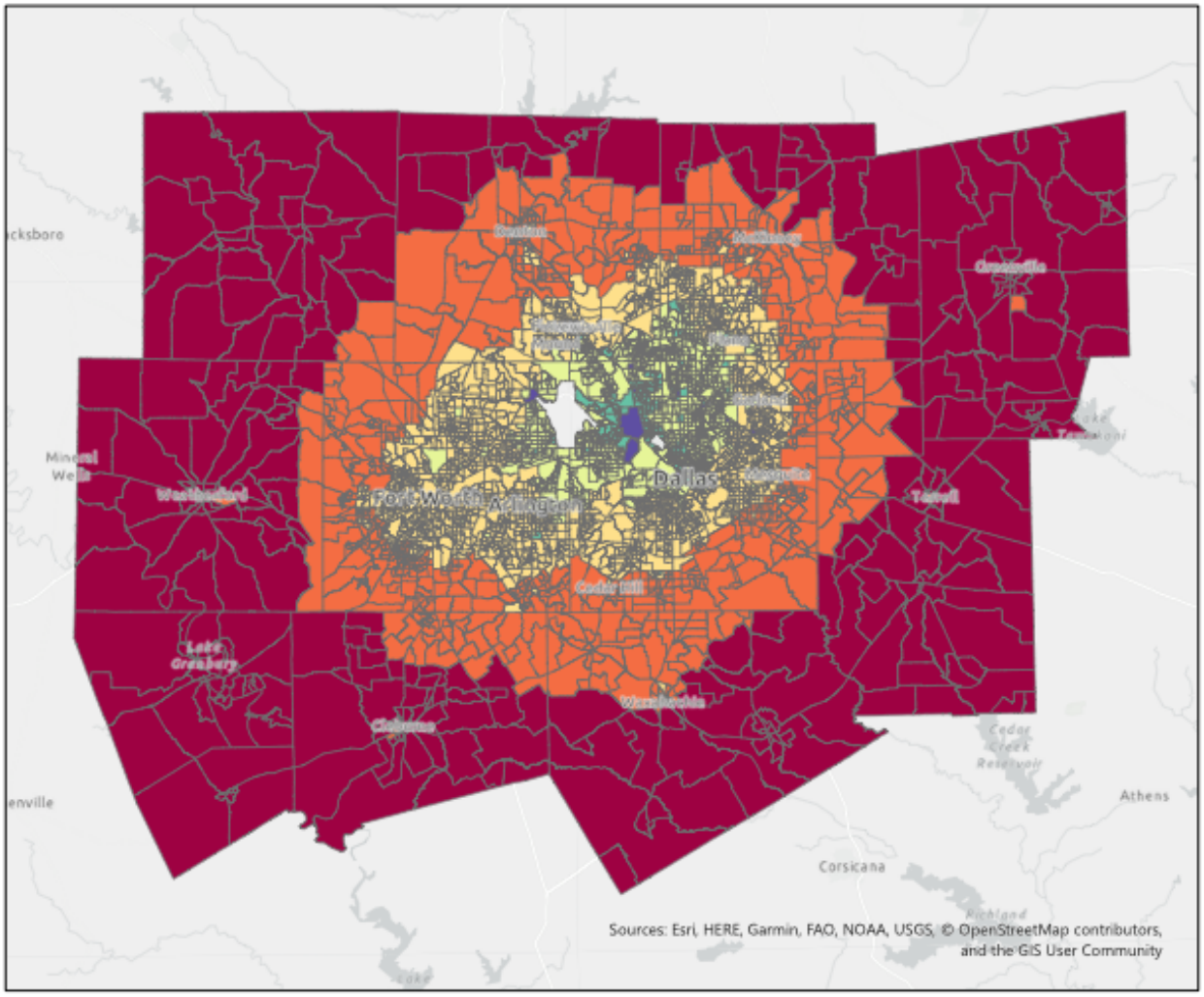
Accessibility of All Jobs to All Workers

- < -1.5 Std. Dev.
- -1.5 - -0.50 Std. Dev.
- -0.50 - 0.50 Std. Dev.
- 0.50 - 1.5 Std. Dev.
- > 1.5 Std. Dev.

