Coloring in the Lines: A Simulation Analysis of Majority-Minority Districts in U.S. City Councils

*Gustavo Novoa

Columbia Unviersity

gfn2103@columbia.edu

Abstract: City councils offer a unique and overlooked arena for the study of redistricting. Previous work in the literature finds that local elections are highly racialized, but it is unclear how this is reflected in the redistricting process. In this paper, we used a sequential Monte Carlo redistricting algorithm to draw a representative sample of the underlying distribution of plausible maps for over 100 city councils. We demonstrate that when majority-minority districts are viable, cities tend to implement more majority-minority districts than the median simulated plan. However, most cities do not maximize the creation of either Black or Latine-majority districts. This gap highlights the institutional difference between a regular redistricting cycle and the initial districting process after switching from an at-large electoral system. We also find that citizenship and segregation rates are important determinants of the number of majority-minority districts that can be drawn, as well as the number implemented.

Keywords: Local Politics; Redistricting; Minority Representation

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Introduction

City council redistricting is a major focus of local interest groups during each decennial cycle. These cycles often produce political battles and scandals that are regularly the subject of news headlines and litigation. In 2022 alone, cities across the country experienced redistricting controversy, from some of the largest like Los Angeles and Houston, to medium-sized cities, like Buffalo and Chattanooga.[1][2][3] During the redistricting process, interest groups lobby extensively for their desired outcomes. In addition to organizing protests, they often attend open council or commission meetings to decry developments they see as unjust or simply counterproductive to their political agenda (Cain and Hopkins). If the council or appointed commission puts forth a map seen as unfair, leaders of neighborhood organizations, minority associations, and even ordinary residents, respond with litigation—sometimes resulting in court orders to restart the redrawing process altogether.

Political scientists, on the other hand, have paid relatively little attention to local redistricting. Instead, a large majority of existing studies compare electoral systems, namely at-large districts versus single-member districts, and their impact on minority representation (see for example, Karnig and Wlech 1980; Mundt and Helig 1992; Leal et al. 2004; Trounstine and Valdini 2008; Meier and Rutherford 2014; Abott and Magazinnik 2020). Despite disagreement earlier in the literature, there is a general consensus now that district or ward systems empower minority city residents whenever present in sufficiently large groups. Unfortunately, these studies never investigate the impact of how single-member districts are drawn.

There are also several case studies documenting the politics around a single city's redistricting process during a particular cycle (O'Loughlin and Taylor 1982; Santillán

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[1] Ura, A. (2022, December 5). Houston's at-large City Council districts deprive Latinos of fair representation, lawsuit alleges. The Texas Tribune.

[2] Lawsuit questioning Chattanooga redistricting process to continue | Chattanooga Times Free Press. (2023, February 27).

[3] Williams, D. (2022, December 18). Court fight over Buffalo's redistricting draws sharp exchanges from rival experts. Buffalo News.

1983; Finke 1984; Shapiro and Bliss 2016). These studies are important for detailing the contentious political process behind redistricting, but their conclusions are hard to generalize across U.S. cities.

Unfortunately, inter-city redistricting analyses are few and far between. However, the few works that do exist offer key testable insights. By comparing the proportional size of the Black and Latine populations of U.S. cities, Lyons and Jewell (1988) found that most cities with a large enough Black population implemented at least one majority-Black district, but less than a third of cities with sufficiently large Latine populations did the same. Analyzing the 2000 redistricting cycle, Behr (2004) found that cities tended to adopt fewer majority-minority districts than what was algebraically feasible. Behr (2004) also found that cities tended to adopt more majority-Black districts than majority-Latine districts and cities with higher segregation rates adopted more majority-minority districts.

These studies, while limited methodologically, offer the only available insights into how districts were drawn in these earlier redistricting cycles. However, they rely on simple algebraic analyses of group proportions to determine the number of majority-minority districts that can be drawn in a given city. This approach can be misleading because it fails to take into account the geographic distribution of different groups across a city's particular spatial composition.

A far superior and newly available approach is to use simulation algorithms to sample plans from the underlying distribution of possibilities. Hankinson and Magazinnik (2023) used this method and leveraged the California Voting Rights Act (CVRA) to analyze Latine representation in cities that switched from at-large elections to district representation in California. They found that cities generally maximize the number of Latine-majority districts when possible. They also found that the optimal Latine proportion for achieving minimal descriptive representation in majority-minority districts is well over 50%. The sample of cities they analyze offers key advantages and disadvantages. It provides the ideal opportunity to determine the causal effect of switching from at-large representation to single-member districts. It also provides insight into how well cities that implement a novel district map represent minority residents. However, this is not the typical redistricting scenario, but instead a novel districting scenario. The outcome of a typical redistricting cycle is highly dependent on the existing map from the previous cycle, so starting from scratch allows for the drawing of districts without being impeded by the status quo (Carson et al. 2014; Henderson et al. 2018). It is also Latine-specific, and therefore does not provide insight as to whether Latine representation in city councils may be distinct from Asian or Black representation.

In order to analyze the degree of minority representation that results from regular redistricting cycles, we applied a redistricting simulation algorithm to 101 cities across 36 U.S. states. This analysis allowed us to update a number of previous findings in the literature, and thus resolve several lingering questions: Do cities continue to implement more Black-majority districts than Latine-majority districts? What roles do segregation and citizenship play in district viability and implementation? Are cities packing minority residents into these majority-minority districts?

We found that across the U.S., cities tend to implement slightly more majority-minority districts than the median race-neutral simulation. However, they do not maximize the majority-minority districts implemented for any one group, nor the total number of majority-minority districts. In practice, the minority concentration of these districts is about equal at approximately 65%. In simulations, however, Latine-majority districts were 59% Latine on average, while Asian and Black-majority districts had similar group proportions as their implemented counterparts. We also demonstrate that citizenship rates are a major determinant in the number of majority-minority districts that are viable, and that segregation is not only important for viability, but also for implementation.

Racial Redistricting and Majority-Minority Districts

In addition to partisanship, much of the existing redistricting literature has centered on racial bias at the state and federal levels. This was a direct consequence of the Supreme Court's unanimous decision in Thornburg v. Gingles (1986),[4] and the standardization of the Gingles Test, which created a legal framework for assessing claims under Section 2 of the VRA. Under the Gingles Test, plaintiffs can make claims of disenfranchisement if they can demonstrate that a minority group is: (1) sufficiently large and compact to form a majority-minority district, (2) that it is politically cohesive, and (3) that the majority votes in a bloc such that it would normally defeat the minority group's preferred candidate.

Majority-minority districts proliferated under this framework, leading scholars to debate their desirability and efficacy. Specifically, scholars argued whether they produced a tradeoff between increased descriptive representation at the district level and decreased substantive representation across the electoral system (Cameron et al. 1996; Lublin 1999; Lublin and Voss 2000). For example, Epstein and O'Halloran (1999) argued that such a tradeoff does exist and found that Black descriptive representation was optimized by the creation of districts with roughly 45% Black VAP (voting-age population). The debate over the efficacy of majority-minority districts in advancing minority interests in state and federal legislatures continues to this day. On the one hand, some scholars argue that majority-minority districts are detrimental to minority policy interests (e.g., Canon 2022), but others point to benefits outside of policy outcomes. For example, Gay (2002) found that constituents were more likely to engage with co-racial representatives, and Pantoja and Segura (2003) found a link between co-ethnic representation at the state and federal level and decreased feelings of political alienation among Latine constituents. Similarly, Barreto et al. (2004) found that co-ethnic representation in Congress led to higher voter turnout among Latine constituents, while Fraga (2016)

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[4] 478 US 30 (1986)

found that co-racial representation in Congress led to higher turnout among Black and white voters, but co-ethnic representation did not lead to higher turnout among Latine voters.

Local Redistricting

The attention that interest groups, individual activists, and city council members pay to the redistricting process suggests that these actors believe that the stakes are high. One of the main reasons behind the significance attributed to the results of the process is the belief that majority-minority districts are necessary to ensure the political power of minority residents in cities. The key benefit attributed to majority-minority districts is the ability for a minority group to select their ideal candidate—often one that can provide both descriptive and substantive representation.

Scholars have also studied racial representation at the local level, but this work has largely revolved around comparing outcomes between single-member districts and at-large councils. Across several decades, the literature has reached a broad consensus that districts benefit minorities relative to at-large systems (e.g., Mundt and Helig 1982; Bullock and MacManus 1990; Leal et al. 2004). Trounstine and Valdini (2008) added nuance to this consensus by emphasizing that the benefits of district representation only apply when a minority group is large and highly concentrated within a city. More recently, scholars have leveraged the California Voting Rights Act (CVRA), which made it easier for residents to sue their city and demand district-based representation. This provided an opportunity for scholars to directly compare descriptive representation before and after the implementation of districts, finding clear evidence that districts increase Latine descriptive representation (Collingwood and Long 2019; Abbott and Magazinnik 2020).

However, there has been little attention paid to the redistricting process itself, and what maps cities implement relative to the range of viable alternatives. This is concerning because, relative to even the most gerrymandered federal congressional districts, city council districts can be significantly more homogenous as they are smaller and more densely populated than their congressional counterparts. Perhaps this relative neglect is due to the perception that political polarization and party membership is simply less relevant in urban contexts. After all, U.S. cities tend to be overwhelmingly inhabited by Democrats, and many cities are governed by nonpartisan offices. In this context of limited partisan competition, race has been argued to be "the dominant factor in the local electoral arena" (Hajnal and Trounstine 2014). Because redistricting literally defines the local electoral arena, then race should be a major determinant of redistricting decisions as well.

