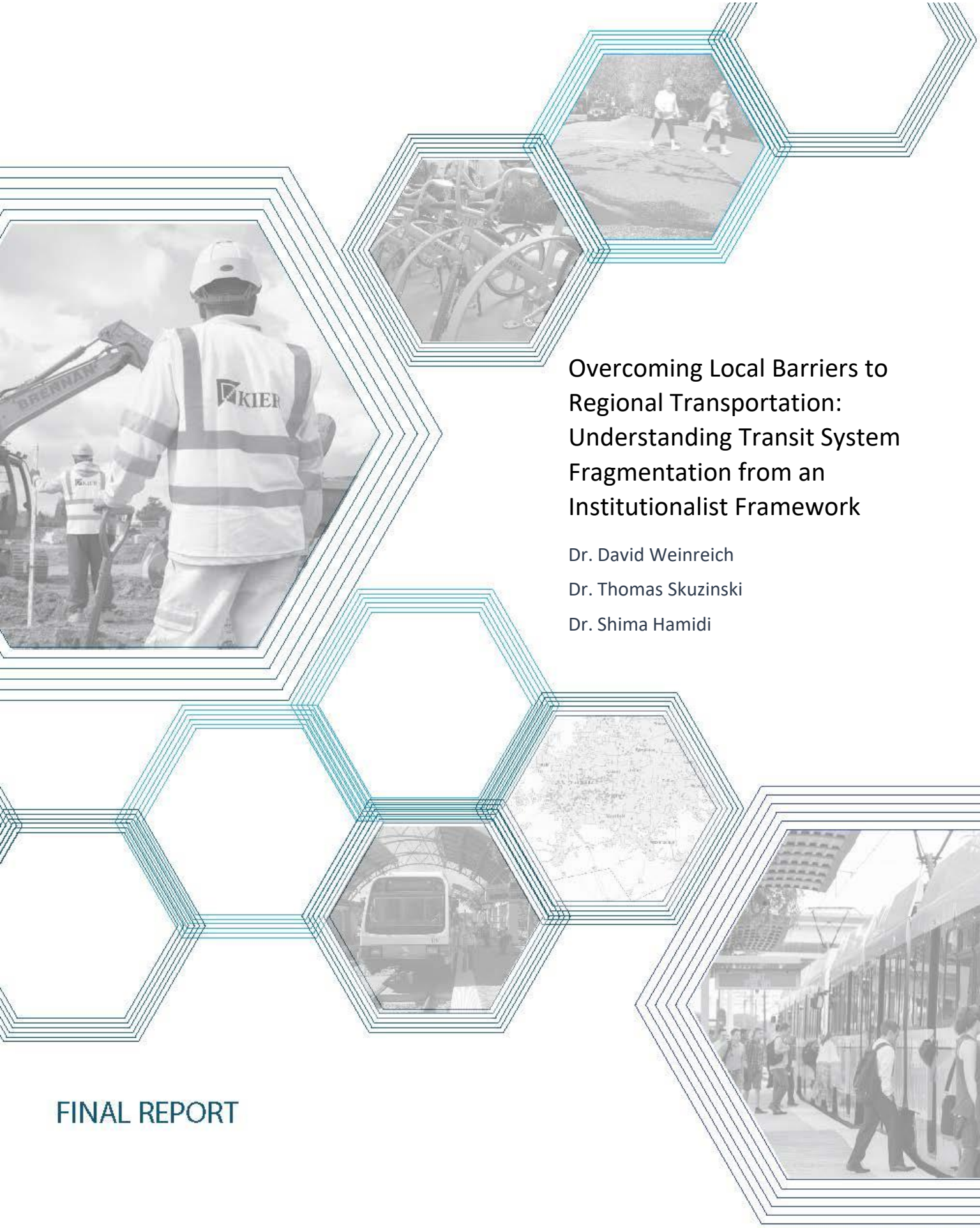

Overcoming Local Barriers to Regional Transportation: Understanding Transit System Fragmentation from an Institutionalist Framework

Dr. David Weinreich

Dr. Thomas Skuzinski

Dr. Shima Hamidi

FINAL REPORT

CEDD
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OVERCOMING LOCAL BARRIERS TO REGIONAL TRANSPORTATION
UNDERSTANDING TRANSIT SYSTEM FRAGMENTATION FROM AN INSTITUTIONALIST FRAMEWORK

FINAL PROJECT REPORT

by

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University of Texas at Arlington & Virginia Polytechnic Institute and State University

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16. Abstract

Metropolitan transportation systems (MTSs) span a fragmented political and administrative geography. The 200 largest metropolitan statistical areas (MSAs) - Census-defined areas of social and economic unity that we would reasonably expect a truly metropolitan system to serve - have more than 400 transit operating agencies (National Transit Database, 2014), and more than 5,000 general-purpose local governments (U.S. Census of Governments, 2012). MTSs face two persistent problems: (1) local governments that opt out of fiscal or functional participation, and (2) a lack of administrative coordination among transit agencies. Both of these can lead to service gaps that impair the connectivity, coverage, and accessibility necessary to make employment, education, health care, and other amenities available to all residents, regardless of where they live in the region. We develop a novel theoretical framework, grounded in new institutionalism, that conceptualizes decisions about regional transportation as products of both rules (formal institutions, state laws, and bylaws) and norms (informal institutions and professional relations). This research develops a metropolitan Transit Governance Index (TGI) for the largest 200 metropolitan regions with two or more transit agencies in operation. This work will allow the testing of propositions about the relationship between the institutional attributes of an MTS and three measures of MTS equity (connectivity, coverage, and accessibility). It provides a foundation for richer advocacy of policy reforms capable of changing those rules and norms that impede MTS equity.

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ABSTRACT

Transportation institutions remain an understudied topic, likely to have significant influences on the quality of transit service, and integration of services across transit agencies. Unfortunately, while past research has examined integration of operations across agencies, it has not examined transit institutions in a national, systematic way. Many studies of metropolitan regions have examined how variation in formal and informal institutions in other policy areas, and how they have shaped the effectiveness, efficiency, and equity or the response to policy problems. While some studies have applied the institutional lens towards public transportation systems, these have primarily been through research designs oriented around case study or small-*n* samples. Such work provides insight into how different modes of system governance influence the operation of public transportation across a region, and the experience of users of public transportation. But this scholarship has had little to say about the underlying institutions, focusing instead on transit operations and technology. Nor have previous studies attempted to develop a comprehensive, contemporary database that would allow development of objective measures of the governance of a large sample of metropolitan regions across the nation.

In this study we trace the development of a transit governance database for the 200 most populous metropolitan statistical areas in the United States. We use this database to describe thoroughly the metropolitan public transportation systems serving these regions, which include general-purpose local governments, multi-jurisdictional special-purpose governments, public and private transit agencies, and metropolitan planning organizations. From our data, we develop measures of the fragmentation and regionalization of the formal governance of these metropolitan public transportation systems. We measure fragmentation through factor analysis of Herfindahl-Hirschmann indices of general-purpose local government concentration by population, employment, and area, and counts of state and local governments. We measure regionalization through factor analysis of a dozen variables chosen based on literature review and pilot testing because they are capable of capturing the full range of formal, institutional variation. These variables include, for example, interagency agreements, multijurisdictional governance organizations, multijurisdictional funding schemes, and conjunctions via shared memberships on key organizational boards. We discuss national patterns evident in these measures, and we use case studies of four metropolitan statistical areas—two in California, one in Michigan, and one in Texas—to illustrate in more detail the calculation of our fragmentation and regionalization measures.

Our database and the measures of fragmentation and regionalization developed from it are original contributions to scholarship on public transportation. They can contribute to theory by illuminating longstanding debates on optimal metropolitan governance and by promoting more rigorous analysis of how formal institutional variation affects outcomes in public transportation systems and for individual transit users. They also can impact practice by providing insights to public transportation planners and policymakers about the role of institutions and how those institutions can be adjusted to support transit connectivity through strategic policy interventions.

I. INTRODUCTION

Connecting people to employment, education, healthcare, and other amenities through public transportation often requires that transit services cross boundaries, from the jurisdictional boundaries between general-purpose local governments to the service area boundaries between transit agencies and even the planning area boundaries of metropolitan planning organizations (see Figure 1). This is especially true in metropolitan regions, in which the markets for public and private goods and services are rarely contained within a single entity's purview, and in which spatial mismatches are known to be common (Laitner, 2015; Hall & Jonas, 2014).

Boundary-crossing often requires coordination among multiple organizations. For example, a regional transit funding scheme may involve participation by multiple local jurisdictions. Connection of fixed routes linking a core city to an outlying suburb may be supported by interagency agreements among transit providers. Through these mechanisms and others, the planning and implementation of public transportation in the organizationally balkanized region could be as efficient, equitable, and effective—if not more so—than that delivered in the region with one or only a handful of organizations. However, we lack the empirical evidence that would help us discern to what extent we can explain systematic variation in transportation outcomes by looking at differences in the formal institutional structure of metropolitan public transportation systems. Are some forms of metropolitan governance better than others?

Answering this question requires, first, measures of governance that can be taken of any metropolitan region, and that can serve as the key explanatory variables in analysis of transportation, and specifically, public transportation, outcomes. The goal of this research project is to develop such measures. This is the first step in a much broader research endeavor. Subsequent steps, which are beyond our efforts here and which we describe in detail in the final section of this report, include looking beyond formal structures (rules, regulations, organizational bylaws, and the like) to the informal institutions—the norms among organizations and individuals in the metropolitan public transportation system. We can then take the final step of analyzing the relationships between institutional variation in metropolitan areas and variation in a wide range of transportation outcomes. We represent the stages of the broader research effort, and the extent of our current work, in the graphic below.

Our research fills three gaps. The first is functional. We became aware through initial exploration of secondary sources that no comprehensive, contemporary database exists about metropolitan public transportation systems. A key product of our work, therefore, is a geographic information system with polygon shapefiles containing the general purpose local governments, transit agencies, and metropolitan planning organizations for the 200 most populous metropolitan statistical areas in the United States, with the general purpose local governments as the base unit.[1] Because each unit has a federal information processing standards (FIPS) code, it can be linked to all the data available through the census at this geographic level. We hope this GIS will be of use to those studying public transportation from an institutional perspective, as well as many other researchers working outside this perspective.

[1] We discuss our justification for choosing metropolitan statistical areas, and for choosing only the 200 most populous of the 383 that exist in the U.S. in 2018, in section II.A.

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The other gaps will be addressed as we move further along in our broader research plan. The second is theoretical. Scholars of the urban and metropolitan condition—found in public administration, political science, planning, public policy analysis, and other disciplines—have for decades debated the optimal approach to governing the many public services and goods provided in America's large conurbations. Some view fragmentation as an inherently problematic condition that inevitably supports inefficiency, segregation, polarization, and civic apathy. The policy recommendation flowing from this viewpoint is to have a regional government whose boundaries are consistent with the territorial scale at which these problems arise. Others, working from a political economy perspective, regard the fragmented metropolis as a promising geography, in which *ad hoc* cooperation and collaboration can be used to scale governance as appropriate to the need. Regional govern*ment* is not necessary, in this view, because regional govern*ance* can function just as well when it is needed. Neither of these views is specific to any particular policy area, but rather to decision making in general. Through our work, we hope to understand whether one of these forms is significantly better at delivering truly metropolitan public transportation. Is regional governance enough to deliver regional transportation? If not, which policy interventions can help improve the form and function of regional governance?

This latter question is at the heart of the third gap we hope to begin filling through our work: to understand, if possible, the formal institutional mechanisms at work in those metropolitan regions with high-performing public transportation systems (regardless of the dimension chose to measure performance), and those that are lacking in low-performing ones. Formal institutions—which range from regulations and bylaws to contracts and memoranda of understanding—are a useful target of study because they are socially constructed and can be targeted by policy interventions. We are not interested in the governance of metropolitan public transportation systems as a structure to be described but as something from which we can gain insights and advance positive change.

We organize the remainder of this report into five sections. In Section II, we define what we mean by the *metropolitan public transportation system*. We defend metropolitan statistical areas as our unit of analysis, exploring their conceptual advantages relative to urbanized areas and combined statistical areas, and explain our decision to study the 200 most populous metropolitan statistical areas.[2] We describe the three entities that play a role in the governance of these systems— general purpose local governments, transit agencies, and metropolitan planning organizations. We then provide some basic statistics on the organization of these systems. In Section III, we review extant scholarship around three questions: (1) what are the existing approaches to the study of metropolitan governance, both generally and with regard to public transportation policy?; (2) how has metropolitan governance been measured?; and (3) what are the formal institutional mechanisms that theory and empirical evidence suggest would matter in the governance of metropolitan public transportation systems. Section IV presents the research design, transitioning from how we conceptualize the fragmentation and regionalization of the system's governance to how we measure these. In this section we cover our data collection

[2] Metropolitan statistical areas were once consistently shorthanded as MSAs. With the introduction of micropolitan statistical areas as a smaller type of core-based statistical area, the federal government and most scholars now avoid using the MSA acronym to prevent confusion by readers. Because we deal only with metropolitan statistical areas, we use the MSA acronym throughout this report.

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methods and analytic methods, and review the limitations of our approach. We present analysis and findings in Section V, examining both national and large-scale regional trends. We also use four metropolitan public transportation systems in the metropolitan statistical areas for Los Angeles, San Francisco, Detroit, and Dallas to illustrate the calculation of the measures in greater detail. The report concludes with Section VI, in which we draw conclusions, summarize findings, and review some of the potential applications of our measures in subsequent research, outlining next steps for refining and expanding the scope of our measures.

II. METROPOLITAN PUBLIC TRANSPORTATION SYSTEMS

Metropolitan public transportation systems include the complete system of fixed route, general public service delivery from planning through implementation in the metro region, rather than just the transportation services provided through a regional transit district or authority. Three types of organization are involved in the governance of public transportation systems in the United States: general-purpose local governments, transit agencies (including all transit districts and transit authorities), and metropolitan planning organizations (MPOs). Each plays a distinct role. Local governments provide and produce a wide range of public services, and sometimes provide public transportation services via a department of transportation or other authority. Transit agencies are public or private entities that operate transit services, typically led by a board of directors. They can vary extensively in their size and scope, from the minimally staffed agency nested within a single small local government providing basic bus connectivity to its community, to the multijurisdictional regional transit agency providing multi-modal service. MPOs, whose formation by state governments is triggered by the designation of an urbanized area, distribute federal highway funds, plan transportation improvements and, occasionally, operate transportation services (Weiner, 2013; Sciara & Wachs, 2007). The MPO can be a stand-alone agency, or a council of governments (COG) serving MPO functions. It can cover an entire metropolitan statistical area, cover a single county or subset of counties, or have a boundary that matches the urbanized area or some other functional geography.