N

0 12.5 25 50 Miles

Map 10: Accessibility of Low Education Workers to Low Skill Jobs



Demographic Characteristics

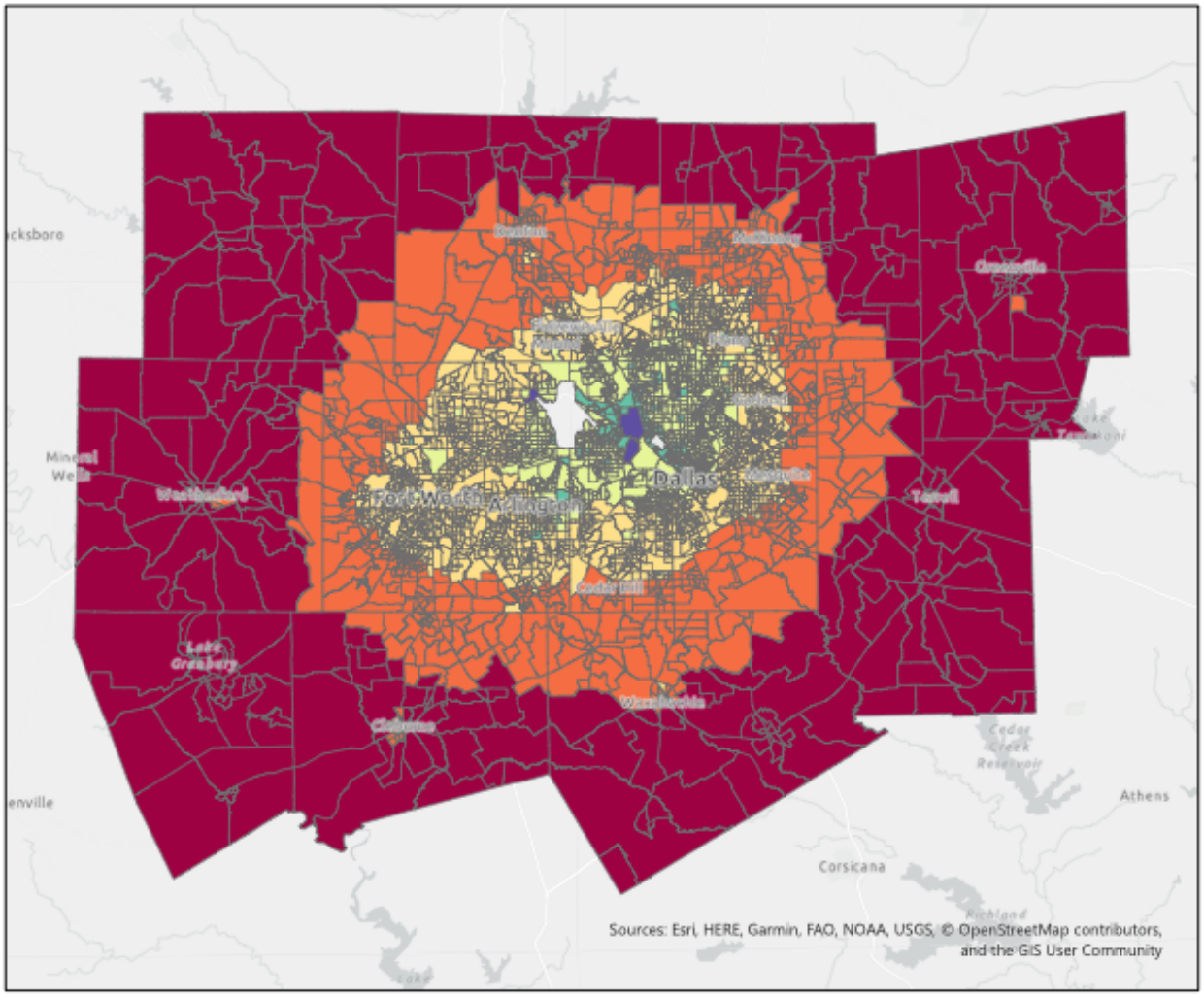
Accessibility of Low Education Workers to Low Skill Jobs

- < -1.5 Std. Dev.
- -1.5 - -0.50 Std. Dev.
- -0.50 - 0.50 Std. Dev.
- 0.50 - 1.5 Std. Dev.
- 1.5 - 2.5 Std. Dev.
- > 2.5 Std. Dev.