High levels of ethnic-racial and class segregation are characteristic of virtually all large U.S. cities with white, Black, and Latine residents consistently living in distinct neighborhoods (Lichter et al. 2015). These factors provide a unique opportunity for mapmakers at the local level to create electoral districts with highly specific demographics within homogenous "communities of interest" (Grofman and Handley 1989). This is because densely packed and politically cohesive neighborhoods are the ideal targets for mapmakers to either empower minority groups by creating majority-minority districts, or to disempower them by either creating super majority districts ("packing") or dispersing minority residents into as many districts as possible in order to dilute their overall influence on city politics ("cracking"). Thus, the highly segregated, ethnically and racially diverse context of American cities offers the potential for both fostering minority political power and engagement and suppressing it.

As in the literature at the state and federal level, there is also some evidence of direct, material consequences to local descriptive representation. Sances and You (2017) find that city fines and court fees are disproportionately targeted at Black residents in U.S. cities, but the disparity is mitigated when the city's council has Black representation. Similarly, Christiani et al. (2021) find that the number of traffic stops that lead to searches is lower in cities with higher rates of Black descriptive representation in city council. Sociologists have even asserted that local governments can use redistricting as a tool for "racially and economically motivated social control", based on historical analyses of redistricting in three midwestern cities (Vargas et al. 2021). Local activists and interest groups seem to share the belief that city governments routinely engage in racial gerrymandering, as plans implemented by city councils are often the subject of litigation alleging racial discrimination.[5] Nonetheless, like local-level redistricting more generally, there is little research on the ubiquity of these racially motivated district plans.

Lyons and Jewell (1988) compare the number of majority-minority districts implemented during the 1980 redistricting cycle to the proportional size of Black and Latine populations in 96 U.S. cities. They find that 34 of the 41 cities with a sufficiently large Black population to create at least one majority-Black district did so, yet only 4 of 13 cities that had a sufficiently large Latine population to draw at least one majority district did so. One of the only other works in this area is that of Behr (2004), who analyzed the 2000 redistricting cycle for a set of large U.S. cities. Using the proportion of Black and Latine residents in these cities, Behr compared the theoretical maximum number of majority-minority districts in each city, finding that cities with large Black populations had more majority-Black districts than cities with large Latine populations had majority-Latine districts. He attributes this difference to higher rates of segregation among Blacks in the U.S.—finding that representation within city council maps was more proportional for both groups when cities were highly segregated. As one of the only analyses of this kind, this remains an important contribution to this literature. However, it lacks analysis of spatial data. Any nonspatial analysis of demographic composition in a geographic space will suffer from the checkerboard problem [6] (Lieberson and Carter 1982) and may overestimate the possibility of creating particular districts within

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[5] E.g., Ayanna Alexander, "Florida City Highlights Conflicts over Local Gerrymandering," AP NEWS (Associated Press, February 2, 2023)

[6] The 'checkerboard problem' describes the erroneous equating of all spaces in which two groups of equal population are clustered independently of one another, regardless of the distance between the clusters. For example, a space in which all members of group A are on one side of the space and all members of group B are on the other side are equated to a 'checkerboard' distribution in which individuals from each group reside in alternating clusters as in a checkerboard.

the constraints usually imposed on redistricting (i.e., compactness and equipopulous districts). Varying distances between population clusters, as well as clusters of varying population density, are accounted for when redistricting simulation is used to sample the underlying distribution of possible maps (Chen and Rodden 2013; Katz et al. 2020).

Most recently, Hankinson and Magazinnik (2023) leveraged the CVRA to conduct a spatial analysis of Latine representation in California using a redistricting simulation algorithm. They find that cities in California that switched to single-member districts generally draw Latine districts when possible and that Latine residents are most likely to elect their preferred candidate in more highly concentrated districts, rather than in slight majority or plurality-Latine districts. As described earlier, their analysis focuses on California cities that switched from at-large to single-member districts, providing an ideal opportunity to study the differences in electoral outcomes brought about by each system. Their analysis also targets an understudied setting of local politics—smaller cities and towns. Approximately 39 out of 107 cities they analyzed have a population smaller than 50,000, and the overall mean population of the cities in their dataset is approximately 83,000.

This paper instead analyzes city council maps that result from standard redistricting cycles in cities that have not recently switched from at-large representation. Because of the size (mean = 412,263) and varied location of the cities in this analysis, Asian-majority and Black-majority districts were also simulated and analyzed—including six cities that implemented both Black and Latine-majority districts within their council map. In doing so, we can more directly speak to the findings of earlier analyses of large city redistricting from past cycles and update the literature on whether the patterns found then continued through the 2010 cycle (Lyons and Jewell 1988; Behr 2004).

Race Neutral Simulations as Benchmarks

Recent work in the literature has begun to implement cutting-edge redistricting algorithms to develop a point of comparison against which to compare implemented plans (McCartan et al. 2022; Hankinson and Magazinnik 2023), but these algorithms have a surprisingly long history. As early as the 1960s, scholars foresaw how regular redistricting could quickly become the partisan tool that today's public recognizes as gerrymandering. To prevent this development, automated redistricting was proposed as a solution to take the politics out of the drawing process. By using an agreed-upon algorithm and selecting only among those maps produced by the algorithm, the entire process could be safeguarded from partisan influence. In essence, the promise of this technology was the opportunity to "push all decision-making to the beginning of the redistricting process" (Vickrey 1961). Engaging in public debate over what considerations to prioritize would at least make any bias in terms of metrics used explicit and publicly available.

However, for almost a half-century, these algorithms had little impact outside of academic discourse. The computationally intensive nature of simulating district maps while optimizing under several typical constraints (contiguity, population equality, compactness, VRA requirements, and more), excluded the technology from political relevancy. Only recently has personal computing become sufficiently cheap and powerful for this tool to begin to serve its practical purpose in the public realm.

Today, the state-of-the-art in automated redistricting simulation is implemented in the Redist R package (Fifield et al. 2020b; Kenny et al. 2022). In some respects, its methodology is similar to other recent work in that it uses a Monte Carlo simulation algorithm (e.g., Mattingly and Vaughn 2014; Chikina et al. 2017; Herschlag et al. 2017; DeFord et al. 2019). However, Fifield et al. (2020b) critique these earlier methods for lacking theoretical bases and for scaling poorly in larger contexts.

The geography and population density of cities may present unique challenges for district mapping. Because redistricting at this level is understudied, an outlier analysis using simulations is especially well suited for revealing obstacles to unbiased map-drawing, as well as for revealing structural bias. Past work has already revealed that heterogeneity in population density makes it more difficult to draw fair districts, particularly when it is correlated with group identities, partisan or ethno-racial (Chen and Rodden 2013; Chen and Rodden 2015). Performing an outlier analysis via simulation therefore has distinct advantages over other measures of bias (e.g., efficiency gap, partisan bias, etc.) because it takes the structural challenges of a particular geopolitical area into account, producing relative rather than absolute comparisons (Burden and Smidt 2020). Using the latest in simulation algorithms, the extent of bias present in current district designs can be plotted against a representative set of legally viable maps.

Data and Methods

In order to analyze the makeup of existing districts and simulate new ones, we merged several datasets. First, we obtained a large set of city council shapefiles of 101 cities, many of which had not been previously digitized (Lee and Velez 2023). We then added population and voting-age population (VAP) demographic data at the census-block level to these city council maps using the Census's Current Population Survey. Because many city council maps are not drawn in consideration of census blocks, the relevant demographic data often needed to be spatially weighted to estimate total populations at the city council district level. Neither citizenship rates nor counts are available at the census-block level. In order to estimate block-level CVAP (citizen voting-age population) data, citizenship rates were assumed to be consistent for all blocks within a particular block group—the smallest unit at which citizenship rates are available from the census (Kenny 2023).

Following previous and concurrent work (Behr 2004; Hankinson and Magazinnik 2023), segregation rates were estimated using the dissimilarity index (Duncan and Duncan 1955a; Duncan and Duncan 1955b) at the census block level. Finally, in order to prepare the city shapefiles for simulation, geographic contiguity had to be ensured in each city. U.S. city limits are often highly irregular, with large sections separated from the city's core, and only connected by roads, bridges, or even waterways.[7] Geographic

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[7] The districts of San Ysidro and Otay Mesa in San Diego, for example, are only contiguous via a small

data was minimally edited to accomplish this, with geographic features added to mimic the roads and waterways that exist in reality but are often not technically part of a city's limits.

In total, the data collection described above was completed for 101 cities from 36 different states. Every city in the dataset is represented by district-based council members, although many also have at-large representatives. The set contains most of the largest cities in the U.S. by population (mean=412,263; median=304,641), but also has 21 cities with a population below 150,000 and 10 cities below 100,000 (see **Table A1** in the appendix for a complete list). The number of single-member districts in these cities also varies widely from three (Kennewick, WA) to 35 (Nashville, TN). Within each city, segregation was calculated for each major ethnic or racial group using the dissimilarity index (Duncan and Duncan 1955a; Duncan and Duncan 1955b).

Using the Redist R package, we simulated novel district plans for each city using 2010 demographic data and 2016 partisan data (the most recent presidential election for which geospatial data is available at the precinct level). The number of districts within each simulation is equivalent to the number of single-member districts within each city. For each city, we simulated a minimum of 20,000 maps using sequential Monte Carlo (SMC) sampling (McCartan and Imai 2020) under only minimal constraints: (1) generally compact districts as measured by edge-cut compactness (Dube and Clark, 2016; DeFord et al., 2019),[8] (2) population equity between districts, with a deviation between districts of no more than 10% in total population, and (3) fully contiguous districts. For illustrative purposes, several simulated maps are plotted along with Miami's 2010 plan in **Figure 1**.

For particularly large cities, or those with a large number of city council districts, sometimes more simulations (as many as 60,000) were needed to ensure the sampling

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sliver of waterway across the San Diego Bay, which had to be manually drawn with GIS software.

[8] While there is no legal consensus over how exactly to determine compactness, there is legal precedent for "general compactness" to be expected of fairly drawn districts. States have different requirements for compactness in redistricting, some with formal definitions, and others with a more general expectation. From McDonald (2019), see for example: No. 4FA-11-02209CI (Alaska Super. Ct. 2011); League of Women Voters of Fla. v. Detzner, 172 So. 3d 363 (Fla. 2015); League of Women Voters of Pa. v. Commonwealth, No. 159 MM 2017 (Pa. Feb. 19, 2018); Jamerson v. Womack, 423 S.E.2d 180 (Va. 1992).