A major contribution of our study is that it provides a current, comprehensive geodatabase of metropolitan public transportation systems in the United States. With this, we can fully describe the geography and characteristics of the general purpose local governments, transit agencies, and metropolitan planning organizations that comprise these systems. While national and state data sources can afford insights and were useful in our data collection process, we did not encounter a source available through a public agency or private organization, or in extant research, that assembled data across multiple organizational types at a scale that covered nearly every state and the vast majority of population and labor in the nation. As noted in our executive summary and introduction, such a geodatabase is foundational to any research on the effectiveness, efficiency, and equity of different approaches to metropolitan public transportation governance and to the policy recommendations that could flow from such work.

One of the goals in this section, then, is to describe American metropolitan public transportation systems—to provide a snapshot of the cases that are typical or extreme on a variety of dimensions, and to look for any broader trends in the organization of these systems across states and regions of the United States. Another goal is to demonstrate the remarkable heterogeneity that exists within these systems both across and within organizational type. This heterogeneity is important in the governance and implementation of transit, because it means that not all units

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within a given organizational type are equal in the operation of the system. Some cities can play no direct role in the governance of the transit system with little negative consequence to the system overall because they have a small population, or few jobs, or cover only a small share of the metropolitan statistical area. The system can work around them quite well. The absence of others would render a system highly dysfunctional. Stated more simply, the integration of some units into the metropolitan public transportation system is much more essential. This heterogeneity is incorporated into our calculation of the transit governance fragmentation and regionalization measurements.

We organize the remainder of Section II as follows. First, we discuss our study population of 200 metropolitan statistical areas and their organization, and examine some broad regional patterns based on the regional divisions used by the United States Census Bureau. Prior research on metropolitan governance often shows similarity, for example, among metropolitan statistical areas in the Midwest or Southeast due to the history of statehood and diffusion of state systems of local government, and we want to assess whether our data on metropolitan public transportation governance are consistent with these patterns. Second, we describe the component parts of the metropolitan public transportation systems, beginning with general purpose local governments and then following with transit agencies and metropolitan planning organizations. For each component, we consider variation in the three characteristics that would be meaningful at a base level in a metropolitan public transportation system: population, employment, and area. We also consider the organization of these components across one another, such as how transit agencies or metropolitan planning organizations overlay general purpose local governments.

A. Metropolitan Statistical Areas (MSAs)

i. Justifying metropolitan statistical areas as the unit of analysis

The United States has 383 metropolitan statistical areas, which are one type of core-based statistical area (CBSA) defined by the Office of Management and Budget. A CBSA is anchored by an urban area with a relatively high population density, and any county with at least 50 percent of its area covered by the urban area becomes a central county within the CBSA. Any outlying counties with sufficiently strong social and economic ties to the central county or counties—as measured by commuting—are also included in the CBSA. Urban areas with at least 50,000 persons are termed urbanized areas, and these form the anchors in the type of CBSA designated as a metropolitan statistical area. A combined statistical area (CSA) is comprised of adjacent metropolitan and micropolitan statistical areas with sufficiently high social and economic linkages, again as measured by commuting. Thus, a metropolitan statistical area will always include one or more counties or county equivalents, will always have a relatively dense urban core, and it may or may not be part of a larger CSA.

An example will help clarify these distinctions (see Figure 1). The Detroit-Warren-Dearborn, CSA has a population of 5,318,744 (2010), and covers ten counties in southeastern Michigan. The CSA is comprised of five CBSAs. These include the Adrian micropolitan statistical area (Lenawee County), three single-county metropolitan statistical area designated for Ann Arbor, Flint, and Monroe (respectively, Washtenaw, Genesee, and Monroe counties), and the Detroit-Warren-Dearborn metropolitan statistical area (Lapeer, Livingston, Macomb, Oakland, St. Clair,

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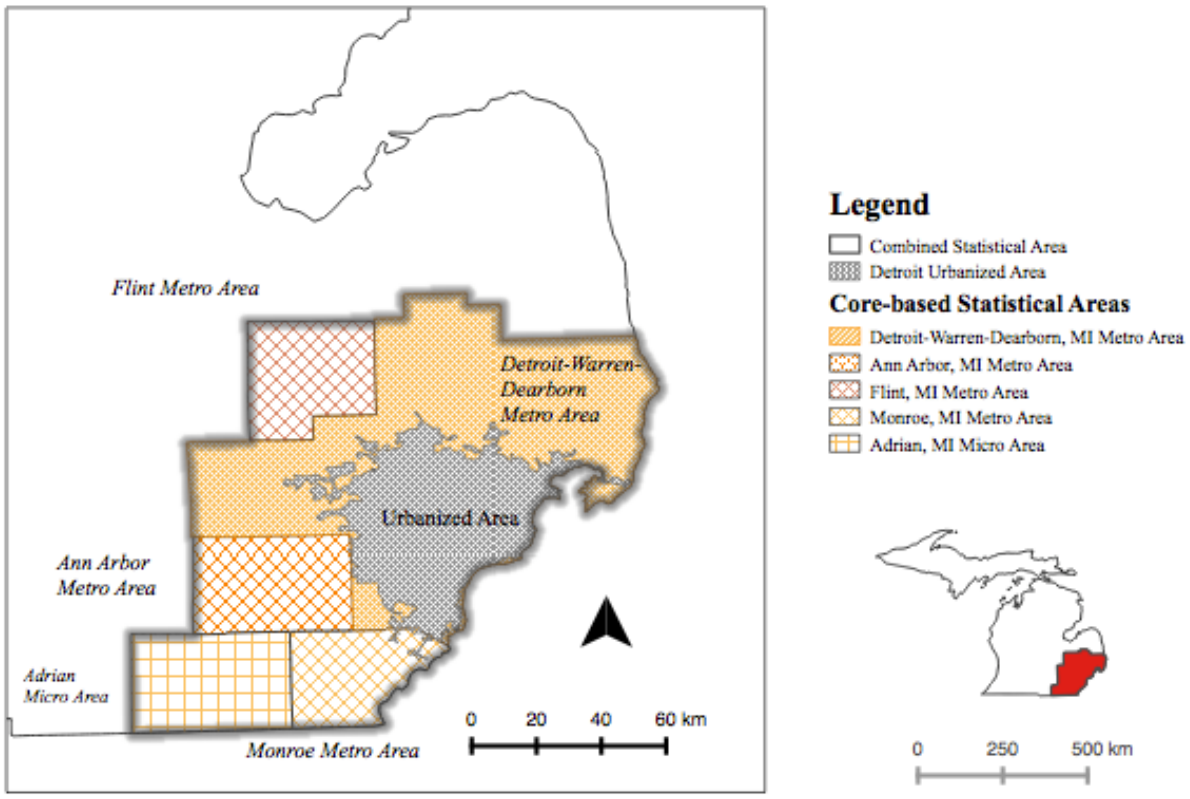
and Wayne counties). The latter metropolitan statistical area had a 2010 population of 4,296,250, while the urbanized area that is the core of the metropolitan statistical area —which covers parts of Wayne, Oakland, and Macomb counties—had a population of 3,734,090.



Map created by: Thomas Skuzinski, 10/20/2018

Source: 2018 TIGER/Esri cartographic boundary files (urban area, core-based statistical area, and combined statistical area polygon selections). NAD83 projection.

Figure 1. Census geographies for the Detroit metropolitan region

As noted earlier, we chose metropolitan statistical areas for several reasons. We prioritized using areas designated as socioeconomic regions for federal government statistical purposes for two reasons. First, these would necessarily have relatively strong social and economic ties that one would reasonably expect a public transportation system to span. Second, we would not be defining our regions according to one of the component organizations of a region's metropolitan public transportation system, such as the service area of the largest transit agency or the planning area of an MPO. The boundaries of the region would be driven by social and economic reality, rather than governance. This left us with three options: urbanized areas, metropolitan statistical areas, and combined statistical areas.

We chose metropolitan statistical areas instead of these alternatives. The metropolitan statistical area has been used most often as the preferred unit of analysis used in research on metropolitan governance generally, and has also been used extensively as a referent in public transportation policy studies. Metropolitan statistical areas contain a mix of metropolitan land use typologies and densities. A system at that scale could only be regarded as equitable, efficient, and effective if it served a wide variety of uses, and residents occupying urban and suburban and perhaps even

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rural areas. Urbanized areas must have a density at the block group level of at least 500 persons per square mile, but large swaths of a social and economic region would never meet this threshold. At a foundational level, this reflects a normative understanding of the metropolitan scale—that it should be more than just an assemblage of relatively high-density neighborhoods. We regard this as critical because the heterogeneity existing at the metropolitan statistical area scale—as opposed to the urbanized area scale—introduces tensions into the system that are resolved, in part, through governance. Third, the threshold of social and economic unity as measured by employment interchange can be lower for a combined statistical area (CSA). For an outlying county to merit inclusion in a metropolitan statistical area, either 25 percent of that county's workers must commute to a central county of the metropolitan statistical area, or 25 percent of the jobs in that county must be held by residents of the other metropolitan statistical area counties. This threshold is evaluated not for counties but for whole core-based statistical areas in assembling combined statistical areas, and the employment interchange can be as low as 15 percent. Some CSAs, then, would have relatively low integration, and CSAs as a group would vary in this level of connection. This difference matters because it suggests that assessing the metropolitan statistical area as a single transportation system is more defensible and more consistent than doing so for a CSA.

We chose only the 200 largest metropolitan statistical areas by population based on American Community Survey 5-year population estimates from 2016. The number 200 was somewhat arbitrary, but was motivated by a desire to study only regions that were large enough in area and population to have the diversity in income and transit needs to necessitate provision of public transportation, to have some complexity in their baseline governance (i.e., the number of general-purpose local governments), and to yield a scope of study that would be national or near-national. Including the metropolitan statistical areas ranked 100 to 200 gains us an additional ten states and another eleven percent of the United States population. The next 183 metropolitan statistical areas, however, would gain us little—two more states, and only another eight percent of the population. We also found that the complexity of local government drops off sharply among the remaining 183 metropolitan statistical areas: nearly all were single-county or two-county metropolitan statistical areas, and had relatively few municipalities and county subdivisions, and these kinds of places were already well represented in the largest 200 metropolitan statistical areas. Thus, there is not a meaningful conceptual difference between our smallest metropolitan statistical area—by population, Charlottesville, Virginia—and the next metropolitan statistical area that was not included (Prescott, Arizona). But a cut-off at 200 allowed a research endeavor that met our needs while also being feasible within the research period.

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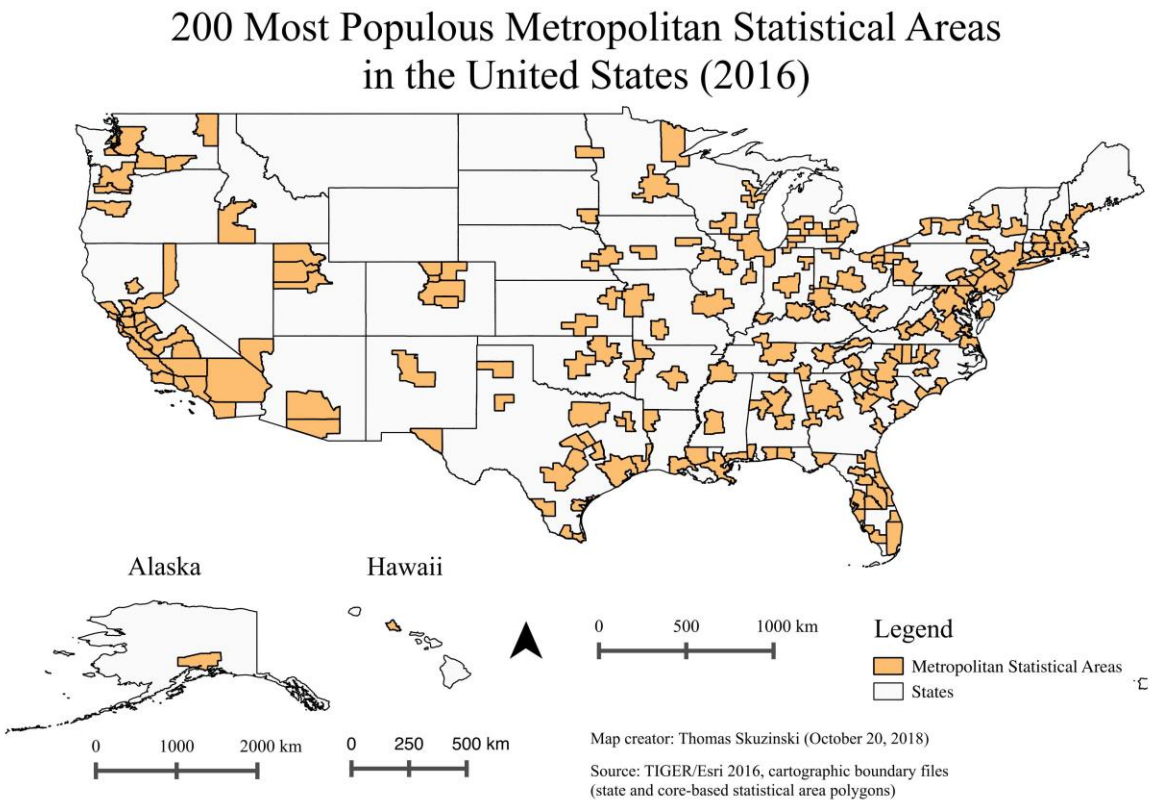

FIGURE 2: Metropolitan Statistical Areas Examined Here

ii. General characteristics of the study Metropolitan Statistical Areas

The metropolitan statistical areas in our study were in 48 of the 50 states. The only states excluded were Vermont and Wyoming. In total, these metropolitan statistical areas cover about only 23 percent of the land in the continental United States. But as would be expected for metropolitan places, they contain far greater shares of the population and economic activity, with 258 million of the nation's approximately 320 million residents in 2015 (more than 80 percent), and about three quarters of the nation's jobs.