N

0 12.5 25 50 Miles

Map 11: Accessibility of Driving Workers to Low Skill Jobs



Demographic Characteristics

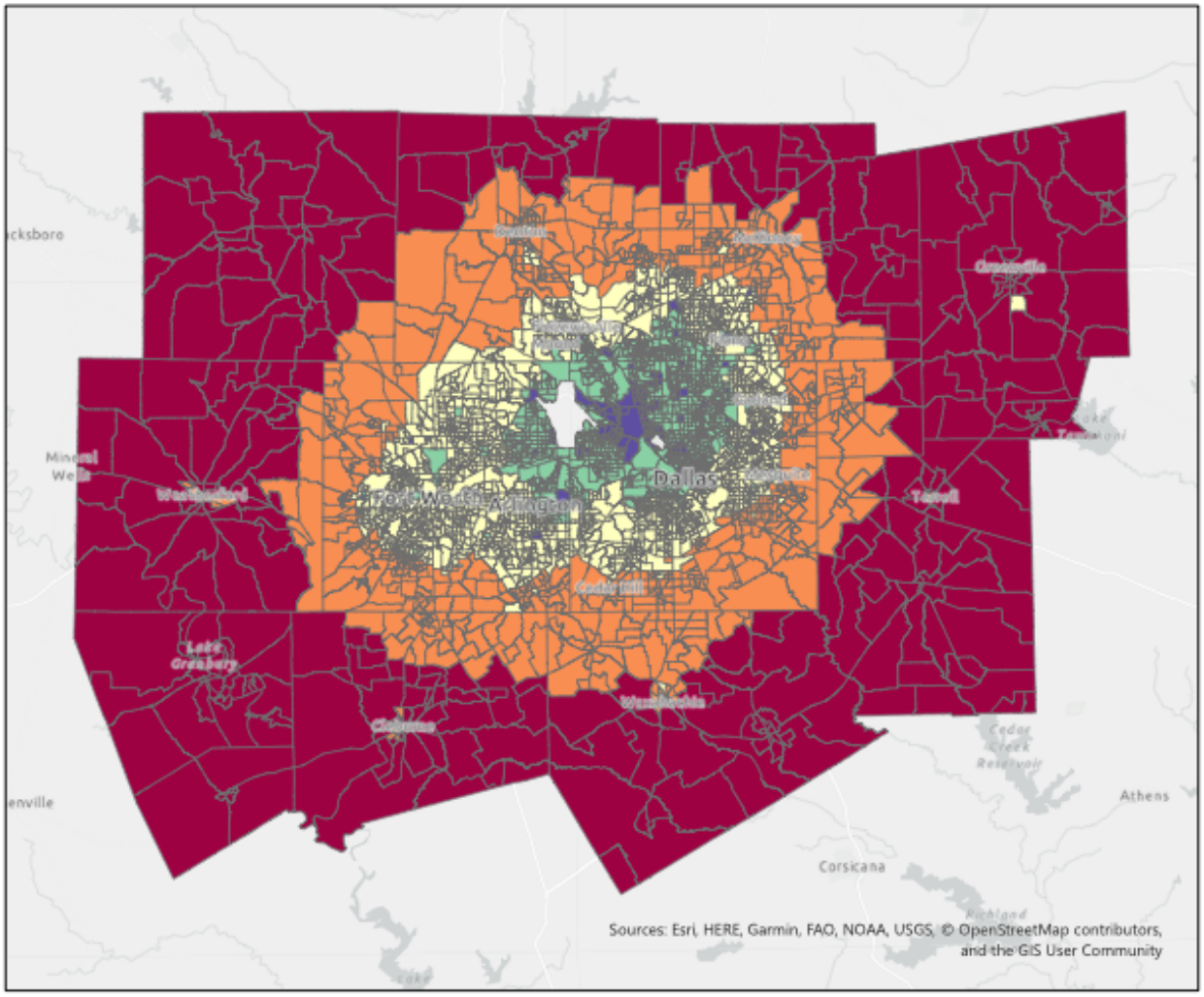
Accessibility of Driving Workers to Low Skill Jobs

- < -1.5 Std. Dev.
- -1.5 - -0.50 Std. Dev.
- -0.50 - 0.50 Std. Dev.
- 0.50 - 1.5 Std. Dev.
- 1.5 - 2.5 Std. Dev.
- > 2.5 Std. Dev.

N

0 12.5 25 50 Miles

Map 12: Accessibility of POC to Low Skill Jobs



Demographic Characteristics

Accessibility of POC to Low Skill Jobs

- < -1.5 Std. Dev.
- -1.5 - -0.50 Std. Dev.
- -0.50 - 0.50 Std. Dev.
- 0.50 - 1.5 Std. Dev.
- > 1.5 Std. Dev.

N

0 12.5 25 50 Miles