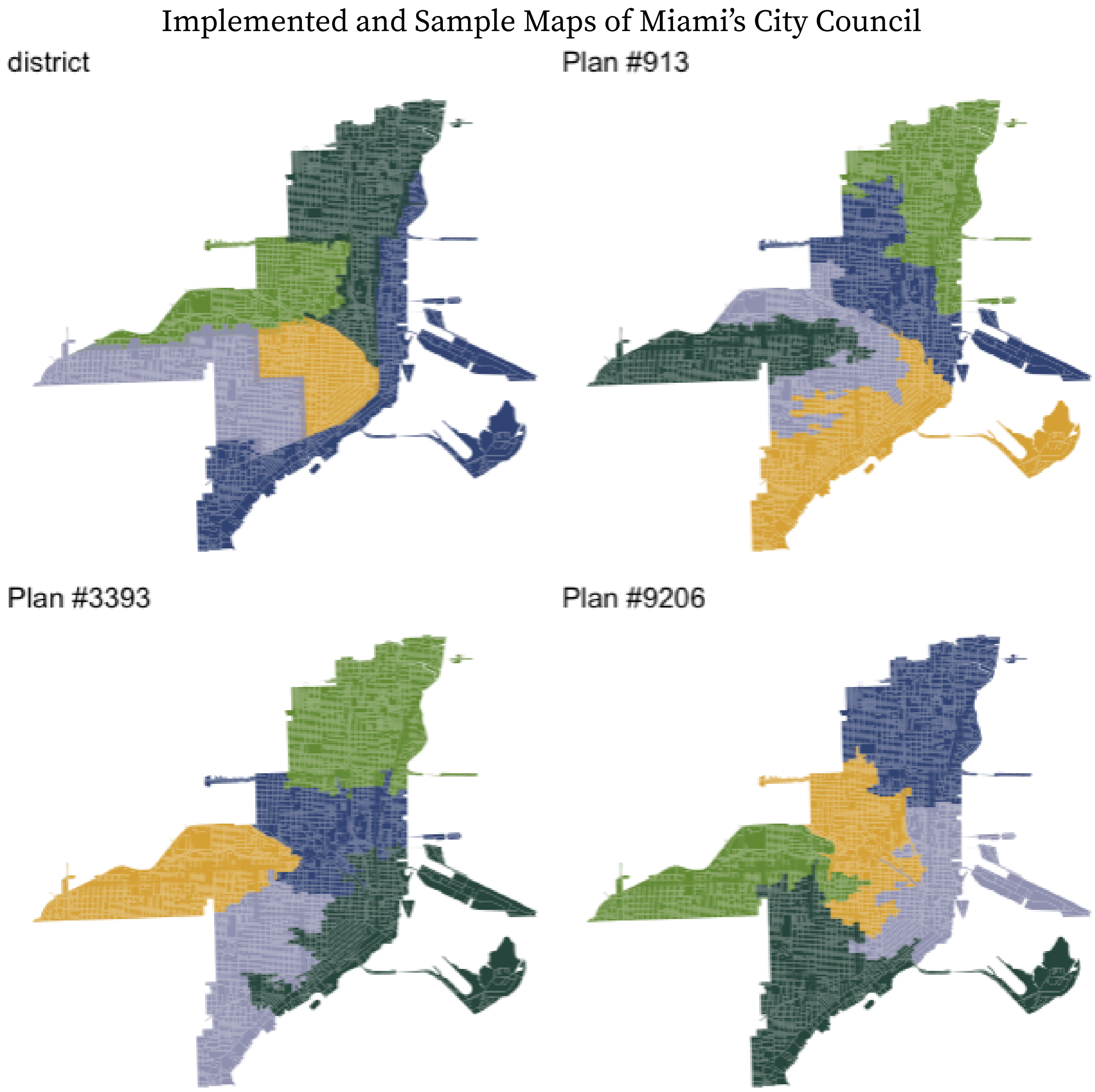

Figure 1. Three simulated plans of the city of Miami are plotted along with the actual 2010 plan, labeled as 'district.' Colors represent each of the five city council districts. The plans displayed demonstrate the discretion cities have in minority representation: the city's actual plan features three majority-Latine districts and one majority-Black district. Plan 913 features three majority-Latine districts and two majority-Black districts. Plan 3393 features one majority-Black district and only two majority-Latine districts. Plan 9206 features four majority-Latine districts and one majority-Black district.

chains were well-mixed. This was determined by using the updated R-hat convergence diagnostic after rank normalization and folding, following Vehtari et al. (2021). Simulations were run until R-hat was under 1.02 for all demographic measures across runs.

The creation of majority-minority districts was never implemented as a constraint, although the package does allow for it. One reason for the absence of a majority-minority constraint is to avoid redistricting primarily on the basis of race, which the Supreme Court held unconstitutional in Miller v. Johnson (1995). Another reason is to simulate plans that do not prioritize the representation of minority groups. Instead, the simulations produced serve as a conservative estimate of what is both viable and plausible via random sampling given each city's demographic and geographic context.

Results

Of the 101 cities analyzed, 71 had at least one viable majority-minority district across thousands of simulations. 28 cities had at least one viable Latine-majority district, 49 had at least one viable Black-majority district, and three had at least one Asian-majority district. Among these, nine had viable majority-minority districts for two different minority groups—eight had both Black and Latine-majority districts, and one had both Latine and Asian-majority districts.

Overall, implemented maps were very similar to the median race-neutral simulation in terms of majority-minority districts. Among cities with at least one Black-majority district, the average city had 3.4 implemented Black-majority districts compared to 2.7 simulated Black-majority districts. Among cities with at least one Latine-majority district, the average city had 2 implemented Latine-majority districts compared to 1.8 simulated Latine-majority districts. The sum of the median simulated map of each city featured about 188 majority-minority districts, compared to 225 majority-minority districts actually implemented during the 2010 cycle. The overall similarity between median simulations and implemented maps can be seen in **Figure 2**. The number

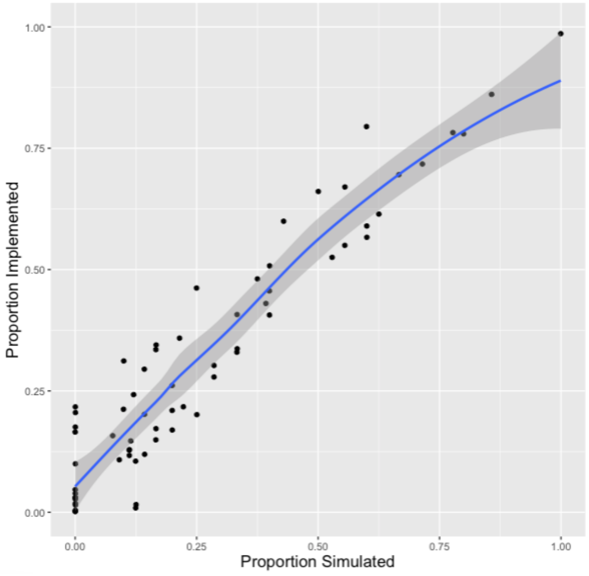
Implemented vs. Median Simulated Majority-Minority Districts

Figure 2. The median proportion of simulated majority-minority districts in each city is plotted against the proportion of majority-minority districts actually implemented. Both values are jittered to show frequency. A LOESS curve is fit to model the relationship.

of majority-minority districts implemented is consistently slightly above the number simulated.

The proportion of majority-minority districts in each council can be seen for each city in **Figure 3**. The only cities that had proportionally less majority-minority districts than their respective median simulations were Miami, Phoenix, and Fort Worth, all cities with large Latine populations. Nevertheless, there does not seem to be a large gap between the implementation of Black-majority and Latine-majority districts as past work has found. The lack of a disparity in implementation may suggest that city politics have become more inclusive of Latine citizens since previous findings—at least with respect to the design of city council districts. Alternatively, the differing results could be due to differences in methodology.

However, cities were not found to maximize the number of districts implemented either. The 171 implemented districts were made up of 112 Black-majority districts, 54 Latine-majority districts, and 5 Asian-majority districts. On the other hand, the maps that maximized the number of majority-minority districts for one particular group