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Table 1. Descriptive statistics for select study metropolitan statistical areas (MSAs)								
	MSA	Pop.	Jobs	Area (sq. mi.)	# Counties	# Other local gov'ts	# Transit agencies	# MPOs
	Average MSA	1,288,595	595,567	3,367	4	59	3	1
10 Most Populous MSAs in study	New York-Newark-Jersey City, NY-NJ-PA Metro Area	21,081,036	9,583,919	8,682.3	21	641	15	5
	Chicago-Naperville-Elgin, IL-IN-WI Metro Area	15,479,043	7,403,787	9,512.2	13	560	9	4
	Los Angeles-Long Beach-Anaheim, CA Metro Area	13,154,457	6,021,502	4,848.9	2	122	21	1
	Dallas-Fort Worth-Arlington, TX Metro Area	6,709,158	3,611,598	9,223.6	13	207	6	1
	Houston-The Woodlands-Sugar Land, TX Metro Area	6,250,146	2,984,892	8,224.8	9	124	7	1
	Philadelphia-Camden-Wilmington, PA-NJ-DE-MD Metro Area	6,035,680	2,774,614	4,602.4	11	375	6	3
	Washington-Arlington-Alexandria, DC-VA-MD-WV Metro Area	5,951,663	2,955,571	6,246.4	17	96	12	3
	Miami-Fort Lauderdale-West Palm Beach, FL Metro Area	5,864,852	2,471,380	5,075.5	3	113	23	3
	Atlanta-Sandy Springs-Roswell, GA Metro Area	5,535,837	2,543,486	8,674.8	29	146	8	2
	Boston-Cambridge-Newton, MA-NH Metro Area	4,694,565	2,597,474	3,487.6	7	197	10	9
10 Least Populous MSAs in study	College Station-Bryan, TX Metro Area	239,096	111,198	2,100.3	3	12	1	1
	Tuscaloosa, AL Metro Area	235,570	97,975	2,847.0	3	19	1	1
	Macon-Bibb County, GA Metro Area	231,517	101,081	1,722.7	4	8	2	1
	Appleton, WI Metro Area	231,011	125,710	955.1	3	51	1	1
	Charleston, WV Metro Area	223,922	119,862	1,745.4	3	19	1	1
	Fargo, ND-MN Metro Area	223,379	136,369	2,811.0	2	118	1	1
	Chico, CA Metro Area	222,564	76,587	1,636.5	1	5	1	1
	Tyler, TX Metro Area	217,552	101,350	921.5	1	10	2	1
	Longview, TX Metro Area	211,682	95,818	1,776.9	3	19	2	1
	Charlottesville, VA Metro Area	210,212	100,506	1,752.9	4	5	2	1

The average metropolitan public transportation system in our study has 63 general-purpose local governments, including four counties and dozens of municipalities (such as cities or villages) and/or county subdivisions (such as townships or, in New England, towns), as shown in Table 1. These communities would, on average, be served by three transit agencies, and together these

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entities would serve 86 percent of the population, 91 percent of the employment market, and about two thirds of the land area of the metropolitan statistical area. The metropolitan statistical area would have a single metropolitan planning organization (MPO), and the MPO would plan and implement policies for a similar in scale to that served by the transit agencies: about 87 percent of the population, 92 percent of the employment market, and 64 percent of the metropolitan statistical area land area.

Means provide limited insight because the different types of fragmentation—by local jurisdiction, by transit agency, by MPO—do not necessarily travel together or increase consistently with increases in metropolitan statistical area population or area. This is evident in Table 1. The metropolitan statistical area with the most general-purpose local governments by raw count is New York with well over 600, and it also has numerous transit agencies (fifteen) and MPOs (five). However, the metropolitan statistical area with the most transit agencies—Los Angeles—is very large, but is not extreme in its number of municipalities (124) and is highly concentrated at the county level with just two counties. Pairwise correlations provide strong evidence that the organizational types are poorly associated with one another (i.e., having more local governments would not be highly predictive of having more transit agencies and MPOs). The correlation between transit agencies and local jurisdictions is only 0.40, and is only 0.41 between MPOs and transit agencies and 0.36 between MPOs and local jurisdictions.

These distinctions among organizational type matter because of the different functions that each type of entity play in the metropolitan public transportation system, described in more detail in our introduction of the study. A metropolitan statistical area with 20 transit agencies serving 50 general-purpose local governments and two MPOs should, in theory, function much differently than one with two transit agencies, 100 general-purpose local governments, and one MPO.

The spatial arrangement of this fragmentation also matters. A simple example is helpful. Consider two metropolitan statistical areas, each with ten general-purpose local governments and three transit agencies. In one, call it Region X, the geography is perfectly polycentric: each local government has an equal share of the region's area, population, and jobs. The same is true of the transit agencies. In the other metropolitan statistical area, call it Region Y, the pattern is much more monocentric. A single local government and transit agency each serve 90 percent of the population and have the same share of the regional employment and land area. In Region Y, the vast majority of the region—in every sense—could be served without having to address any organizational complexity via agreements or conjunctions or complex funding schemes. In Region X, reaching the same share of the population would require the coordination of both transit agencies, and nine of the general-purpose local governments.

iii. The organization of local governments in Metropolitan Statistical Areas

The metropolitan statistical areas vary widely in how they are organized into the component organizational pieces of the metropolitan public transportation puzzles, and it is this organizational heterogeneity that is most salient to the present study. Consider counties. The Atlanta-Sandy Springs-Roswell, Georgia metropolitan statistical area has 29 counties, the most of any despite not being the largest by area or population or employment. By contrast, 47 MSAs are single-county, and another 38 only have two counties. Seventeen other metropolitan

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statistical areas have ten or more counties, fueled simply by the scale of their socioeconomic reach or by the relatively small area of counties as drawn by the state government, or by both. It is not surprising that the New York-Newark-Jersey City and Chicago-Naperville-Elgin metropolitan statistical areas have, respectively, 21 and 17 counties, but the very large size of California's counties means that even sprawling Los Angeles-Long Beach-Anaheim only has two.

The story is similar with regard to the non-county general-purpose local governments—municipalities and, in some states, county subdivisions. At one extreme, a region could be organized into a single unified city-county, and this extreme does occur in our data with Urban Honolulu, Hawaii. Many of the least fragmented metropolitan statistical areas are simply small in area or population and employment. Of our 200 metropolitan statistical areas, the Laredo, Texas metropolitan statistical area ranks 181st by population and 197th by employment and the Reno, Nevada metropolitan statistical area ranks 179th by area, and both have only four general-purpose local governments. The other extreme is purely theoretical: a local government for each resident of a metropolitan area. But in some metropolitan statistical areas local jurisdictions are remarkably small. Duluth, Minnesota has 151 non-county general-purpose local governments for its 279,748 residents; thus, on average, it has a local government for every 1,853 residents. Pittsburgh's 458 such units each serve, on average, 5,150 residents. Nine MSAs have local units serving, on average, at least 100,000 residents while 45 metropolitan statistical areas have ones serving an average of less than 10,000 residents. We revisit the measurement of local government fragmentation in much more detail in a later section.

iv. The organization of transit agencies and MPOs in MSAs

Metropolitan statistical areas with single transit agency are quite common in our study: 74 of the 200 have this attribute. Even within this group, there is remarkable heterogeneity. Sometimes these single agencies are nested in a municipal government and serve only that local jurisdiction, such as Amarillo City Transit, which serves about half the Amarillo, Texas population—more than 136,000 people—simply by serving the City of Amarillo. In other regions a single agency can serve dozens of municipalities. The Rochester, New York MSA has 133 local jurisdictions, and 120 are served by one transit agency. The Denver-Aurora-Lakewood, Colorado and Las Vegas-Henderson-Paradise, Nevada MSAs each have a single transit agency serving over two million residents. Denver’s Regional Transportation District has a service area reaching about 95 percent of the region’s residents and 97 percent of its jobs, despite only covering about 44 percent of its land area. The Regional Transportation Commission of Southern Nevada serves more than 99 percent of the residents, jobs, and area of the Las Vegas MSA.

Most metropolitan statistical areas, however, are served by multiple transit agencies. Both Los Angeles-Long Beach-Anaheim, California and Miami-Fort Lauderdale-West Palm Beach, Florida have 23 transit agencies. Many of the agencies have overlapping service areas. In Los Angeles, the 23 transit agencies in the aggregate serve all of the region’s area. In Miami only 95 of the 106 local jurisdictions are served by a transit agency, but this is still enough to include more than 99 percent of the population.

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The vast majority of the 200 metropolitan statistical areas —154—have a single metropolitan planning organization (MPO), while at the other extreme the Boston-Cambridge-Newton metropolitan statistical area has nine. The single MPOs serve most of the population (87 percent) and jobs (92 percent) in their metropolitan statistical areas, despite only serving about two thirds of the region's area. These are nearly the same as the figures for all MSAs.

B. General-Purpose Local Governments

i. Counties and county equivalents

The 852 counties and county equivalents comprising the metropolitan statistical areas in our study vary greatly by population, size, and area. The smallest county by population in our study—Calhoun County in the St. Louis, Missouri metropolitan statistical area—has only 1,646 residents across its five incorporated communities, and also covers the smallest area (just over two square miles). Armstrong County in the Amarillo, Texas metropolitan statistical area was the smallest employment center, with only 240 jobs.

At the other extreme, the most populous county was Los Angeles County, with more than 10 million residents, and not surprisingly it was the largest county-level employment center with nearly 4.5 million jobs. After Anchorage, Alaska's Matanuska-Susitna Borough—which covers nearly 25,000 square miles—the largest continental United States county is San Bernardino. It serves an area of more than 20,000 square miles in the Riverside-San Bernardino-Ontario metropolitan statistical area in California.

Even though metropolitan statistical areas are defined around an urban anchor with a relatively high population density and population (at least 50,000 population, with some contiguous census tracts containing at a density of at least 1,000 persons per square mile), the inclusion of whole counties in defining metropolitan statistical area boundaries means that many will often include areas that are suburban and even rural in their character. Not surprisingly, the correlation between population and employment centers is very high—a value of 0.98—at the county level because so few counties would function as a predominantly residential place in which households dominate firms.

Metropolitan counties are simply too large—in every sense—to be mono-functional as purely a residential or employment center: the average county in the largest 200 metropolitan statistical areas has about 300,000 residents, 140,000 jobs, a land area of about 180 square miles, and 15 municipalities or county subdivisions. Nearly 16 percent of the 852 counties in the 200 largest metropolitan statistical areas contain over 500,000 residents each, and nearly 19 percent span 25 or more municipalities or county subdivisions.

The role of the county also varies markedly by state, with some functioning as the only local government for the residents who do not live in incorporated communities. In many states, however, counties are subdivided into administrative units--called townships or towns--... Counties also vary in their public service responsibilities and revenue-generating capacities. Importantly for our study, even within an MSA counties can play different roles within the metropolitan public transportation system. Some have a transit agency nested within county

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government, often through a department of transit or similar unit. Others play a part in raising revenue for transit provision through a multijurisdictional funding scheme. Still others play no direct part at all, simply functioning as territory to which the metropolitan public transportation system might extend.

ii. Municipalities and county subdivisions

The non-county local jurisdictions in our study included municipalities (incorporated units, such as cities), county subdivisions (administrative units of the county, most often called townships), and the unincorporated part of each county. States vary in their systems of local government. Virginia, for example, has incorporated towns, independent cities that are completely independent of counties, and unincorporated land for which the county is the sole local government unit. The state has no county subdivisions. Michigan, by contrast, has county subdivisions that include general law and charter townships; municipalities include cities, general law villages, and home rule villages. Thus, in Michigan all unincorporated county land is governed by a type of township, while in Virginia the county governs this land. As noted earlier, the construction of our database relied on these non-county local jurisdictions as the unit of data collection, and these needed to cover 100 percent of the MSA to ensure we were fully representing the entirety of the metropolitan public transportation system. In an MSA without county subdivisions, this required creating separate entries for unincorporated county land and creating shapefiles for them as well, since the census does not recognize these as a distinct geography. In an MSA with county subdivisions, we could rely on census designated place and county subdivision shapefiles to afford us full coverage. In the subsequent discussion, we do not parse the many different types of non-county local jurisdictions.

Our database contains 12,569 non-county local jurisdictions. Of this total, 537 are the unincorporated parts of counties, 7,643 are municipalities (cities, towns, villages, and boroughs), and 4,388 county subdivisions (towns in Wisconsin and the New England states, townships in many of the Midwest and Plains states). The seven most populous county subdivisions, all of which contain more than 200,000 residents, are towns in the New York portion of the New York-Newark-Jersey City MSA, which spans New York, New Jersey, and Pennsylvania. The most populous municipalities remain the major core cities, such as New York City or Chicago. The maps below are symbolized to distinguish the different types of non-county local jurisdictions and their shares of population and employment, for a selection of MSAs that represent the major regions of the U.S. and show how differently they can be organized.

C. Transit Agencies

The average transit agency in the 200 most populous metropolitan statistical areas in the United States has a service area of 933 square miles that reaches to 760,000 residents and 376,000 jobs. Despite this seemingly large size, the average transit agency service area still only captures 27 percent of the regional area, containing 39 percent of its residents and 43 percent of its jobs. This means that most transit agencies—88 percent—are in a region in which they are not the only public transportation provider. The fourteen transit agencies that have the most residents and jobs in their service area—which of course do not necessarily have the greatest ridership—are not surprisingly in the three most populous MSAs: New York-Newark-Jersey City, NY-NJ-PA; Los

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Angeles-Long Beach-Anaheim, CA; and Chicago-Naperville-Elgin, IL-IN-WI. The two largest transit service areas by size are both found in Riverside-San Bernardino-Ontario, California: the portion of the multi-MSA Southern California Regional Rail Authority in that MSA and Victor Valley Transit Authority both have service areas greater than 20,000 square miles, and another 18 transit agencies serve areas of at least 5,000 square miles. Again, this does not mean that the entire area has accessible access to transit, but simply that an organization exists in the governance structure of the region with some level of purview over a very expansive area.

Transit agencies do not reach to every non-county local jurisdiction in our 200 MSAs. Of the 12,569 in our study, a remarkable 6,132 are not formally part of any transit agency service area, owing to the low-density suburban and sometimes rural character of parts of MSAs. About 37 percent (4,689) are served by just one. The remaining 1,748 are served by multiple transit agencies, most often a combination of an agency nested within the local government and a regional service. Twenty three local units are served by five or more transit agencies, and all but eight of these are in Los Angeles-Long Beach-Anaheim and San Francisco-Oakland-Hayward MSAs.

III. CONCEPTUAL FRAMEWORK

Many scholars have used an institutional lens to examine metropolitan public transportation systems, as we describe in more detail below. This has resulted in a body of research tracing back several decades (e.g., Hamilton & Hamilton, 1981; Womack & Altshuler, 1979; McDowell, 1984) and continuing into more recent years (e.g., Weinreich, 2017; Bollens, 2016; Nelles, 2012; Gerber & Gibson, 2009; Goldman & Deakin, 2000). In the following section, we focus on scholarship that allows us to answer: *what are the potential institutions that mitigate the organizational boundary problem in metropolitan public transportation systems*?