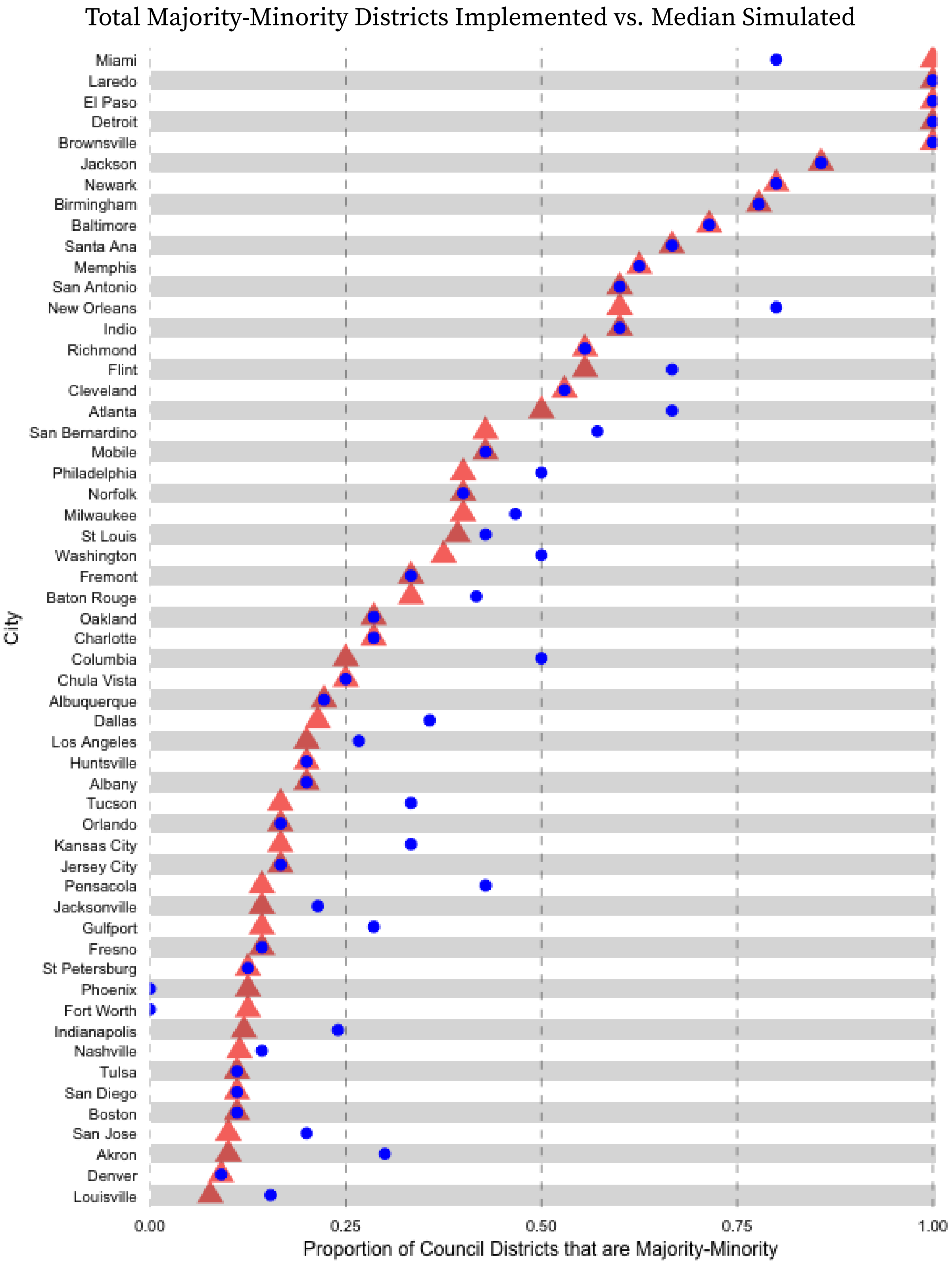

Figure 3. The proportion of majority-minority districts implemented during the 2010 redistricting cycle in each city is indicated by dark blue circles and the maximum proportion of majority-minority districts across all simulations is indicated by red triangles. Only cities in which at least one majority-minority district by CVAP was implemented or simulated is displayed. Majority-Latine, Black, and Asian districts were summed.

featured 174 Black-majority districts, 77 Latine-majority districts, and seven Asian-majority districts. This contrasts the findings of Hankinson and Magazinnik (2023) in Calfornia, suggesting that the results of redistricting are distinct from the results of districting for the first time. Maps that maximize the number of majority-Latine and those that maximize the number of majority-Black or majority-Asian districts are often mutually exclusive. For that reason, it is also important to compare simulated maps to implemented maps by their overall number of majority-minority districts. These differences are plotted in **Figure 3** and **Figure 4**. Consistent with group-specific comparisons, we find that cities tend to implement more majority-minority districts than race-neutral simulations, but most cities do not maximize this quantity.

In practice, the concentration of minorities within implemented majority-minority districts in the cities analyzed was consistently about 65%. This was equal for Latine, Asian, and Black-majority districts. Across simulations, however, Black-majority districts were also 65% Black, but Latine-majority districts were only 59% Latine. This may speak to the relatively higher levels of Black segregation in U.S. cities. It may also be related to lower levels of voter turnout among Latine residents. Cities may be consciously drawing more concentrated Latine districts in order to ensure that Latine citizens in those districts can elect their preferred candidates.

Considerations of VAP and CVAP

Within the legal realm of redistricting, the principal issue around measures of population has centered on whether to use a count of the total population or the voting-eligible population. In Evenwel v Abbott,[9] the court left open the possibility that states could use a count of eligible voters (either VAP or CVAP) instead of the overall population to determine whether districts are equally populous and satisfy the one person one vote requirement.

In scholarly work, the impact of whether one uses CVAP or VAP is used to determine

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[9] Evenwel v. Abbott, 578 U.S. (2016)

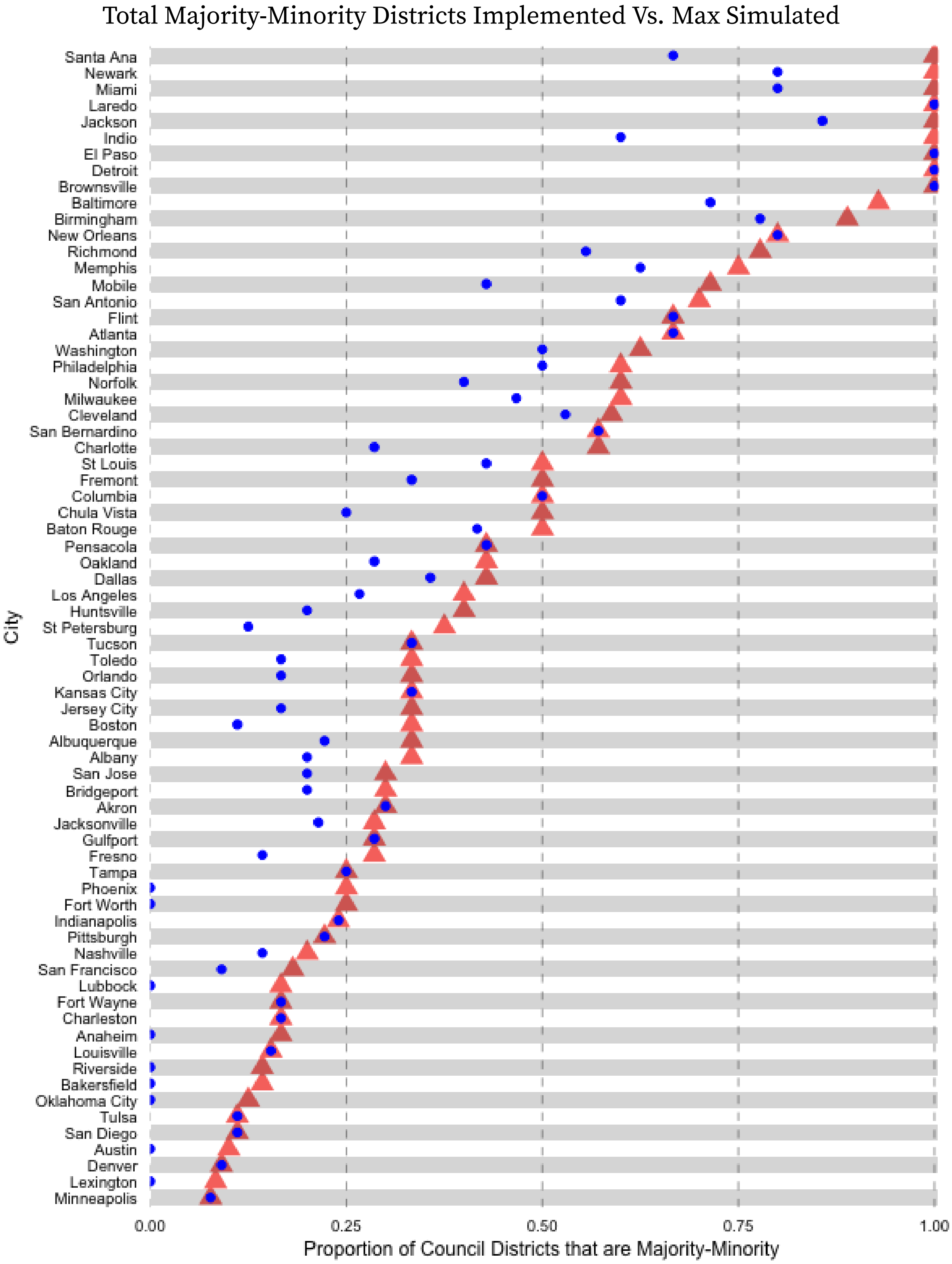

Figure 4. The proportion of majority-minority districts implemented during the 2010 redistricting cycle in each city is indicated by dark blue circles and the maximum proportion of majority-minority districts across all simulations is indicated by red triangles. Only cities in which at least one majority-minority district by CVAP was implemented or simulated is displayed. Majority-Latine, Black, and Asian districts were summed.