We organize our review as follows. First, we discuss the boundary problem that inheres in these systems due to organizational fragmentation, and competing perspectives on the optimal response to this fragmentation. Second, we discuss the institutional perspective, distinguishing formal and informal institutions and reviewing how an institutional perspective has been used to date in the study of metropolitan public transportation systems. Finally, and most importantly for the subsequent discussion of our data collection and analysis, we develop and describe a list of institutional mechanisms through which fragmentation can be overcome and through which, at least in theory, a more regionalized system can be realized.

A. The Boundary Problem

The typical metropolitan public transportation system, as described at length in Section II, is highly balkanized. It is this crazy-quilt of local governments, transit agencies, and metropolitan planning organizations that must deliver transportation, and we noted in the introduction to this report that these systems are best understood as an exercise in the crossing of boundaries. The boundary problem is most often understood as a characteristic of local government autonomy (Briffault, 1995; Cashin, 1999; Reynolds, 2003), which encourages the proliferation of municipalities, incentivizes competitive behaviors, and reifies socioeconomic segregation and polarization. Boundaries matter even more directly in the public transportation domain. Where

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multiple service providers exist, coordination can be difficult for a variety of reasons, leading to incompatible fare structures, increased travel time, diseconomies in facilities and routes, and poor disaster preparedness (e.g., Iseki & Taylor, 2008; Rivasplata et al., 2012).

Fragmentation is the term most often used as shorthand for the splintering of regions into multiple units. Despite being a touchstone concept and animating much of the debate about the optimal mode metropolitan governance, is rarely defined. We define it as *the division of planning and policy implementation among multiple units of government in a given area*. In our work, the "given area" is the metropolitan statistical area (MSA), as discussed in Section II.A. In most scholarship, and this is true in ours as well, the multiple units of government are general-purpose local governments, which includes municipalities, counties, and county subdivisions. In federalist contexts more broadly, we would simply refer to these as "sub-state governments." Understanding why fragmentation matters requires that we consider the normative arguments attached to the nature of local governments.

For some scholars, fragmentation is problematic—especially in the U.S. context—because of the power that local governments tend to have. Legal scholars have described the local government boundary problem (Cashin, 1999; Reynolds, 2003), noting that local governments have enough autonomy granted to them by the state and are reliant enough on property taxes and user fees that their decisions tend to be highly parochial—they serve the local interest and are competitively advantageous, but give no consideration to the welfare of the regional public (Briffault, 1999). The result, understandably, is a landscape of winners and losers in the metropolitan area. Political scientists and public administration scholars have also shared in this view (e.g., Lyons & Lowery, 1989), and calls for metropolitan reform have been a frequent part of the metropolitan political landscape over the past 150 years (for reviews, see Swanstrom, 2001; Brenner, 2002). If fragmentation is, indeed, a problem, then two solutions are possible, both of which would require policy interventions by state governments. The first is to simply erase and redraw local government boundaries. Efforts to promote interlocal mergers, city-county consolidations, annexations, two-tier regional-local structures (e.g. Miami-Dade County, FL), and even regionally-elected metropolitan government with multi-purpose special districts (Portland, OR) can all be seen as boundary reform exercises (Wallis, 1994a; 1994b). The second option is to change the decision space in which local governments operate: to remove some of their autonomy and encourage coordination and collaboration with other local governments, and with the state government. The movement toward state growth management is perhaps the clearest manifestation of this, as it directly targeted the autonomy local governments had in land use and economic development policies.

For other scholars, fragmentation is not inherently problematic. The political economy perspective of the public choice theorist requires that we not assume fragmentation is a cause or correlate of the negative outcomes in metropolitan areas, but rather that we test whether this is true and then find ways to enable local governments to solve failures of the metropolitan marketplace (Ostrom & Ostrom, 1972; Ostrom, Tiebout, & Warren, 1961). Local governments are not inherently competitive, but have instead demonstrated a remarkable capacity for collective action and self-organization to solve problems that go beyond their boundaries (Feiock, 2004, 2007, 2009; Feiock et al., 2009; LeRoux & Carr, 2010). Indeed, to the extent local governments behave competitively or parochially, it is reasoned to be out of a position of

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defensive localism (Barron & Frug, 2005), in which governments lack the fiscal and political freedom to act in ways they otherwise would because of how their autonomy has been constructed. The appropriate response requires not the erasure of boundaries or the removal of autonomy, but rather the intelligent delegation of it by states (Barron & Frug, 2005; Barron, 2003).

Testable propositions flow from both perspectives. Enough variation in metropolitan governance exists—including in the domain of public transportation, as we illustrated thoroughly in Section II—that we can assess how local governments behave under conditions of fragmentation, how they use the autonomy they are granted, and the extent to which coordinative, collaborative, and cooperative tools can be used to successfully overcome boundaries. Our work is positioned to directly inform the debate outlined above in two ways. By having both fragmentation and regionalization measures, as outlined in Section IV, we will be able to speak to whether increases in fragmentation also lead to increases in countervailing regionalizing mechanisms. In subsequent research, we can assess whether metropolitan areas with highly fragmented systems still function well (i.e., function efficiently, equitably, and effectively), either because they have extensive formal regionalizing mechanisms in place or because they have been able to rely on informal cooperative norms to knit the system together. As we noted earlier in Section I, the appeal of using metropolitan public transportation systems as a policy lens for metropolitan governance is that it is reasonable to expect that transportation delivery be regional—that it find a way to cross the jurisdictional and organizational boundaries that exist in metropolitan areas. As Stephens and Wickstrom (2000, p. 49) note, "virtually all scholars of urban affairs, including those of the public-choice school, agree with reform advocates that some services—such as mass transportation…—should be delivered on a regional basis," and this is a point echoed by many prominent scholars (Nelles, 2013; Weir, Rongerude, & Ansell, 2009; Alpert, Gainsborough, & Wallis, 2006.

B. Governance as a Response to Boundaries

Governance is a term amenable to myriad definitions. Oakerson provides an appealingly simple definition of governance as the institutions "by which human beings regulate their interdependencies in the context of shared environments" (2004: 19). However, this does not fully illuminate some of the key dimensions of the word as we use it. First, we highlight the contrast with govern*ment*. At the metropolitan scale, government would require a single, unitary, general-purpose local government that territorially matches the socioeconomic geographic extent of the region. This would be the preferred response of the most ardent of regional reform advocates. Krahmann (2003) emphasizes both scale and sector in distinguishing government and governance. She defines government as "policymaking arrangements and processes that centralize political authority within the state and its agencies" (2003: 329) while the former is "the structures and processes that enable governmental and nongovernmental actors to coordinate their interdependent needs and interests through the making and implementation of policies in the absence of a unifying political authority" (2003: 331). Second, governance—despite not being government—must still have some ability to implement policy attached to it. Soderbaum (2004: 420) makes this central to his definition of governance as "spheres of authority at all levels of human activity that amount to systems of rule in which goals are pursued through the exercise of control." Lastly, governance is dependent on networked

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organization. For example, Rhodes (1996) offers the following definition: "self-organizing, interorganizational networks that complement markets and hierarchies as governing structures for authoritatively allocating resources and exercising control and co-ordination."

Governance, described as it is above, is paradigmatic in metropolitan public transportation systems. They rarely rely solely on a single govern*ment*. They must often function through participation of both public and private transit agencies in the system. And the form the system takes—with linkages among local governments, transit agencies, and MPOs—can readily be conceptualized as a network. We define governance in our study as *a system of formal and informal institutions used to pursue goals by governmental and nongovernmental actors with varying sources and levels of formal and informal authority to adopt and implement policies to advance the public interest and / or private interest*. As institutions are central to this definition, we spend the next section defining them and their role in studies of public transportation.

C. The Institutional Perspective

i. Formal and informal institutions

Institutions are "the humanly devised constraints that structure political, economic, and social interactions…composed of both formal rules (statute law, common law, regulations), informal constraints (conventions, norms of behavior, and self-imposed rules of behavior); and the enforcement characteristics of both" (North, 1991, p. 4). This definition reflects a rational choice institutionalist approach used frequently in public administration (Feiock, 2007; Ostrom, 2005) and many other fields. Other approaches exist, such as historical institutionalism and sociological institutionalism (Hall & Taylor, 1996; Skuzinski, 2017), but these emphasize—respectively—the importance of path dependencies and the embeddedness of individuals in rules, norms, and cultural worldviews. Neither is especially salient in our work.

While institutionalists vary in their theorization of the relationship of the individual to institutions and the effect of this relationship on decision-making processes, all share the distinction between formal and informal institutions outlined above. We find this distinction useful, and we limit our study to formal institutions, at this stage, for several reasons. First, because these are formal they are more likely to express in written form. Statutes, regulations, inter-organizational agreements, and organizational bylaws tend to be readily accessible and frequently updated digital documents. Informal norms, by contrast, often require more intensive data collection through survey questionnaire, semi-structured interview, or focus group. Gathering comprehensive data on inter-organizational and intra-organizational norms for 200 metropolitan public transportation systems would simply not be feasible. Second, because norms function either as complements to or substitutes for formal institutions, gathering data on them will arguably be more meaningful following a study of the latter. Third, formal institutions are more durable: the process of formal adoption, whether through a written regulation or contract or bylaws, creates a constraint that functions across changes in organizational personnel. Even formal institutions leave room for discretion and monitoring and enforcement is rarely perfect, but we would expect them to stay consistent enough over time that our measures would be unlikely to need updating more than every few months. Fourth, formal institutions are typically harder to exit. An informal understanding among two local governments or two transit agencies

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can easily break down, even if the organizations' personnel remain the same. Customs, heuristics, and strategies are meant to be responsive to changing circumstances, but rules and their equivalents should provide a harder constraint on organizational decision-making.

We further limit our attention to governance institutions directly connected to the day-to-day implementation of public transportation—operations funding, route and stop planning, and service provision. While other decision-making processes can have a bearing on transportation outcomes—such as capital funding and planning, or the planning and regulation of land use—we found in preliminary work that the greatest variation in governance occurred around the organization and orientation of transit agencies with regard to operations. More importantly, because we intend the transit governance measures to function as explanatory variables of transit equity outcomes, it is more conceptually defensible to trace these outcomes to variation in operations governance.

ii. Institutional perspectives on metropolitan public transportation systems

The application of an institutional perspective—one which credits primary explanatory credit to institutional variation, or which is concerned with explaining such variation—to metropolitan transportation can be seen in studies of transportation policy integration developing primarily in European and Canadian scholarship (e.g., Stead & Meijers, 2009; Hull, 2008; May, Kelly, & Shepherd, 2006; Geerlings & Stead, 2003) and interorganizational collaboration in U.S. metropolitan transportation planning, especially in the wake of federal mandates for metropolitan planning in the United States (e.g., Taylor & Schweitzer, 2007; Haynes, et al., 2005; Goldman & Deakin, 2000; Wachs & Dill, 1999).[3] These studies, while not always explicitly institutionalist in their theorization or even committed to a recognizable theoretical framework, are nevertheless about formal institutions that yield collaboration, coordination, cooperation, and integration.

From this work, are few observations are worth highlighting. First, institutions are part of the notion of integration in transportation systems, including those institutions that would shape the structure of a metropolitan public transportation system. Two of the leading figures in the literature on transportation policy integration use the metaphor of a ladder. Preston (2010, p. 330) includes the "integration of infrastructure provision, management and pricing for public and private transport" and "the integration of (transport) authorities," along with integration in other dimensions, such as across sectors and policy domains, as rungs on his ladder. Hull (2005, p. 322) includes "institutional and administrative integration"—defined in part as "the integration of transport planning across administrative boundaries"—as one of the more difficult rungs to reach in her conceptualization, though all the others are also clearly institutional in their nature, from integration of fares to modal integration. All would depend on the use of formal and informal institutions for their achievement.

[3] We do not address any articles that focus on intra-organizational characteristics or dynamics that have no bearing on the extent to which a region functions as a unified whole versus a disjointed set of organizations that happen to occupy a single regional geography. Thus, a study that classifies different types of independent MPOs based on organizational structure (Kramer & Hopes, 2007) or the decision-making modes of a regional organization (Innes & Gruber, 2005) would not be included in our review, while one investigating the share of local elected officials serving on MPO boards as an explanation of the balance of local versus regional investments (Gerber & Gibson, 2009) would be relevant.

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Second, the scale at which governance occurs—itself a result of institutional choice in even the most foundational treatments of institutionalism (Williamson, 1985)—matters to outcomes in planning, policy adoption, and implementation (e.g., Marsden & May, 2006; Shaw et al., 2009). Marsden and May (2006, pp. 784-787), working in the UK, discuss at length the importance of institutional barriers to integrated transportation, finding support for the greater effectiveness of a "single conurbation authority, with lower tier authorities responsible for detailed implementation…[versus] separate, potentially competing, single-tier authorities" and that "develop[ing] integrated strategies which can be implemented within the context of split institutional responsibilities…is likely to be less effective." Shaw and colleagues (2009) explored the effects of devolution—the shift of power downward from centralized levels of government to local levels—on transport policies in the UK, and found that it could lead to both transport policy divergence and convergence. Gerber and Gibson (2009) highlighted how the tensions between the regional and local scales found in the representational composition of MPOs in the U.S. resolved, in significant part, according to whether a local jurisdiction's representative on the board was an elected official.

Third, governance institutions can be understood readily as manifesting vertically (via higher-level organizational structures and intergovernmental relations to coordinate actions within a system) and horizontally (via mechanisms that connect among the units within a given level). The horizontal-vertical conceptualization is a commonplace throughout metropolitan governance scholarship and the broader literature on collaboration in multi-level policy settings. Hamilton, Miller, and Paytas (2004) expressly use a conceptual matrix in which horizontal and vertical relations can each be more centralized or more decentralized, yielding metropolitan regions whose governance mode can be described by the intersection of these features. This approach has also been applied specifically to the public transportation policy domain, as one would expect given the explicitly multi-level governance approach of the partnership model under ISTEA and TEA-21 (Goldman & Deakin, 2001). Nelles (2012) has used both horizontal and vertical dimensions of governance, and the linkages between them, to understand public transportation systems. Weir, Rongerude, and Ansell (2009) emphasize the important of vertical power in sustaining horizontally-grounded regional capacity for regional transportation policymaking.

While the scholarship touched on above was motivational to our work, we perceived several gaps in institutional treatments of metropolitan transportation governance. In the U.S. scholarship, ample attention had been paid to regional planning, but scant research looked at the nature or effects of institutional variation in transit agencies, including the scale at which they operate and their frequent position at the nexus of both horizontal and vertical regional governance. We are unaware of any treatments that conceive of a system of metropolitan public transportation operations, with governance shared among general-purpose local governments, transit agencies, and MPOs. In the policy integration literature, more attention was given to the transportation system as a whole, but we had not seen any attempt to theorize the myriad mechanisms that might lead to a system being characterized as more institutionally integrated. Moreover, institutional integration across organizational boundaries was only rarely the focus in this work. Our goal, then, was to develop a catalog of regionalizing mechanisms that would resonate with existing scholarship but also provide a way of understanding and measuring the governance of any public transportation system.

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Two caveats before we continue. First, as emphasized already, we address in our work only the formal institutions that can address the fragmentation of metropolitan regions; we save for future research a treatment of the norms (the informal institutions) that play a potentially significant role as well. Second, we do not presume that the presence of these mechanisms will have a positive impact on public transportation outcomes. Rather, they are simply an indication that the formal boundary problem of fragmentation has been overcome. Other problems may still exist that may negatively affect the functioning of the metropolitan public transportation system, and it is not necessarily the case based on theory or empirical evidence that vertical and horizontal mechanisms of regionalization when present yield positive outcomes. Each of the mechanisms described below, then, should be read as one that shifts the form of governance from one more fragmented to one less fragmented. It is the task of subsequent research to discern whether this shift is beneficial.

D. Regionalization

We group our regionalizing mechanisms into two types. The first are vertical mechanisms, which overcome the organizational boundary problem by removing decision-making primarily to an organization that functions at a scale one or more levels above the general-purpose local government.

i. Vertical mechanisms of regionalization

To assess whether regionalization exists vertically in a given area, we would need to look at the role of multijurisdictional implementation that includes two or more general-purpose local governments) and direct implementation by higher levels of government (in our work in the United States context, the state government). The theoretical logic is that implementation that hinges on local decision-making will by definition be more oriented to local interests than to extra-jurisdictional interests. By contrast, one can presume that actors who are agents of a multijurisdictional body or who are state appointed will have interests that are more regional in scope, and that the same is true of local actors whose ability to exit the region has been hindered through higher-level rules. In short, particular institutional arrangements on the vertical dimensions should be more conducive to a mode of governance that can be characterized as more regional than local. In the remainder of this subsection, we describe the theoretical and empirical relevance of these mechanisms, speaking to them generally and then specifically with regard to their manifestation in public transportation.

Scholars of metropolitan governance have long understood that state rules, as found in legislation and administrative regulations, affect the behaviors of local governments and—by extension—the form and function of metropolitan governance. Most of the work in this area has considered the formal institutions of local government formation (Carr and Feiock 2016; Savitch and Adhikari, 2017; Leon-Moreta, 2015; Farmer 2008; Carr, 2004), boundary changes (Palmer and Lindsey, 2001; Rusk, 1995; Galloway and Landis, 1986; Nelson, 1990), and autonomy (Briffault 1995, 1990; Cashin, 2002; Barron and Frug, 2005; Stephens, 1974). Many authors characterize the local policymaking space as highly limited (Peterson 1981; Frug and Barron 2008; Sharp, Daley, and Lynch 2011; Bowman and Kearney, 2012), meaning that the rules of the state do play a meaningful and significant role. Other scholarship has considered the role of the state as an

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active participant in or promoter of regional planning policy (May, 1995). The "second wave" of regionalism was generated by the dozens of federal programs that mandated or incentivized regional planning or coordination of some kind (Wallis, 1994a; Walker, 1987; Stam and Reid, 1980), and state growth management efforts provided a fertile ground for exploring the role of the state in promoting multi-level land use planning (Gale 1992; Margerum, 2002).

In the metropolitan public transportation context, the vertical dimension of multi-level governance manifests in both planning and implementation, and it does so through both the state government and through multijurisdictional regional organizations. With regard to regional organizations, extant work helps us understand the operation of regional bodies focused on transportation, including MPOs (Sciara & Wachs, 2007; Gerber & Gibson, 2009; Bollens, 1997) and metropolitan transportation commissions (Innes & Gruber, 2005). Schlossberg, (2004) used a study of policies in Michigan, Ohio, and Florida targeting provision of transit to disadvantaged populations to support the assertion that state-level policies directly shape the prospects for coordination in a policy domain.

To assess the extent of vertical regionalization in a metropolitan public transportation system we consider three questions:

(1) **State funding**: Does the state government provide funding for transit operations in all or part of the metropolitan statistical area?
(2) **Higher-level governing**: Does a multijurisdictional transit agency exist that is nested within the state government or whose key decision-making body is primarily state appointed?
(3) **Multijurisdictional funding**: Does a multijurisdictional funding scheme exist, and is it one in which participation by local units is mandated?

Again, before leaving this section we note that we are not touting these approaches as beneficial. Indeed, researchers have regularly found evidence of ineffective, inequitable, or inefficient work done by regional bodies (e.g., Boyle and Mohamed 2007; Bollens 2016). Rather, we are simply acknowledging that theory supports the characterization of a given metropolitan area with these traits as *more* regionalized because of the higher scale at which decision-making occurs.

ii. Horizontal dimensions of regionalization

As Gainsborough (2001: 500) notes, "[if] institutional arrangements are important determinants of local government behavior because they help shape the preferences of political actors by altering opportunities and constraints on action, then it seems likely that institutional arrangements will also impact the willingness of political actors to cooperate across local government boundaries by altering the costs and incentives of such action." Such cooperation is the hallmark of formal horizontal regionalization, which builds on network ties between organizations and individuals who are active decision-makers in policy networks. These ties can occur through two mechanisms. The first is the use of an agreement to reify a cooperative or collaborative relationship, typically among local governments and referred to as an interlocal, intermunicipal, or interjurisdictional agreement (Andrew 2009; Chen & Thurmaier 2009; Matkin

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and Frederickson 2009; LeRoux et al,. 2010; Zeemering, 2012; Gillette, 2001). Scholars have described such interlocal agreements as the foundation for "picket-fence regionalism" (Thurmaier & Wood, 2002). The second are dyadic or multiplex ties that occur through shared membership in networks or organizations, which we shorthand as conjunctions.

Interlocal agreements are a common manifestation of horizontal governance, whether in general public services delivery (Shrestha & Feiock, 2011; LeRoux & Carr, 2010; LeRoux & Carr, 2007), public safety (Andrew et al., 2015; Andrew & Hawkins, 2013), or economic development (Feiock et al., 2012; Feiock et al., 2009; Olberding, 2002). Much of this scholarship attempts to unpack the determinants of cooperation broadly, often using the adoption and endurance of formal agreements as the key outcome variable. The determinants are typically drawn from theories of social networking and transaction cost economics, with decision-makers behaving as rational actors. Thus, we can reasonably expect, for example, that formal cooperation is more likely in the presence of fiscal and economic stress, among entities with similar interests, and when a history of past cooperation is present. However, the main takeaway from this body of work for our present purposes is that agreement among organizations is a common institutional method of solving the metropolitan boundary problem.

A second way in which boundary-crossing occurs in metropolitan areas is through the presence of conjunctions. While these originally were conceived as existing among administrative actors who belonged to the same epistemic communities (Frederickson, 1999), we use the term more loosely to acknowledge formal inter-organizational linkages that exist via membership on decision-making bodies within policy networks (Henry et al., 2010; Burriss, 2008).

Applied to the metropolitan public transportation system, the logic is as follows. A transit agency or MPO has its primary impact through how it overlays the general-purpose local governments in a given region. To the extent more local units are within an organization's geographic ambit (for transit agencies, the service area; for MPOs, the planning area), we can reasonably expect that the system as a whole is more integrated. These local units can strengthen their integration with the region if the transit agency has interagency operations agreements with other transit agencies, effectively providing interorganizationally networked access to other parts of the metropolitan area. They should also find organizational decision making more readily inclusive of them if they have a formal representative voice on the decision-making body of an MPO or transit agency.

Thus, to assess the extent of horizontal regionalizing mechanisms in a metropolitan public transportation system we answer two questions:

(1) **Interagency agreements**: Where more than one transit agency serves a region, to what extent are the transit agencies formally connected through interagency agreements about their operations?
(2) **Formal conjunctions**: To what extent do the primary decision-making bodies of key organizations in the metropolitan public transportation system, such as transit agencies and MPOs, have members from other organizations in the region?

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E. The Challenge of Regionalizing Transit Agencies

Transit agencies must integrate services across agencies, or politicians must create regional transit authorities. Transit agencies sit atop the system of general purpose local governments, or fused to it through nesting of transit agencies as departments within municipalities. Alternatively, transit can be provided by the state government, making transit agencies state institutions. Only in rare circumstances are there regional transit agencies, but these are, generally speaking, expanded versions of multijurisdictional transit agencies, which can be as small as two cities or two counties, but in some cases, may be established to encompass many counties (e.g. Denver RTD) or an much of a region (e.g. Boston MBTA). Transit governments can also be established to encompass multiple states, like St. Louis Bistate Development Agency.

However regionally united transit agencies are a rare occurrence. The literature examines the dynamic of providing transit service in a region with multiple transit agencies. Rivasplata (2012) provide a useful typology of theoretical perspectives from which to examine integration of transit agencies, including the systems engineering, public management, institutional and microeconomic lenses (2012: 57). Their study and many others focus on the public management lens, while very few take the institutional perspective, as ours does. And they identify several venues for coordination that are echoed in other studies, including management of payment coordination, schedule coordination, information distribution across operators, facility and vehicle sharing, emergency/special event coordination, and joint agreements (Rivasplata, 2012; Miller, 2003; Miller et al., 2005).

Of these elements, only the last one, joint agreements, can be seen as an example of the formal institutional arrangements that this study seeks to examine, as well as public system management. However it is important to recognize that all the elements of transit integration are required to make for a seemless system that adequately serves the rider's needs. For example, the proliferation of transfers between agencies costs time and leads to inconvenience (Iseki & Taylor, 2008; Rivasplata et al., 2012). Poor coordination of schedules makes it possible for the rider to miss his/her transfer. The failure of fare policies to include discounted transfers from one system to another causes inequities for riders who have to pay full price for both tickets, not to mention inconveniences that result from separate purchases when no regional fare card exists (Rivasplata et al., 2012). Lack of information sharing across operators means agencies are not letting one another know about ridership volume or other information that could help adjust frequency and scheduling. Absence of facility and vehicle sharing means agencies are not developing shared facilities or using interchangeable equipment, leading to passenger inconveniences. Finally, the absence of emergency and special event coordination could be catastrophic; for example, when one operator's route goes down, nearby operators may not have an agreement to step in and help. All of these can be accomplished with informal "handshake" agreements between agencies (i.e. norms). But they can be ensured, and most easily studied, through examination of interlocal agreements, as we do in this study.

Rivasplata et al. (2012) focused their questions on the public management lens, discussed above. However their open ended responses cited several institutional reasons why agencies might not be able to coordinate. For example, several respondents cited political barriers from the lack of a strong coordinating MPO or Regional Transit Authority in their region (2012: 64-65). However

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funding requirements were even more problematic for local transit agency integration. This included the difficulty of a transit agency crossing county boundaries due to sales taxes tied to that level of government, with the respondent remarking that funding at higher levels of government could help alleviate the situation. This was in fact the most comprehensive national study we could find that was conducted on transit agencies' ability to create cross-agency service integration, though others have cited inflexible funding arrangements as one of the major barriers to better service integration across agencies (Miller, 2004), along with transportation decision making that complicates the redistribution of power, authority and control, and a number of factors that tack closer to norms: satisfaction with the status quo, inertia and resistance to change, lack of a common vision among inderdependent agencies, and lack of an enabling environment to foster fundamental change (Miller & Lam, 2003).

Though this literature does not provide a clear picture of the connection between transportation governance and service quality, it does indicate a number of specific ways that poor coordination across agencies can lead to poor integration. It also suggests that regional governance, finance, and investigation of institutional coordination methods like service agreements and joint powers boards (Miller et al., 2005: 108) will provide a way to measure the institutional strength of the region's ability to develop interagency integration, though, of course, the actual implementation of such integration depends on norms like the long-term establishment of a strong unified vision, and willingness to work together, (Miller & Lam, 2003). These studies suggest ways that formal finance and governance institutions may improve coordination; but instead, the authors focus on technology as a way to bridge the institutional divide, through smart cards and improved information sharing (Miller et al., 2005).

F. Localization of Funding

Transit agencies have become increasingly political over time, and this trend is perhaps connected to the localization and politicization of transportation funding identified by Wachs (2003). Part of this is a product of the limitations on taxation for general purpose local governments, which often force the creation of a new independent special purpose authority to perform a particular function (Burns 1994)—a situation which is particularly acute in states like California, where a tax revolt or other state policies have deprived traditional general purpose local governments of the ability to raise additional tax revenues (Connolly et al., 2010; Bollens, 1987), resulting in pressure for the state to allow counties to put local option taxes on the ballot to fund necessities like public transit and road improvements. At the same time, there has been a general decline in revenues from the state and federal motor fuel taxes, due to inflation and increasing fuel economy, creating another driver for states to authorize local option taxation. Several authors have focused on the role of local option taxes in localizing and fragmenting the transportation planning process, since local funding often results in local planning, and poor connection across jurisdictions (Weinreich, 2016a; Goldman, 2007; Goldman, 2003). Transit is particularly vulnerable to local taxing processes, since local funding supports such a large percentage of transit operations money in the US. While this is also problematic for roads, it is not as much so. This is because a much greater share of costs are shared by federal and state governments. For example, the federal government pays 90% of maintenance costs for construction of interstate highways and 80% for non-interstate highways projects (FAST Act §§

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1408, 1435; 23 U.S.C. 120), while state motor fuel taxes often pay substantial portions of the maintenance costs.
These studies suggest that a process that incentivizes local taxation is likely to encourage parochial decision making, based on case study examples, though there has been little comprehensive national study of the issue since 2001 (Goldman et al.), which catalogued the existence of local option taxation nationwide, though not other formal institutions.

G: Regionalizing Transit from the Federal Level

The federal government has tried to encourage better integration across transit agencies and local governments, but only with limited success, due to the weakness of the Metropolitan Planning Organizations (MPOs) through which these attempts have often been made, while other federal transit programs are often poorly funded, especially for transit operations, limiting their ability to incentivize integration across agencies. Extant work helps us understand the operation of regional bodies focused on transportation, including MPOs (Sciara & Wachs, 2007; Gerber and Gibson 2009; Bollens 1997) and metropolitan transportation commissions (Innes and Gruber 2005), giving us a picture of a highly technocratic organization with weak funding and little support for actions that might infringe on either local or state autonomy. There has historically been opposition from both local and state levels to giving MPOs too much influence. Additional state rules have diminished MPOs' authority still further. For example, in some states, MPOs only span a single county, making multijurisdictional transportation planning rather difficult, with multiple MPOs in the same metro region—essentially defeating the purpose of forming MPOs in the first place (Goldman & Deakin, 2000: 58). In other regions, MPOs may be broken into subunits, each with its own autonomous planning powers. For example, the Southern California Association of Governments (SCAG) has separate sub-regions for each of its constituent counties, undermining SCAG's efforts at regional planning (Bollens, 1997).