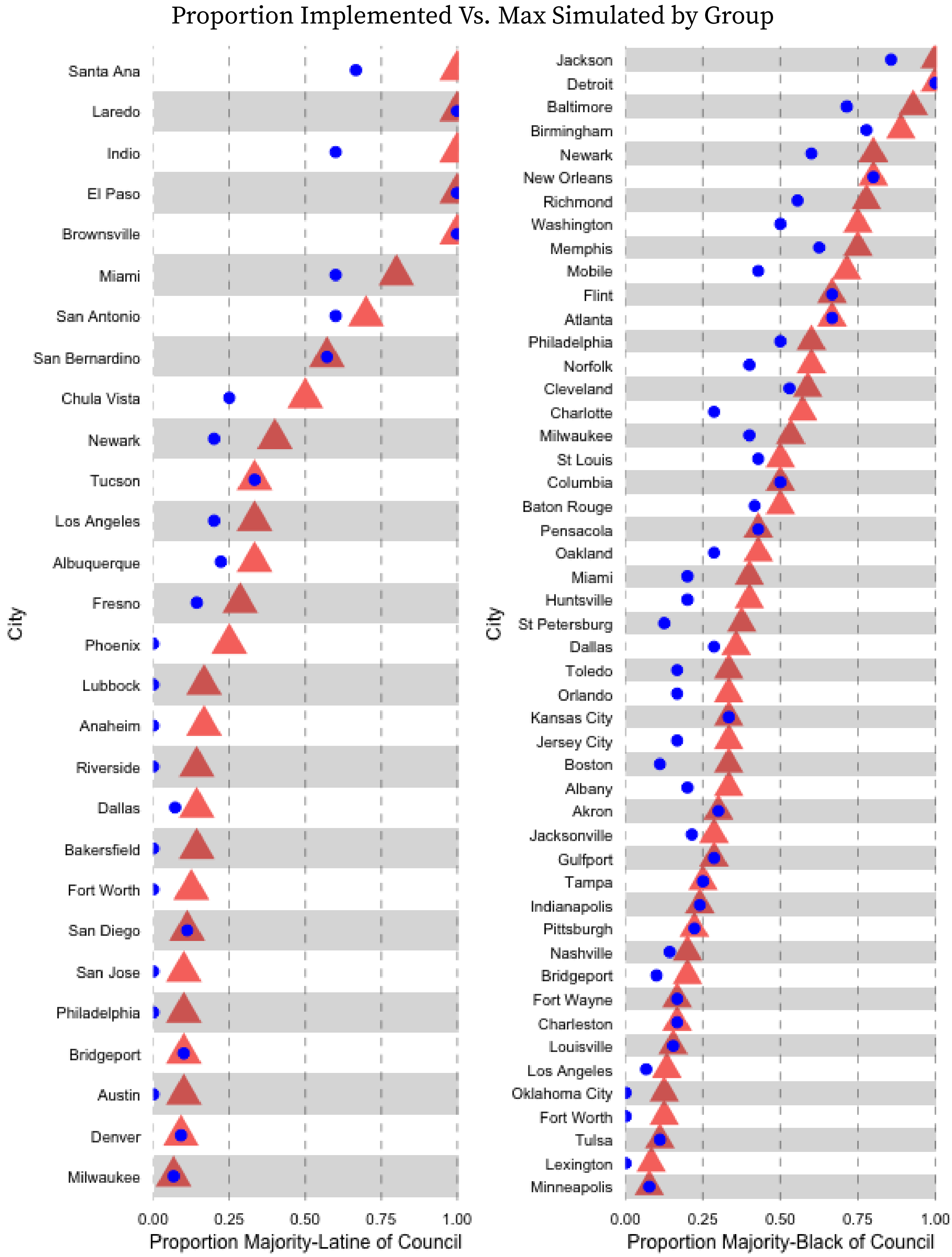

Figure 5. On the left: the proportion of majority-Latine districts implemented during the 2010 redistricting cycle in each city is indicated by dark blue circles and the maximum proportion of Latine-majority districts across all simulations is indicated by red triangles. Only cities in which at least one majority-Latine district by CVAP was implemented or simulated is shown. On the right: the same data is plotted but for majority-Black districts. Only cities in which at least one majority-Black district was implemented or simulated is shown.

the viability of majority-minority districts is rarely discussed. Yet, which was used and which should have been used is regularly the subject of litigation. Most recently, in Grace Inc. v. City of Miami, the city of Miami was sued in a U.S. district court for its implementation of a map that created Latine supermajority districts and hindered Black representation. One of the plaintiffs' expert witnesses explicitly cited the city's use of VAP rather than CVAP in order to understate the extent to which Black residents were packed into a single district. The city of Miami's district plan was subsequently thrown out by the court.[10]

It is unclear how widespread the practice of using VAP rather than CVAP to suppress minority representation is, but in many cities, drastically different maps result from the use of the two metrics. These differences are highlighted in **Figure A1** and **Figure A2**, which contain a significant gap between the number of majority-minority districts that are produced when CVAP is used relative to when VAP is used, across both actual and simulated maps. This gap is driven largely by Latine districts: across actual maps, 93 majority-Latine districts exist when measured by VAP (median simulated=87), but only 55 when measured by CVAP (median simulated=51). In contrast, Black-majority districts are gained when using CVAP: 120 districts were implemented by CVAP (median simulated=112), but 112 exist when measured by VAP (median simulated=100). These gaps further highlight the discretion that city councils and redistricting commissions have in allocating election opportunities during the redistricitng process.

Effects of Segregation

Behr (2004) found that high levels of segregation were associated with both the number of algebraically viable districts and the number implemented for the 2000 cycle. The results from this analysis corroborate this previous finding—the more segregated a group is within a city, the more majority-minority districts can be simulated, even after adjusting for the overall size of the group (**see Table 1**). It is unsurprising that it is easier

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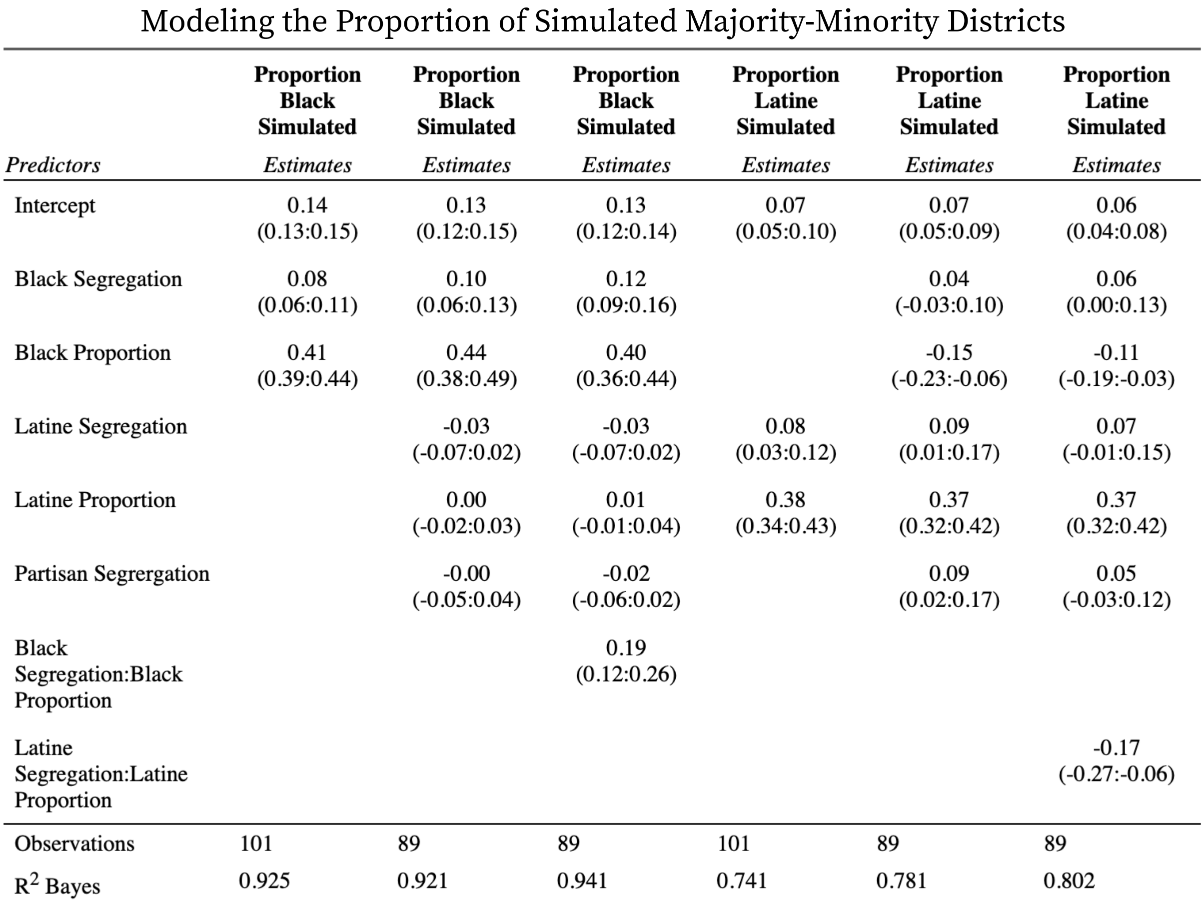
[10] Grace, Inc. v. City of Miami, 1:22-cv-24066-KMM (S.D. Fla. May. 23, 2023)

to draw districts around demographic groups that are geographically concentrated. On the other hand, it does not necessarily follow that implementation should depend on segregation as closely, given other goals of mapmakers, such as the creation of equally populous districts and the preservation of incumbent districts. To test the relationship between segregation and the number of implemented majority-minority districts, models were fitted with segregation rates and a number of related predictors. Predictors were also rescaled to make model coefficients more easily interpretable. Across all specifications, a city with a level of Black segregation that is one standard deviation above the mean had between 8% and 12% more Black-majority districts by proportion. Meanwhile, Latine segregation was found to be insignificant and could not be differentiated from zero in most of the model specifications (See model results in **Table 2** and **Table 3**). These relationships are also plotted in **Figure 3**.

The coefficients of partisan segregation, local ideology, and Democratic vote share were all found to be indistinguishable from zero in all of the models specified. Because past work has suggested a possible effect (Behr 2004), the relationship between the number of majority-minority districts implemented and the number of at-large seats in each city's respective electoral system was also tested (see **Table A2**), but the coefficient was indistinguishable from zero across multiple specifications.

There are two avenues through which segregation likely affects the adoption of majority-minority districts. The first is what Behr (2004) called "viability," or the ease with which compact districts can be drawn. Districts that are irregularly shaped or "look gerrymandered" are more likely to draw public attention and be challenged in the courts. A second avenue is through the concentration of political organization. In highly segregated cities, power may fall more directly along ethnic and racial lines, making it easier for minority groups to organize and demand district representation. The model results for Black-segregation persist even after adjusting for the number of Black-majority districts simulated, suggesting that even comparing two cities that had a similar number of Black-majority districts simulated, the more segregated city implemented



Modeling the Proportion of Simulated Majority-Minority Districts

	Proportion Black Simulated	**Proportion Black Simulated**	**Proportion Black Simulated**	**Proportion Latine Simulated**	**Proportion Latine Simulated**	**Proportion Latine Simulated**
Predictors	*Estimates*	*Estimates*	*Estimates*	*Estimates*	*Estimates*	*Estimates*
Intercept	0.14 (0.13:0.15)	0.13 (0.12:0.15)	0.13 (0.12:0.14)	0.07 (0.05:0.10)	0.07 (0.05:0.09)	0.06 (0.04:0.08)
Black Segregation	0.08 (0.06:0.11)	0.10 (0.06:0.13)	0.12 (0.09:0.16)		0.04 (-0.03:0.10)	0.06 (0.00:0.13)
Black Proportion	0.41 (0.39:0.44)	0.44 (0.38:0.49)	0.40 (0.36:0.44)		-0.15 (-0.23:-0.06)	-0.11 (-0.19:-0.03)
Latine Segregation		-0.03 (-0.07:0.02)	-0.03 (-0.07:0.02)	0.08 (0.03:0.12)	0.09 (0.01:0.17)	0.07 (-0.01:0.15)
Latine Proportion		0.00 (-0.02:0.03)	0.01 (-0.01:0.04)	0.38 (0.34:0.43)	0.37 (0.32:0.42)	0.37 (0.32:0.42)
Partisan Segrergation		-0.00 (-0.05:0.04)	-0.02 (-0.06:0.02)		0.09 (0.02:0.17)	0.05 (-0.03:0.12)
Black Segregation:Black Proportion			0.19 (0.12:0.26)			
Latine Segregation:Latine Proportion						-0.17 (-0.27:-0.06)
Observations	101	89	89	101	89	89
R^2 Bayes	0.925	0.921	0.941	0.741	0.781	0.802

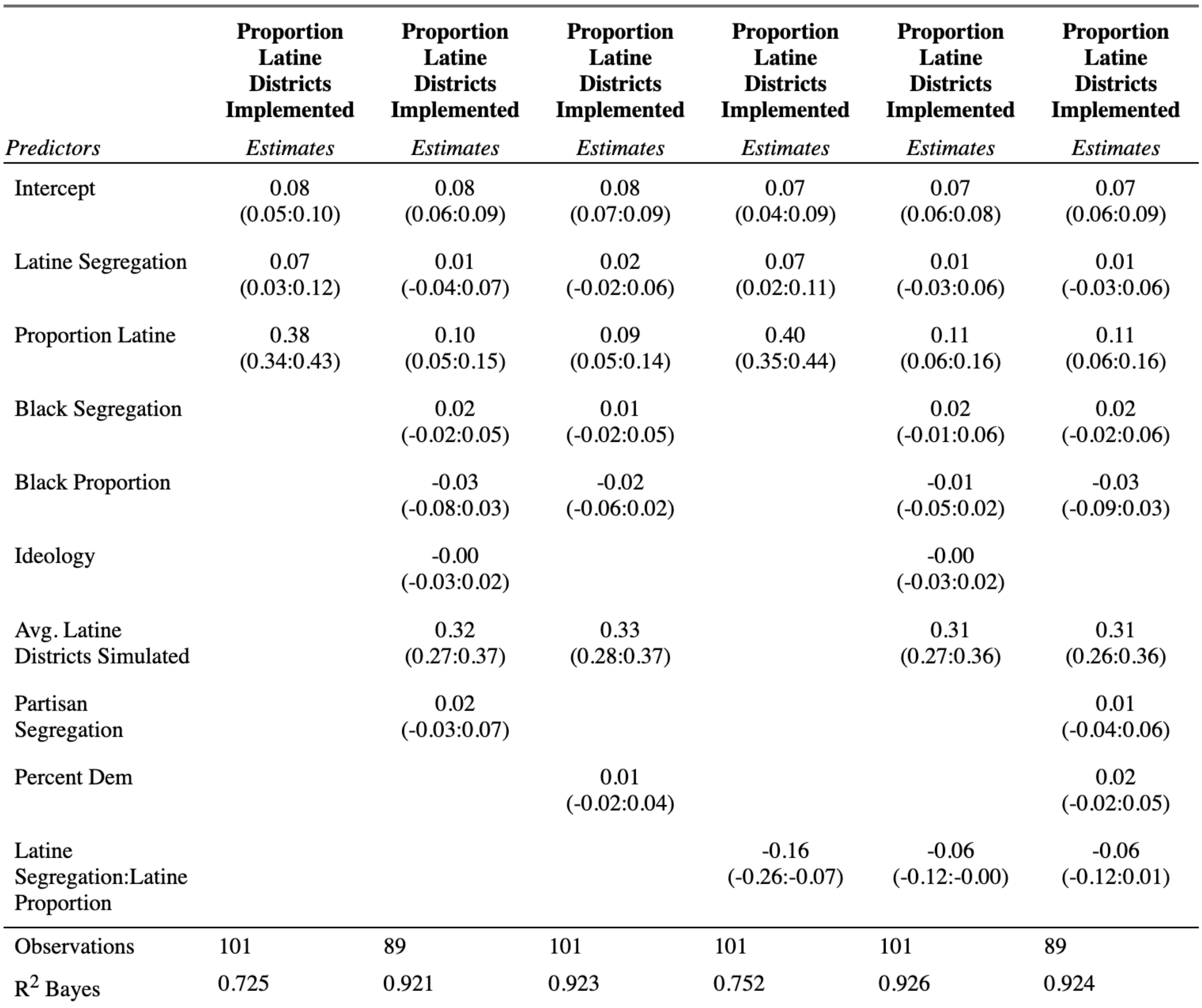
Table 1. This table features three models predicting the proportion of simulated Black-majority districts and three models predicting the number of simulated Latine-majority districts. 95% confidence intervals are shown underneath each coefficient. All predictors have been rescaled to make them more easily interpretable: the regression coefficient is the degree to which the proportion would increase given a shift from one standard deviation below the mean of the measure, to one standard deviation above the mean. Within each set of three, the first model is the most basic, with only group proportion and the dissimilarity index as predictors. The second model adds these same values, but from the opposite group. The third model interacts the group dissimilarity and the group proportion. Partisan segregation is measured by the dissimilarity index of Democrats and Republicans in the city.

Modeling the Proportion of Majority-Black Districts Implemented

	Proportion Black Districts Implemented	**Proportion Black Districts Implemented**	**Proportion Black Districts Implemented**	**Proportion Black Districts Implemented**	**Proportion Black Districts Implemented**	**Proportion Black Districts Implemented**
Predictors	*Estimates*	*Estimates*	*Estimates*	*Estimates*	*Estimates*	*Estimates*
Intercept	0.17 (0.15:0.18)	0.16 (0.15:0.17)	0.17 (0.16:0.18)	0.16 (0.15:0.17)	0.16 (0.15:0.17)	0.16 (0.15:0.17)
Black Segregation	0.09 (0.06:0.11)	0.08 (0.04:0.11)	0.09 (0.05:0.12)	0.11 (0.08:0.13)	0.12 (0.08:0.15)	0.10 (0.06:0.14)
Proportion Black	0.45 (0.42:0.47)	0.41 (0.35:0.46)	0.43 (0.38:0.48)	0.41 (0.39:0.44)	0.43 (0.38:0.48)	0.40 (0.35:0.46)
Latine Segregation		0.01 (-0.03:0.05)	-0.00 (-0.04:0.04)		-0.00 (-0.04:0.03)	0.00 (-0.03:0.04)
Latine Proportion		-0.01 (-0.03:0.02)	-0.01 (-0.04:0.01)		-0.01 (-0.03:0.02)	-0.01 (-0.03:0.02)
Ideology		-0.01 (-0.03:0.02)			0.00 (-0.02:0.03)	
Avg. Black Districts Simulated		0.01 (-0.04:0.05)	0.01 (-0.04:0.05)		-0.03 (-0.07:0.02)	-0.02 (-0.07:0.03)
Partisan Segregation		0.03 (-0.01:0.07)				0.02 (-0.02:0.06)
Percent Dem			0.00 (-0.03:0.03)			0.01 (-0.01:0.04)
Black Segregation:Black Proportion				0.12 (0.06:0.19)	0.13 (0.06:0.20)	0.10 (0.03:0.17)
Observations	101	89	101	101	101	89
R^2 Bayes	0.942	0.946	0.941	0.949	0.948	0.951

Table 2. This table features six models predicting Black-majority districts, across a number of different predictors. 95% confidence intervals are shown underneath each coefficient. All predictors except for the average districts simulated have been rescaled to make them more easily interpretable: the regression coefficient is the degree to which the proportion would increase given a shift from one standard deviation below the mean of the measure, to one standard deviation above the mean. Ideology is estimated using MRP (Warshaw 2023). The average number of districts simulated is the mean number of majority-Black districts across all simulated maps for the respective city.

Modeling the Proportion of Majority-Latine Districts Implemented



	Proportion Latine Districts Implemented	**Proportion Latine Districts Implemented**	**Proportion Latine Districts Implemented**	**Proportion Latine Districts Implemented**	**Proportion Latine Districts Implemented**	**Proportion Latine Districts Implemented**
Predictors	*Estimates*	*Estimates*	*Estimates*	*Estimates*	*Estimates*	*Estimates*
Intercept	0.08 (0.05:0.10)	0.08 (0.06:0.09)	0.08 (0.07:0.09)	0.07 (0.04:0.09)	0.07 (0.06:0.08)	0.07 (0.06:0.09)
Latine Segregation	0.07 (0.03:0.12)	0.01 (-0.04:0.07)	0.02 (-0.02:0.06)	0.07 (0.02:0.11)	0.01 (-0.03:0.06)	0.01 (-0.03:0.06)
Proportion Latine	0.38 (0.34:0.43)	0.10 (0.05:0.15)	0.09 (0.05:0.14)	0.40 (0.35:0.44)	0.11 (0.06:0.16)	0.11 (0.06:0.16)
Black Segregation		0.02 (-0.02:0.05)	0.01 (-0.02:0.05)		0.02 (-0.01:0.06)	0.02 (-0.02:0.06)
Black Proportion		-0.03 (-0.08:0.03)	-0.02 (-0.06:0.02)		-0.01 (-0.05:0.02)	-0.03 (-0.09:0.03)
Ideology		-0.00 (-0.03:0.02)			-0.00 (-0.03:0.02)	
Avg. Latine Districts Simulated		0.32 (0.27:0.37)	0.33 (0.28:0.37)		0.31 (0.27:0.36)	0.31 (0.26:0.36)
Partisan Segregation		0.02 (-0.03:0.07)				0.01 (-0.04:0.06)
Percent Dem			0.01 (-0.02:0.04)			0.02 (-0.02:0.05)
Latine Segregation:Latine Proportion				-0.16 (-0.26:-0.07)	-0.06 (-0.12:-0.00)	-0.06 (-0.12:0.01)
Observations	101	89	101	101	101	89
R^2 Bayes	0.725	0.921	0.923	0.752	0.926	0.924

Table 3. This table features six models predicting Latine-majority districts by CVAP, across a number of different predictors. 95% confidence intervals are shown underneath each coefficient. Ideology is estimated using MRP (Warshaw 2023). All predictors except for the average districts simulated have been rescaled to make them more easily interpretable: the regression coefficient is the degree to which the proportion would increase given a shift from one standard deviation below the mean of the measure, to one standard deviation above the mean. The average number of districts simulated is the mean number of majority-Latine districts across all simulated maps for the respective city.