Excessive localization is possible in cases where MPOs have very little institutional ability to enforce or encourage multijurisdictional coordination. Local taxing and spending powers plays an especially important role. When MPOs do not have taxing authority, they may depend on local governments to raise revenue for them, but in consequence, local governments will have the discretion to make many of the important decisions over project priorities outside the MPO's own planning process (Crabbe et al., 2005; Goldman et al., 2001). It is still unclear to what extent local funding has impaired regional planning. There are anecdotal accounts of this impact in a number of studies, focused on one, or just a few regions, with many of these limited to California cases, even though this is a nationwide phenomenon (e.g. Crabbe et al., 2005; Goldman et al., 2001; Goldman, 2007; Weinreich, 2016a). Case studies have found that county leaders are often more concerned with needs within the county lines than those on a regional scale.

When focused on MPOs, such studies often consist of surveys, designed to understand whether MPO decision making processes, and the most recent transportation legislation, have been operating efficiently (Gage, 1992; Gage, 1993; Gage & McDowell, 1995; Deyle & Wedenman, 2014; Wolf & Fenwick, 2003). From these studies, we know that 60% of surveyed executive directors of regional councils from across the US indicated that key regional decisions were made outside their council (Gage, 1993: 16). We know that MPOs' transportation/land use

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policies are so varied that no single mathematical model is capable of estimating them. Furthermore, state legislation governing the relationship between transportation and land use decision making has played a major role in authorizing transportation/land use decisions in the few regions that do plan the two together (Wolf & Fenwick, 2003: 127), indicating the instrumental role that state legislation may play in fragmentation decisions as well. Gage & McDowell (1995) identify the changes for cross-jurisdictional coordination (both helpful and not) brought by the 1991 passage of the Intermodal Surface Transportation Equity Act (ISTEA), which required more contact across agencies and across local, regional and state levels, but has not provided sufficient power over funding decisions to make all its goals a reality.

Other authors have concurred that, while greater leadership and legislation has supported a resurgence of regional planning, transportation decision making remains a local process in many metro areas (Sciara, 2017; Sciara & Handy, 2017).

However, public transit funds are less reliable. The federal New Starts program requires local transit agencies to apply for funds, which provide about 50% of the cost when projects are selected; and federal public transit funds provide only 8.3% of public transit operations costs (American Public Transportation Association, 2017). These are inconsistent across service types, and most require transit agencies to apply for funding. These include the 5307 urbanized area grants, providing money for urban transit operations; 5310 grants, providing funds for transit of individuals with disabilities and seniors; and 5311 grants, providing formula grants to rural area transit services, (the rest coming from state subsidies, local subsidies, passenger fares, and other sources) Additionally, the federal government provides 5337 grants to purchase new equipment (Federal Transit Administration, 2018). Altogether, transit funding is less predictable, and requires more local funding, especially for operations and maintenance. Consequently, there is greater need for a study on sub-federal cross-jurisdictional cooperative structures in public transit than there is for highways; and greater need for a study on operations funding than for capital expenses (which are more generous and reliable at the federal level).

The cooperation between multijurisdictional transit authorities and local governments is typically successful when MPOs arrive at a high level of regional consensus (Wachs & Dill, 1999, p. 303). Jonas et al. (2014) explored a case study of the Denver region, where a regional authority with heavy reliance on cooperation from local governments was able to build a strong light rail system. However, in situations when there is an absence of clear regional interests, resistance can emerge and cause an MPO's member governments to oppose efforts aimed at raising shared funds (Sciara & Wachs, 2007, p. 379).

We summarize the mechanisms described in this and the previous subsection in the table below:

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Table 8. Regionalizing Mechanisms

Category	Descriptive name	Description	Source
Hierarchy	Multijurisdictional operation	A district, authority, or other governmental or quasi-governmental body spans two or more units and exercises control over a significant aspect of service operation	(Weinreich, 2017; Miller, 2002)
	Multijurisdictional funding	A district, authority, or other governmental or quasi-governmental body spans two or more units and exercises control over a significant aspect of service funding	
	State operation	The state(s) in which an MSA is located exercise(s) control over a significant aspect of service operation	(Goldman et al, 2001b; Briffault, 2000)
	State funding	The state(s) in which an MSA is located exercise(s) control over a significant aspect of service funding	
Exit prevention	Local option taxation	The non-participation of a local unit in providing funding is limited by regulations requiring multijurisdictional voting or other participation-based incentives/mandates	(Weinreich, 2016b;Goldman, 2007)
	Inter-organizational agreement	Two or more adjacent transit agencies (either independent or nested within a local government) execute an agreement to coordinate significant aspect(s) of service operation	(Transit Cooperative Research Program, 2012;Chen, 2009)
Conjunction	Transit agency vertical conjunction	A transit agency's decision-making body has representative(s) on it from a given county / municipality and/or the MPO(s) with which its service area overlaps	(Gerber & Loh, 2015; Bae & Feiock, 2012; LeRoux et al, 2010; Frederickson, 1999)
	Transit agency horizontal conjunction	A transit agency's decision-making body has representative(s) on it from adjacent transit agency(ies)	
	MPO vertical conjunction	A MPO's decision-making body has representative(s) on it from a given county / municipality and/or transit agency(ies) in its planning area	
	MPO horizontal conjunction	A MPO's decision-making body has representative(s) on it from adjacent MPO(s)	

IV. MEASURING GOVERNANCE

A. General-purpose local governments as the data unit

Our measures require beginning at the level of the general-purpose local government. These are the lowest scale units for which fragmentation could have a meaningful impact on transportation policy and services.

Gathering data at the level of the general-purpose local government has practical benefits as well. In a nested, multi-level context, working at the lowest scale ensures consistency in data

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collection. Where a measure applies at a county or transit agency level, we can easily "scale-up" by giving the same value to a measure for each municipality to which it applies. Thus, each row in our database is a general-purpose local government. It is identified through its name and through FIPS codes.

B. Pilot Study

Pilot regions were selected in order to identify possible complications with our coding procedure and quantitative analysis. We targeted regions that were large, highly fragmented and complex, with multiple transit agencies, and multiple states. MSAs we selected contained more than one million residents, had two or more transit agencies, and variation in their state systems of local government (based on Stephens & Wikstrom, 2007). Four of seven pilot cases had more than one state and one had multiple MPOs. We also selected regions based on geographic diversity, since governmental organization is often similar within each region of the country. We selected two pilot regions from the East Coast, one from the Midwest, one from the Southeast, one from the Great Plains, and one each from California and Florida, which represented, respectively, 20 and 16 of the total 200 MSAs.

We used these selection attributes because of our interest in having indicators and measures that could accommodate the full range of institutional complexity we were likely to encounter when we calculated the fragmentation and regionalization measures for 200 regions, and because they would provide information about factors that could facilitate or hinder intergovernmental coordination. In the seven pilot regions, we refined institutional variables based on the framework above (Table 8). We used the pilot data collection process to refine our scope, methods, variables, and calculation methodology. In particular, we confined our scope to operations variables due to their greater institutional predictability. While operations funding, interagency agreements and other formal relationships were fairly consistent from year to year in the same agency, capital construction programs could easily begin or end with the approval and completion of a single project, or a single federal program supporting projects nationwide. For example, capital funding increased significantly following the American Relief and Recovery Act of 2009, but this program was not renewed. Nevertheless, the provisions of this one bill (Pub.L. 111-5) significantly increased local transportation matching funding, and other formal relationships over capital projects over their life. By contrast, operations funding and other formal relationships could be measured and predicted more reliably over time. This helped us determine that from a conceptual standpoint, institutional relationships supporting operations translated most directly into service gaps, and the potential for inconsistencies across jurisdictions and agencies. Based on this finding, we decided to narrow our focus to study of formal institutions governing operations.

C. Transit agency service areas

This task required use of 2015 American Community Survey 5 year estimates data. Jurisdictions could include cities, townships, boroughs, unincorporated areas of counties (because transit agencies can/should serve unincorporated geographies, and many people live in them), and other local jurisdictions. Separate columns note which county, state, and MPO local jurisdictions fall

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into, as well as the transit agencies that serve each jurisdiction, making it possible to sort by any of these geographies.

Transit agencies were selected using National Transit Database (NTD) 2012 data to identify the existence of transit agencies, as well as the latest General Transit Feed Specification (GTFS) data to identify jurisdictions served. Unfortunately, both these sources depend on voluntary submission of data by transit agencies, leaving many agencies out of the databases altogether, and others with incomplete data. NTD and GTFS became our default source. However in many areas, further information was available from state DOTs, MPOs' Regional Transportation Improvement Program documents (RTIP), google search, from transit agency, or state statute. In such cases, we refined the information from NTD and GTFS. For example, in many states, statute specifies jurisdictions that are members of the transit agency. However in other states, statute specifies initial transit agency members, and a *process* for annexation of additional members, making it difficult to identify jurisdictions served by statute alone, and requiring us to rely on GTFS and NTD data in many instances. Other sources like agency websites sometimes made this unnecessary, such as instances where agency bylaws, downloadable shapefiles, or "About" pages provided clear information specifying jurisdictions served by the agency. We also called or emailed every transit agency from the NTD for which contact information was obtainable, requesting further mapping data, and searched on google for transit agency information. These methods were particularly important in rural portions of the MSAs, where many rural and on demand services provide transit that was not included in NTD or GTFS, presumably due to the agencies' small size and lack of resources.

We limited the agencies included in the final database to those serving the general population, providing services to all riders. We did not include agencies that limit ridership to a specified population like paratransit (which caters to persons with disabilities), medical transit, university transit, VA transit, or company rideshare, among others. All of these are limited to a very specific group, not open to the public. We usually identified the population served by going to the "About" page of the transit agency website, or looking at schedules, fares, and conditions for ridership. For example, agencies requiring riders to be registered as persons with a disability or medical problem, or services that require university ID cards would be excluded from the database.

Many transit agencies are nested within counties or cities. Typically, these agencies do not have representatives from MPOs or from other municipalities. In cases where the county or the municipalities run the transit, the County Commissioners or the City Councilors are the decision makers. For example Broward County Transit in Miami-Fort Lauderdale MSA is a division of Broward County (http://www.broward.org/Pages/Welcome.aspx). The County Commissioners are in charge of the service, elected by county residents. The County Commissioners sometimes will appoint an advisory committee to assist them with transit issues. Another example of a service run by a municipality is the Ann Arbor Area Transportation Authority (AAATA), which brands itself as "TheRide." This is a public transit system serving the Ann Arbor and Ypsilanti area in Michigan. The members of the transit board are appointed by the mayors of Ann Arbor and Ypsilanti, with approval from their respective city councils. The transit reaches beyond just the cities of Ann Arbor and Ypsilanti and runs into the nearby townships in the area, though they are not represented on the board

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D. Measuring Fragmentation

We begin with the fragmentation calculation. Many measures of metropolitan fragmentation exist (Savitch & Vogel, 1996; Hendrick & Shi, 2015; Hendrick & Jimenez, 2011; Miller & Lee, 2009). These are almost always applied to general-purpose local governments, and we also use general purpose local governments for reasons described in subsection IV.A above. The most basic fragmentation measure is the use of raw counts normalized by population or area; this can be expressed in multiple ways: persons per government; number of governments per 10,000 people, square miles per government, and the like (Dolan, 1990; Parks & Oakerson, 1993; Goodman, 1980). While this provides insight into the size of each unit and allows for rudimentary comparisons across metropolitan areas, by working through averages it treats each unit as equally weighted.

In the public transportation system context, and in most policy domains, this kind of measure is conceptually flawed. Consider two simplified, hypothetical MSAs, region A and region B, each with 100,000 people spread across 50 square miles, and each with five general purpose local governments. These would have the same normalized fragmentation measures (20,000 persons and ten square miles per government), but the two regions could be organized very differently. Perhaps region A is highly monocentric, with a single central city government serving 80,000 people across 25 square miles. By contrast, region B is more polycentric, with the single largest government serving 25,000 people across 15 square miles. In both regions, suppose the other four governments have equal shares of the remaining population and area. For public transportation purposes, in region A, much of the region (80 percent of the people and 50 percent of the area) could be served without the need for any coordinative efforts at all. Both regions are fragmented, but the organization of the fragmentation—the boundary problem we described in the introduction—is much more potentially problematic in region B. It may be the case that region B is a more cohesively governed region due to the use of coordinative governance mechanisms, but the fragmentation baseline must be measured in such a way that it fully captures how that concept matters to public transportation governance.

A better measure, then, would account for the structure of fragmentation. Two options have been used by metropolitan governance scholars: concentration and diffusion (Miller, 2012). Concentration measures adapt the Herfindahl-Hirschman Index (HHI), which was developed to measure market concentration, to the metropolitan context. It is calculated by squaring the fractional market share of each firm, however that market share might be measured, and then summing the resulting numbers. The extreme—a monopoly—would have a measure score of 1 while perfect competition would approach zero. If percentage shares are used rather than fractional shares, the measure would range from 10,000 down to zero. The corollaries metropolitan governance would be unitary regional government versus extreme fragmentation. Diffusion measures, which use the square root rather than the square of the shares, have also been used to measure the character of metropolitan governance. The scale starts at 1 (monopoly) and goes, theoretically, to infinity, and it emphasizes the political importance of small units. Land area or population are common measures to which the concentration or diffusion measures can be applied (Miller, 2012).

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An HHI concentration measure is a logical choice for quantifying the base fragmentation of transit governance because for transportation purposes we should view a monocentric MSA, with a monopolistic core city (in terms of population and/or area) as less fragmented than another MSA that is less concentrated. Even without any coordinative mechanisms, a large share of the regional population across a large part of that region could be served.

Consider two examples. Imagine an MSA has a single general-purpose local government—a consolidated city and county, with no other separate local jurisdictions. This is the entirety of the MSA and, therefore, contains the entire population of the MSA, all employment for the MSA, and the total MSA area. The measure of fragmentation can be done separately for each of the three dimensions—population, employment, and area. The calculation for population in this example would be: (100 ^ 2) = 10,000. The same would be true for employment and area. A value of 10,000 is the theoretical maximum of the HHI (or a value of 1 if using fractional shares). In a market setting this would indicate a perfect monopoly. In a metropolitan area it indicates complete concentration of local government.

Now imagine an MSA that has 50 general purpose local governments. Each contains a proportional share—two percent each—of each weighting dimension: the entire population, the employment, and the area of the MSA. Again, the measure of fragmentation can be done separately for each of the three dimensions—population, employment, area. The calculation for population in this example would be: [(2 ^ 2) + (2 ^ 2) + ... + (2 ^ 2)] = 200. If fractional shares are used, the calculation would be: [(0.02 ^ 2) + … + (0.02 ^ 2)] = 0.02. The same would be true for employment and area. In any market, perfect competition approaches zero. In an MSA, perfect fragmentation would do the same.

Once we calculated the fragmentation score, we scaled it to allow for easier interpretation. In Table 9 below, we show the most fragmented and least fragmented regions based on the HHI measure, with both scaled measures and the unscaled scores, and we include per capita and dispersion measures to show the distinction among these approaches.

E. Measuring Regionalization

Based on our discussion of the vertical and horizontal modes of regionalization in Section III.D, we arrived at a typology of coordinative mechanism categories: *hierarchy*, in which a multijurisdictional governing unit or the state government exercises control over an aspect of public transportation service implementation; *exit prevention*, through which a governance unit is impeded from non-participation in implementation; and *organizational coordination*, in which two units are connected through shared representation in their decision-making bodies. Hierarchy and exit prevention are an expression of vertical regionalization, while organizational coordination is an expression of horizontal regionalization. The typology was based on an iterative process that included a broad literature review and application of concepts within the context of a pilot study. We summarize these three types of mechanism and the variables that are used to operationalize them in Table 10 below, and then describe the measurement of the variables in detail in subsequent subsections.

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Before proceeding, we note that for most variables we used dichotomous measures because formal institutions either are present and can help mitigate underlying fragmentation (a code of 2, since higher connotes more regionalized), or they do not (a code of 1), or there is no potential for them to exist with regard to that municipality in that MSA (a code of 0), for example if there was no transit service to the municipality, or no governance unit representing the municipality provided transit funding. A disadvantage of dichotomous measures is that they can be critiqued for failing to capture granular variation in the same way that continuous variables can. However, for most of our variables there is no conceptual middle-ground: nuance is often found in how those rules are interpreted and translated into decisions, and this can be ascertained only via study of norms in subsequent work.

TABLE 10. The Components of the Regionalization Measure

Category	Variable	Abbrev.	Data source	Coding
Hierarchy	Multijurisdictional (sub-state) funding	MJ_Fund	State legislation; MPO documents (transportation improvement program (TIP) and long-range transportation plan), Transit Agency Comprehensive Annual Financial Reports. Annual budget, agency bylaws or website	2 = Municipality is in area of regional body (two or more jurisdictions) that collects transit funding for operations needs for that MSA.[4] 1= Single-jurisdiction transit funding coming from the jurisdiction. 0=No Transit funding from the local jurisdiction.
	State governance	State_Gov		2 = Municipality is in area of MSA in which a majority of the board governing operations is appointed by the state government. 1=No state-appointed majority of transit agency serving the jurisdiction. 0=No transit agency serving the jurisdiction.
	State funding	State_Fund		2 = Municipality is in MSA in a state that funds operations needs in that state's portion of the MSA. 1=No state funding in that state's portion of the MSA 0=No transit service or state funding in that state's portion of the MSA.
Exit prevention	Exit Prevention for sub-state funding	EP_OptOut	State legislation; county and	2 = Municipality can opt to *not* participate in the funding program, but only with an area-wide vote

[4] I.e. Not merely authorized, but actively implementing the law and funding the service.

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			municipal legislation, Comprehensive Annual Financial Reports, Annual budget, State local option taxation records, taxation district membership	(not a vote by jurisdiction), with "area" defined as the entirety of the taxing district. 1=Municipality pays funding for transit operations program, but can opt out, or contributes voluntarily. 0=Municipality does not pay for any transit operations program.
	Interagency agreement	IA_TA+TA	Calls and surveys to transit agencies, supplemented by MPO and TA website searches	2 = Municipality is in a transit agency *or* houses its own transit agency, and that transit agency is a party to a formal operations agreement with at least one adjacent transit agency. 1=Municipality is not in a transit agency with a formal operations agreement with at least one adjacent transit agency. 0=No transit agency present, or only one transit agency, and thus, no possibility for an agreement.
Conjunction	Transit agency / municipality conjunction	FCTA+M	Bylaws, meeting minutes, and/or website of a target transit agency (the largest one by area serving the municipality being coded)	2 = Municipality has voting representation on transit agency decision-making body. 1=Municipality does not have voting representation on transit agency decision-making body. 0=No transit agency serves municipality.
	Transit agency / county conjunction	FCTA+Ct		2 = Municipality is in county that has voting representation on transit agency decision-making body. 1=Municipality is in county that does not have voting representation on transit agency decision-making body. 0=No transit agency serves municipality.
	Transit agency / transit agency conjunction	FCTA+TA		2=Municipality has relationship with [x] TA which has representation on another [Y] TA decision-making body. 1=Municipality has no relationship with a transit agency that has representation on another transit agency's decision-making body. 0=The municipality is not served by any transit agency.
	MPO / municipality conjunction	FCMPO+M		2 = Municipality itself has voting representation on MPO decision-

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				making body. 1=Municipality has no voting representation on MPO decision-making body. 0=No MPO serves the municipality.
	MPO / county Conjunction	FCMPO+Ct	Bylaws, meeting minutes, and/or website of the MPO serving the municipality being coded	2 = Municipality is in county that has voting representation on MPO decision-making body. 1=Municipality is not in a county that has voting representation on MPO decision-making body. 0=No MPO serves the municipality.

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i. Hierarchy: direct provision of service by a state-controlled transit agency or state-controlled multijurisdictional entity

The State_Gov variable identified whether a transit agency was a state-level agency. We used board membership data to determine this, as a proxy for decision making authority. We encountered a variety of governance situations, ranging from full state governance, as a department of the state DOT to just a single state representative on the board, representing more of a conjunction than full control. We coded an agency 2 whenever at least a majority of the board was state-appointed. Appointments could come from any state entity, including the DOT, the governor or the state legislature. Board membership information came from either the agency's annual report, its comprehensive annual financial report, its bylaws or its website. If a majority of the board was appointed by a state entity, we coded all jurisdictions served by the transit agency to be 2; if a majority was appointed or elected by local governments or local citizens, we coded all jurisdictions served by the agency to be 1; and if there was no transit agency serving the jurisdiction, we coded it 0. In cases where more than one transit agency served a given municipality, we used the higher of the two transit agencies' codes, to represent the full scope of state governance relationships. For example, in a case where one transit agency is a state agency, and another is a city one, the jurisdiction could still have transit connecting it to the rest of the state, should they decide to implement such a service, and was coded 2. In some cases the transit agency website had very little information; if this was the case, we contacted agency staff by email for more information, though in these cases, we did not hear back.

An example of a state transit agency is CT Transit, which provides service to many areas in Connecticut. In the New Haven MSA, board members on CT Transit represent the state and the agency was coded 2. Conversely, local transit agencies in the same region had a majority of memberships appointed locally, so were coded 1.

Another example is Tri-MET in the Portland-Vancouver-Hillsboro MSA, which has board members selected by the governor. Unlike CT transit, Tri-MET is not a state*wide* agency, but still considered a municipal corporation of the State of Oregon (TriMET 2018), with board members appointed by the governor, rather than locally elected or appointed locally; thus, jurisdictions served by Tri-MET were coded 2 (ORS § 267.090). Such an entity would be distinct from multi-jurisdictional entities where the board is appointed or elected locally, such as the Bay Area Rapid Transit District (board elected locally), the Denver Regional Transportation District (board elected locally), or the Southern California Regional Rail Authority (board appointed by county members) (Bylaws, 9-12-2014).

ii. Hierarchy: direct funding by the state or multijurisdictional entity

The state funding variable helps identify whether state tax money is supporting transit service in the region. In most transit agencies, we used the "nonoperating expenditure" section of the annual budget or comprehensive annual financial report (CAFR) to search for revenue sources, looking for any state operating sources. Non-operating revenue will usually be categorized by federal, state, or local, and may include details like the particular state grant programs from which operating revenue was received. If transit agencies had received any operations support

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from the state, we coded 2 for the all jurisdictions in the MSA from that particular state, since all people in the state would be supporting the service; thus any jurisdictional divisions would have been made as a result of local decisions, not state decisions, and all jurisdictions would be included. However in MSAs with more than one state, we only coded 2 for the jurisdictions served by the same state as the transit agency receiving state funding. For example, we would look at the budget from each transit agency, to identify which state(s) it received funding from, and code 2 for the portion of the MSA in the state(s) that provided funding for operations (capital funding was not counted since it is outside the scope of this project).

Some states like New York and California provided substantial financial support for local services. In other cases like Alabama, the state provided next to nothing to local transit agencies, leaving local governments to pay for it themselves with local funding. Most areas were somewhere in between. If the state provided something, we coded it 2, recognizing that the exact amount and share of funding can change significantly from year to year, making it difficult to hold constant in time, and under the assumption that there would be no financial barrier in place across jurisdictions, though we recognize that this can be refined further in future studies.

CT transit (in Connecticut) is one example of this, where the service is a state department, so receives significant state funding. Nevertheless, a significant number of important decisions are still made by local branch departments. Municipalities voluntarily participate if a local transit agency provides service in the region. Other noteworthy cases include Alabama's MSAs, which are an example of cases that did not receive any state funding. Also noteworthy was Columbus, which is an example of a bi-state MSA, where the municipalities in one state (Georgia) utilize state funding for transit, while there were not any services on the Alabama side receiving state funding.

Also in the *hierarchy* category, we developed a variable for multijurisdictional funding, which identified the presence or absence of sub-state sources of revenue funding transit operations in the MSA. Again, we did not include funding for capital expenses, like building a new transit line, nor did we include funding for roads or other non-transit local services, since these were outside the project scope.

Multijurisdictional funding sources (MJFund) that were coded 2 could include: a taxing district, sometimes called an independent special district, supporting a transit service, a local option tax approved by voters, a county or a transit agency that covers more than one jurisdiction, a toll levied by an independent special district and used to support transit operations, or general fund support from a county that serves more than one local municipal jurisdiction. However if individual cities are voluntarily contributing money to a transit agency, including when multiple cities are doing so, we coded this as a 1 for jurisdictions that are funding the service and 0 for cities that are not paying, since the decision is made by each jurisdiction, so is not multijurisdictional.

We gathered this information from state documents like the comptroller's office, transit agency/city/county sources like the most recent available comprehensive annual financial report (CAFR) the budget, or the website, as well as the long range and short range transportation plans for the particular metro area. Occasionally we would get information about taxes from the a newspaper or authorization legislation, but in those cases, we checked to make sure the tax had actually been enacted, and supported transit operations, rather than capital expenses.

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We came across certain special cases. For example, there were cases where a city and county financial statement indicated that the transit agency received direct support from another transit agency. This could be in the form of a proprietary or enterprise fund as well as interfund transfers. In such cases, the source of the original funding stream indicates how we coded it.

We identified a number of cases where grant funding from either the federal or state governments required sub-state matching funds in order to receive support. We counted this as money as coming from the level of government making the match (i.e. local/sub-state, rather than federal or state).

Tolls added another complication, for example in cases like New Jersey or the San Francisco Bay Area, where they were used to fund public transit operations. In the New Jersey case, they were counted as state funding, so did not apply to the "multijurisdictional funding" variable. However in the San Francisco Bay Area MSA, they have three Regional Measures, approved by voters in 1988, 2004 and 2018, which were counted as the functional equivalent to local option taxes, since they were approved by voters, although they are a fee not a tax. (The multijurisdictional funding variable does not distinguish whether funding is a fee or a tax, and counts both local option funding approved by voters and approved by general purpose local governments like city councils or county boards of supervisors).

It is also important to illustrate cases that were coded 1. These were largely funded by local governments. For example, in Wichita, KS, only one city, Wichita, contributed local funds. Similarly, in Topeka MSA, while Topeka received some state funds, the transit system is reliant on single-city funding for its sub-state sources. Consequently, the reach of the transit system does not extend beyond that one municipality.

iii. Exit impedence: participation of local governments in funding with high exit barriers

This variable asks how the decision was made to provide the local funding, and whether local municipalities could opt out. In cases where there was a taxing district, voting on a local option tax, if the vote was tallied across the district, and a districtwide majority was used to determine whether it passed, this was coded as a 2 for the entire district, while a majority counted city by city was coded as a 1 for the municipalities that were part of the taxing district. Additionally, we coded funds coming from a county general fund as 2, as long as the county covered more than one municipal jurisdiction. This is because local jurisdictions could not opt out of this funding decision. In cases where funding came from individual cities, we coded those cities as 1, and coded cities that did not provide transit service as 0. We gathered the information to code this variable from state enabling statutes, agency annual reports, agency web pages. When these were insufficient, we gathered information from state and county election results, or newspaper articles, announcing the passage of a tax (however we only used news articles that discussed the circumstances of how the vote was counted). When the same jurisdiction was served by more than one transit service, we used the higher of the two agency's codes for this variable, to represent the possibility of multijurisdictional transit service supported by a funding stream that is immune to local opt outs.

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While in many instances this variable was coded similarly to MJFund, this was usually because in circumstances when a county government is supporting the service, it is a multijurisdictional funding source, and there is no possibility for cities to opt out. Or they were from cases where a local option tax is voted on at the county or multi-county level of government, ensuring that the tax is both multijurisdictional and has no way for cities to opt out. However in special taxing districts, which are especially common in Michigan, Texas and states in the Midwest, cities have the option to not join the district (and not pay the tax). This would be coded 2 for MJFund, since it is a multijurisdictional funding source, but 0 for cities that did not join (and did not pay the tax), and 1 for cities that voluntarily contributed to the service but did not pay the multijurisdictional tax.

iv. Organizational coordination: voluntary agreements among transit agencies

Interagency Agreements (IAs) are essentially contracts between governments, and are akin to contracts between companies. The term is often used interchangeably with memoranda of understanding (MOU), contract, and service agreements. In some states, transit agencies, MPOs and general purpose local governments coordinate through formal structures known as joint powers authorities (JPAs), which are particularly common in California. Since the effect of creating such an authority is the joint management of a service, we included them in this category as well, conceptually, serving as a more comprehensive and institutionalized agreement to cooperate over time. Since the scope of this study is formal operational structures, we limited ourselves to interagency agreements over the operation of services, excluding agreements over construction of new transit lines, or purchase of new equipment, which would all be capital expenses, and outside the project scope. Additionally, since we are focused on transit fragmentation, we limited ourselves to interagency agreements between transit agencies (not cities, counties, MPOs and other agencies). However in instances where a city, county or other government operates a transit agency, we looked at interagency agreements between that government and other transit agencies in the MSA. We did not include agreements with transit agencies outside the MSA.