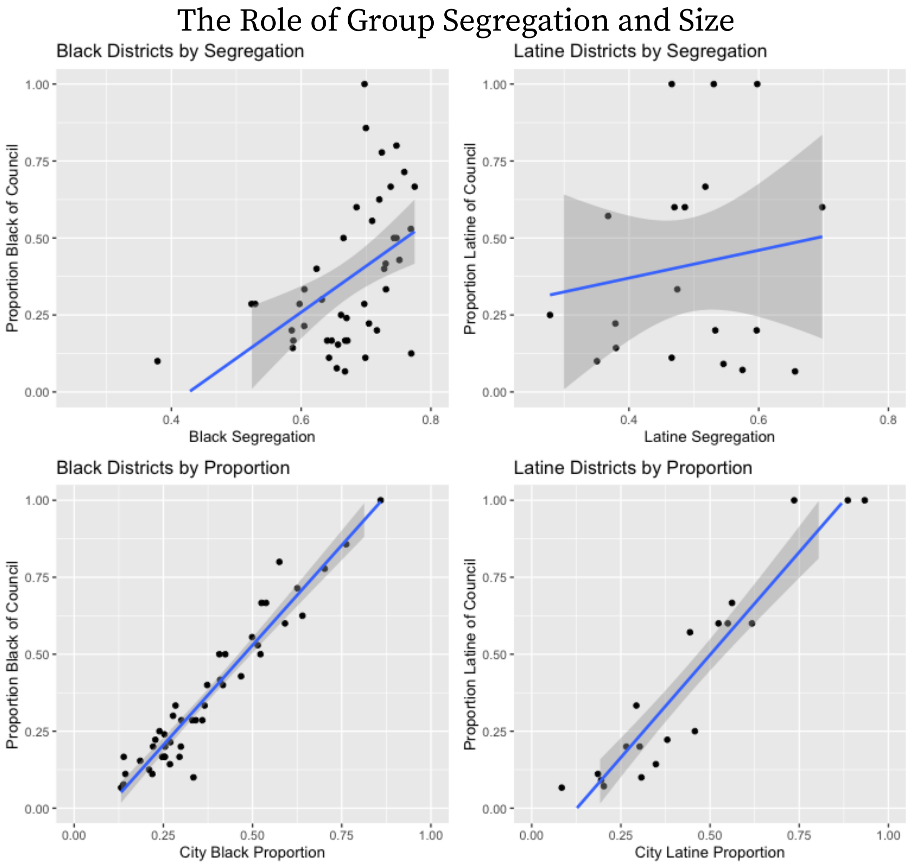


Figure 6. The top row compares the relationship between segregation and the proportion of majority-minority districts in cities by each group. The bottom row compares the proportional size of the group to the proportion of majority-minority districts in city councils.

more Black-majority districts on average. This finding provides preliminary evidence that segregation may foster political organization among Black residents.

Discussion

This paper links together a sparse, but important literature on redistricting in U.S. city councils, analyzing dozens of cities across the country, and how they draw their respective city council maps. Previous work (Lyons and Jewell 1988; Behr 2004) had found that cities implemented significantly fewer majority-minority districts than what was algebraically feasible during the 1980 and 2000 redistricting cycles. In this analysis of the 2010 redistricting cycle, minority representation was found to be a serious consideration of virtually every city. In fact, only three cities, among the 71 in which at least one majority-minority district was viable, implemented fewer majority-minority districts than the median simulation produced by the redistricting algorithm.

Previous work also found a large gap in the majority-minority districts implemented for Black citizens relative to Latine citizens, with the latter significantly underrepresented. This gap was not found in this analysis of the 2010 redistricting cycle, nor in Hankinson and Magazinnik (2023), which found that cities maximized Latine representation when possible. It is unclear if there was a significant shift in Latine representation at the local level between the 2000 and and 2010 redistricting cycles, or if the gap found in previous work is a product of not using a method that takes into account the spatial distribution of racial groups, such as an automated redistricting algorithm.

It seems that minority representation is generally an important consideration in contemporary city council redistricting. With that said, minority representation does not appear to take precedence over other considerations, such as the design of the existing map or the compactness of individual districts. There are also plenty of exceptions to this general trend, with cities trying to stifle minority representation. Miami's 2020 redistricting plan, which was ruled unconstitutional for suppressing Black representation, is nearly identical to its 2010 plan.

The analysis presented here is only a snapshot of one redistricting cycle. In order to better understand how cities adapt to demographic shifts, and population change more generally, time series data comparing cities across redistricting cycles are needed. This is especially important in light of the acceleration in migration patterns caused by urban gentrification and the Covid-19 pandemic and (Lee and Velez 2023). Another remaining gap in our understanding of local redistricting is the actual effect of these majority-minority districts. Future work should further analyze the impact of majority-minority districts at the local level with respect to advancing descriptive and substantive representation, as well as to increasing voter participation.

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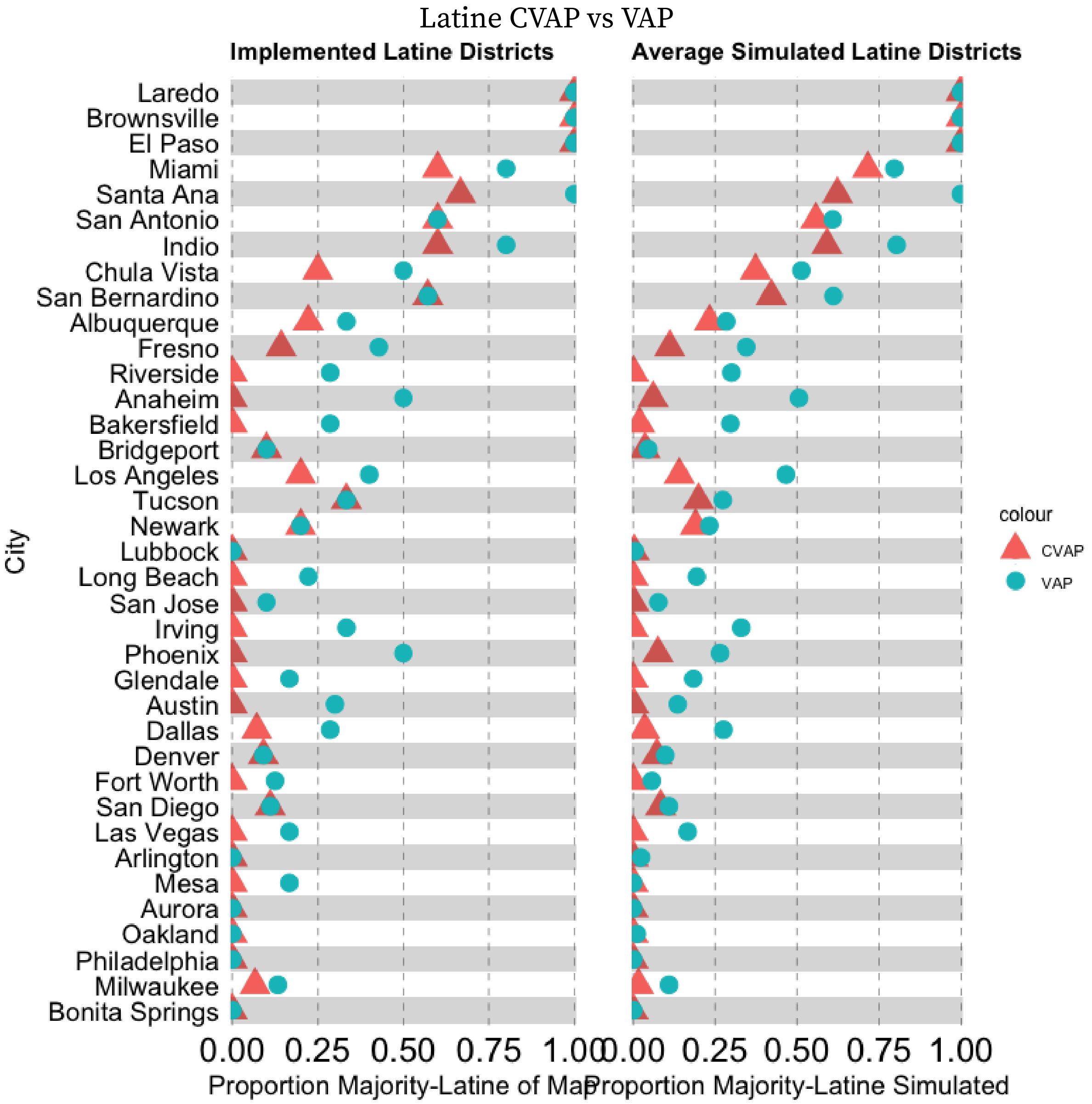
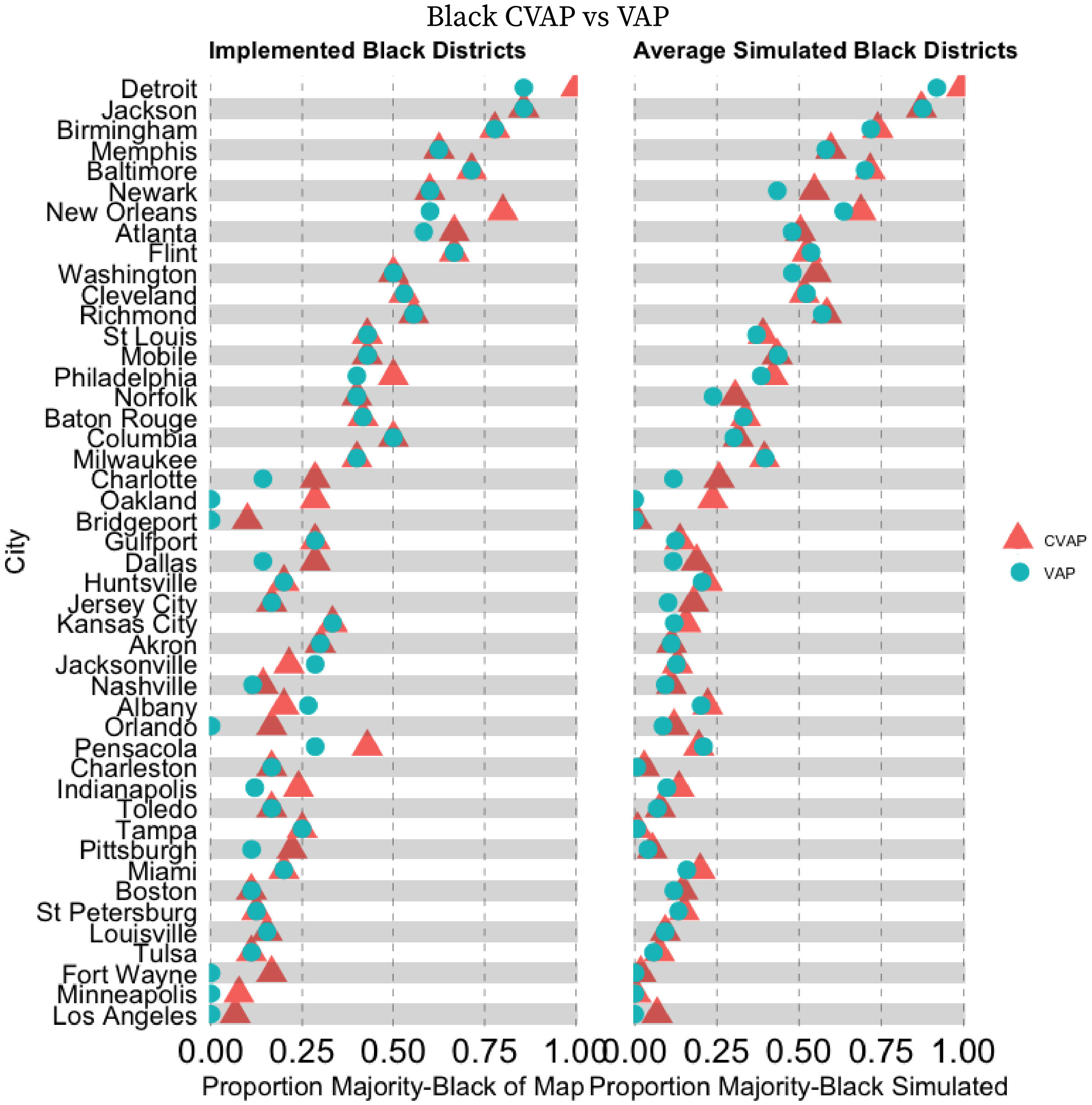
Appendix



Appendix Figure 1. The left figure plots the proportion of Latine-majority districts that were actually implemented. The red triangles represent CVAP districts and the blue dots represent VAP districts. The right figure is similar, but plots the mean Latine-majority districts across all simulated maps.



Appendix Figure 2. The left figure plots the proportion of Black-majority districts that were actually implemented. The red triangles represent CVAP districts and the blue dots represent VAP districts. The right figure is similar, but plots the mean Black-majority districts across all simulated maps.

Predicting Proportion of Majority-Minority Districts

	Proportion Majority Black Districts	**Proportion Majority Black Districts**	**Proportion Majority Latine Districts**	**Proportion Majority Latine Districts**
Predictors	*Estimates*	*Estimates*	*Estimates*	*Estimates*
Intercept	0.17 (0.15:0.18)	0.16 (0.15:0.17)	0.08 (0.06:0.10)	0.08 (0.06:0.09)
Black Segregation	0.09 (0.06:0.11)	0.08 (0.04:0.11)		0.01 (-0.03:0.05)
Proportion Black	0.45 (0.42:0.47)	0.40 (0.34:0.46)		-0.04 (-0.11:0.02)
At Large Districts	-0.01 (-0.03:0.02)	0.00 (-0.02:0.03)	-0.02 (-0.07:0.02)	0.01 (-0.02:0.03)
Latine Segregation		0.01 (-0.03:0.05)	0.08 (0.03:0.12)	0.02 (-0.03:0.07)
Latine Proportion		-0.01 (-0.04:0.02)	0.38 (0.33:0.43)	0.10 (0.05:0.15)
Percent Dem		0.01 (-0.01:0.04)		0.02 (-0.02:0.05)
Avg. Black Seats		0.01 (-0.04:0.05)		
Partisan Segregation		0.03 (-0.01:0.07)		0.03 (-0.02:0.07)
Avg, Latine Seats				0.32 (0.27:0.37)
Observations	101	89	101	89
R^2 Bayes	0.942	0.946	0.727	0.922

Appendix Table 3. Four models are shown above, the first two predicting Majority-Black districts and the second two predicting Latine-majority districts. 95% confidence intervals are shown underneath each coefficient. Ideology is estimated using MRP (Warshaw 2023). All predictors except for the average districts simulated have been rescaled to make them more easily interpretable: the regression coefficient is the degree to which the proportion would increase given a shift from one standard deviation below the mean of the measure, to one standard deviation above the mean. The average number of districts simulated is the mean number of majority-Latine or majority-Black districts across all simulated maps for the respective city. At-large is the number of at-large districts each respective city has in addition to single-member districts.

City	State	Pop.	Districts	City	State	Pop.	Districts
Akron	OH	206634	10	Jacksonville	FL	809874	14
Albany	NY	93576	15	Jersey City	NJ	237125	6
Albuquerque	NM	494962	9	Kansas City	MO	441833	6
Anaheim	CA	334909	6	Kennewick	WA	63593	3
Ann Arbor	MI	113716	5	Laredo	TX	218041	8
Antioch	CA	109485	4	Las Vegas	NV	553807	6
Arlington	TX	374729	6	Lexington	KY	274245	12
Atlanta	GA	424096	12	Lincoln	NE	245301	4
Aurora	CO	304641	6	Long Beach	CA	486571	9
Austin	TX	683404	10	Los Angeles	CA	3911500	15
Bakersfield	CA	301775	7	Louisville	KY	241072	26
Baltimore	MD	602658	14	Lubbock	TX	213587	6
Baton Rouge	LA	222217	12	Memphis	TN	639736	7
Birmingham	AL	229300	9	Mesa	AZ	461167	6
Bonita Springs	FL	43842	6	Miami	FL	386740	5
Boston	MA	567759	9	Milwaukee	WI	575250	15
Bremerton	WA	45306	7	Minneapolis	MN	364726	13
Bridgeport	CT	138901	10	Mobile	AL	195111	7
Brownsville	TX	174135	4	Nashville	TN	523547	35
Charleston	SC	106372	12	New Orleans	LA	454207	5
Charlotte	NC	607111	7	Newark	NJ	281378	5
Chula Vista	CA	221736	4	Norfolk	VA	248182	5
Cleveland	OH	443949	17	Oakland	CA	393632	7
Colorado Springs	CO	375744	6	Oklahoma City	OK	538141	8
Columbia	SC	118020	4	Omaha	NE	417809	7
Concord	CA	126360	5	Orlando	FL	211226	6
Concord	NC	61640	7	Pensacola	FL	51923	7
Dallas	TX	1216543	14	Philadelphia	PA	1439814	10
Davenport	IA	96595	8	Phoenix	AZ	1450884	8
Denton	TX	105431	4	Pittsburgh	PA	316272	9
Denver	CO	556575	11	Reno	NV	206626	5
Des Moines	IA	192050	4	Richmond	VA	189498	9
Detroit	MI	871789	7	Riverside	CA	306351	7
El Paso	TX	603545	8	Sacramento	CA	480392	8
Eugene	OR	146483	8	Saint Louis	MO	315546	10
Evansville	IN	114237	6	Saint Petersburg	FL	245804	7
Fayetteville	AR	66288	4	San Antonio	TX	1278171	9
Flint	MI	115691	9	San Bernardino	CA	205743	11
Fort Collins	CO	131505	6	San Diego	CA	1299352	10
Fort Wayne	IN	231147	6	San Francisco	CA	723724	6
Fort Worth	TX	633849	8	San Jose	CA	897883	7
Fremont	CA	202574	6	Santa Ana	CA	344086	3
Fresno	CA	472517	7	Seattle	WA	570430	28
Glendale	CA	204747	6	Spokane	WA	197513	8
Grand Rapids	MI	193006	3	Tampa	FL	328578	4
Gulfport	MS	71400	7	Toledo	OH	305292	6
Huntsville	AL	169155	5	Tucson	AZ	525268	6
Indianapolis	IN	771725	25	Tulsa	OK	379833	9
Indio	CA	69736	5	Virginia Beach	VA	453884	7
Irving	TX	194407	6	Washington	DC	605282	12
Jackson	MS	175085	7				