We focused on agreements or contracts between two or more transit agencies regarding transit operations. This could include both joint operation of lines, lines that go between service districts, lines that go to another government/agency's stations, or other forms of cooperation requiring an agreement. We coded each municipality in the shell which is in a transit agency that is part of an interagency operating agreement as a 2. Municipalities in transit agencies that are not part of an interagency operating agreement were coded as 1, while municipalities that were not in a transit agency at all were coded 0. In circumstances where more than one transit agency serves the same jurisdiction, and only one of them has an interagency agreement, we counted the higher code (2), since this represents the presence of a formal cooperative governing agreement covering that jurisdiction.

We began this research by requesting information from transit agencies, MPOs, state DOTs and other knowledgeable parties who could provide us an interagency agreement or other formal document of cooperation. We sent Freedom of Information Act (FOIA) requests to the transit agencies on the list, and sent official letters and emails requesting public records pertaining to joint operation of lines, lines that go between service districts, lines that go to another

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government/agency's stations, fare collection systems, shelter or other facility sharing, or any other forms of cooperation requiring an agreement.

We called many agencies to follow up. However we found disappointing results. Staff at most transit agencies and MPOs were unfamiliar with what interagency agreements were, as well as with more common terms like MOUs. Consequently, we decided to send a survey to every transit agency for which we had contact information, targeted to specific staff positions like agency counsel, when contact information was available. (Since we had already called the MPOs, we did not need to send surveys to them). We used this method to fill in missing data, targeting agencies that had not responded to our calls, emails or public records requests. Since the end result exhibits little room for variation, simply identifying the presence/absence of interagency agreements serving each particular agency, the change in methodology during the data collection process should not greatly impact the results.

The survey responses and public records we received were our primary source for coding for the IA_TA+TA variable. However we also gathered information from other sources, particularly a Transit Cooperative Research Program report (Thomas and McDaniel, 2012), which helped us locate additional municipalities or transit agencies with interagency agreements, from which we did not receive survey responses. Though most of the agreements in the report were not between transit agencies, or were covering capital projects, we identified IAs between several additional agencies.

We also searched the Internet for further evidence of IAs. In those cases we used webpages, online documents, and transit agency meeting notes as information sources. To overcome limitations of using web pages, such as the potential for outdated information, we kept detailed notes and screen shots detailing our findings.

v. Organizational coordination: conjunction via dyadic network ties through shared board memberships

We coded conjunctions among transit agencies as follows. If a transit agency's decision-making body—usually named a board of directors—had a seat on it reserved for a representative from another transit agency, we coded FCTA+TA as 2 for all local units in the service area of that transit agency. If a local unit was served by multiple transit agencies, and at least one of them had representation on its board from another transit agency in that MSA, this too would warrant a 2. If a transit agency served an MSA with at least two transit agencies, and that transit agency had no such representation on its board, then we coded FCTA+TA as 1 for all local units in its service area. Consistent with our other variables, we reserved coding with zeroes for those transit agencies in MSAs in which they were the only transit agency, thereby negating the possibility of any interagency conjunction; as well as cases where there were no transit agencies providing service. Only nine transit agencies of the 613 we studied—covering 82 local jurisdictions in just three metropolitan statistical areas—warranted coding with a 2. In total, 6,132 local units were not served by a transit agency and another 949 were served by a transit agency that was the only one in the MSA; a total of 7,081 local units were, therefore, coded as zeroes. The remainder were

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coded as 1, indicating that the vast majority of transit agencies saw little need to share board membership when they existed in an MSA that provided the opportunity for doing so.

Sources included bylaws, meeting minutes and transit agency websites. Bylaws were considered the strongest source, when available, since they provided information about permanent relationships in the name of the main decision-making board, and the seats on it that are permanently reserved for representatives from other municipalities, counties, transit agencies and MPOs. Meeting minutes were considered the next strongest source, since they are an official document providing information about cross-governmental relationships. However these relationships could be temporary. For example, a board member on an MPO might come from a particular city, but represents all cities in his/her county in a position that rotates among cities; thus these relationships may change over time. In many instances when the prior two sources were unavailable, we relied on government and agency websites for the latest board composition. Like the meeting minutes, these positions are not necessarily permanent, and provide a snapshot in time. Meeting minutes have a clear date, making it possible to place the board composition in time; however websites required us to check and record the date stamp to account for this dynamics.

We did not find many conjunctions between Transit Agencies. Regions with more TA+ TA connections were usually larger MSAs, with more strongly developed transit systems, like San Francisco-Oakland-Hayward MSA, where Caltrain serves three counties, with representatives from governments in each one. We checked for neighboring transit agencies using ESRI ArcGIS, looking at the five transit agencies that share a border with Caltrain, including San Francisco Municipal Transportation Agency, San Mateo County Transit District and Santa Clara Valley Transportation Authority (VTA), which overlap in service area with Caltrain and have their representation on Caltrain's board. So we coded as 2 for the municipalities in transit agencies that showed such conjunctions (http://www.caltrain.com/about/bod.html).

Florida has a few similar examples of services with their agency governance connected to a general purpose local government. One is in the Deltona-Daytona Beach-Ormond Beach, FL Metro Area. The Volusia County Council created the county's public transportation system, Votran. Votran is a service of Volusia County Government, with Votran being the brand of the countywide transportation system. Another example is Sunrail, a commuter rail system in central Florida owned and operated by the Florida Department of Transportation. Although it is a state agency, governed by the Central Florida Commuter Rail Commission Governing Board, which acts in an advisory capacity to the Florida Department of Transportation during the first seven years of SunRail operations, the local board will assume operations and maintenance of the system in the eighth year of SunRail operations. Additionally, a Volusia County Council Member is a Governing Board member on the Central Florida Commuter Rail Commission and serves as Volusia County's representative on the Governing Board. Votran and Sunrail are adjacent to each other and share each other's border. Although there is another transit agency nearby, it does not share a border, so is not counted in our coding. (Coding 1/1= 1) (For more information, please see http://www.votran.org/about-us/index.stml, http://corporate.sunrail.com/about-sunrail/administration/governing-board/)

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Seldom were there representatives from the MPO on the transit agency decision making board. However, there were cases where the transit agency had representatives from the MPO on a permanent institutional board. We usually found these cases in California. For example, in the Bay Area, their MPO, the Metropolitan Transportation Commission (MTC), had an ex officio representative on the Santa Clara Valley Transportation Authority's (VTA) Technical Advisory Committee (TAC). While the Bay Area and MTC cover several MSAs, VTA is located in the San Jose-Sunnyvale-Santa Clara, CA Metro Area (http://vtaorgcontent.s3-us-west-1.amazonaws.com/Site_Content/tac_011018_m.pdf).

Not all examples were in California. For example, in the Austin-Round Rock, TX metro area, Capital Metropolitan Transportation Authority's (CMTA) board consists of three members appointed by the Capital Area Metropolitan Planning Organization (CAMPO), including one elected official. (https://www.capmetro.org/board/#!). Occasionally, we ran across cases where MPOs were the transit operators. For such cases, we signified the existence of MPO to Transit Agency conjunctions by coding them 2. For example, in the Reno metro area, the Regional Transportation Commission of Washoe County (RTC) is the public body responsible for the transportation needs throughout Reno, Sparks, and Washoe County, NV. (https://rtcwashoe.wpengine.com/public-transportation/) Or in Chico, CA, Butte County Association of Governments (BCAG) serves as the administrative and policymaking agency for the region's public transit service. Butte Regional Transit or the "B-Line" is a consolidated transit system that provides urban and rural fixed route service. (For more info please see, http://www.blinetransit.com/).

V. ANALYSIS AND FINDINGS

A. Calculating the Fragmentation Measure

Here we discuss the process of using principal component analysis (PCA) measurements for both fragmentation and regionalization for each MSA. Section IV develops variables for regionalization (see V.B, below). However first we calculated measures for fragmentation. We tried combinations of the data weighted by population, area and employment that would best describe the data. Specifically, the percentage of the MSA population/area/employment found in each jurisdiction was multiplied by the variable values for each jurisdiction, and then totaled to obtain an MSA value for each variable. We identified several combinations of weighted numbers with the strongest factor loadings to create a single fragmentation measure: 1) population fragmentation (FragPopMSA), 2) population and employment fragmentation (FragPopEmp), 3) population and area fragmentation (FragPopArea), and 4) number of states in the MSA (Statenum), with the last variable added to those we had coded, based on observation that many of the coded variables broke along state lines. These variables were combined into one factor representing the degree of fragmentation within the MSA using PCA, an analytical technique that takes a large number of correlated variables and extracts a small number of factors that embody the common variance in the original data set. The extracted factors, or principal components, are weighted combinations of the original variables. When a variable is given a great deal of weight in constructing a principal component, it indicates that the variable loads heavily on that component. The greater the correlation between an original variable and a principal component, the greater the loading and the more weight the original variable is given in

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the overall principal component score. The more highly correlated the original variables, the more variance is captured by a single principal component.

TABLE 11. Fragmentation Measure Variables and Factor Loadings

Observed variable	Factor loading*
FragPopMSA	0.938
FragPopEmp	0.884
FragPopArea	0.752
Statenum	-0.398
Eigenvalue	2.39
Explained variance	59.7%

* Correlation with fragmentation

The principal component selected to represent fragmentation was the one capturing the largest share of common variance among the four variables. This one component accounted for about 60% of the variance in the dataset. Because this component captured the majority of the combined variance of these variables, no subsequent components were considered. Factor loadings are shown in Table 11. As expected, one of the variables loads negatively on the fragmentation factor, that being the number of states. The rest load positively. Thus, for all component variables, higher values translate into lower values of the fragmentation factor. For the sake of simplicity, we multiplied the principal component values by -1 to obtain a factor that translates higher values to higher fragmentation.

To arrive at a final fragmentation measure, we transformed the principal component, which had a mean of 0 and standard deviation of 1, to a scale with a mean of 100 and standard deviation of 25. This transformation produced a more familiar metric (like an IQ scale) and ensured that all values would be positive, thereby allowing researchers to take natural logarithms and estimate elasticities. With this transformation, the more fragmented MSAs have values above 100, while the less fragmented MSAs have values below 100.

The larger the value of the measure, the more fragmented the MSA. Scores ranged from a high of 147.04 to a low of 0.25. At the most fragmented end of the scale are Philadelphia-Camden-Wilmington, PA-NJ-DE-MD, Chicago-Naperville-Elgin, IL-IN-WI, Washington-Arlington-Alexandria, DC-VA-MD-WV and Cincinnati, OH-KY-IN MSAs. At the least fragmented end of the scale were outlying metropolitan areas such as Urban Honolulu, HI MSA, and smaller MSAs such as Laredo, TX MSA, Lincoln, NE MSA and Naples-Immokalee-Marco Island, FL MSA. The fragmentation measurement is positively skewed. Most MSAs clustered around intermediate levels of fragmentation (see Figure 3).

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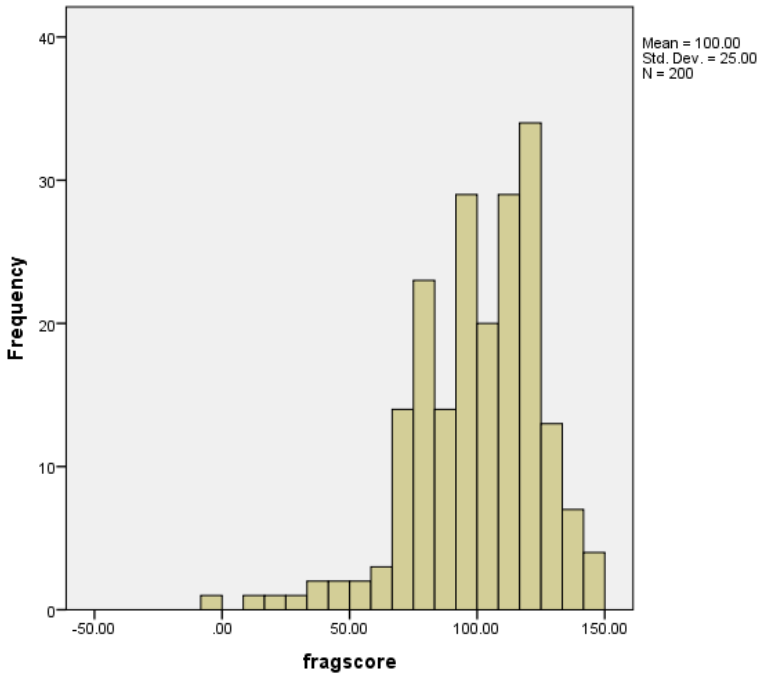

FIGURE 3. Histogram Distribution of MSA Fragmentation Measurement

B. Calculating the Regionalization Measure

Next we used the data to develop a single regionalization measure. Table 12 shows the list of variables, definition and data sources. We derived 11 measures of regionalization from the 200 MSAs studied here. Next, all values were weighted by municipalities' population as a percentage of the MSA total to obtain the MSA level values for each variable.

Using principal component analysis (PCA), the 11 variables described in Sections IV.C-IV.D were combined into one factor representing the degree of regionalization within the MSA. The principal component selected to represent regionalization was the one capturing the largest share of common variance among the 11 variables. This one component accounted for about 42% of the variance in the dataset. Because this component captured the majority of the combined variance of these variables, no subsequent components were considered. Factor loadings are shown in Table 12. As expected, all variables load positively on the regionalization factor. Thus, for all component variables, higher values translate into higher values of the regionalization factor.

TABLE. 12. Regionalization Measurement Variables and Factor Loadings

Observed variable	Factor loading*
IA_TATA	0.632
FCMPOM	0.471
FCMPOCt	0.529
FCTAM	0.668
FCTATA	0.578

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State_Gov	0.642
MJ_Fund	0.699
State_Fund	0.266
EP_OptOut	0.691
TARegPop	0.702
MPORegPop	0.518

* Correlation with regionalization

Again, to arrive at a final regionalization measure, we transformed the principal component, which had a mean of 0 and standard deviation of 1, to a scale with a mean of 100 and standard deviation of 25. With this transformation, the more regionalized MSAs have regionalization values above 100, while the less regionalized MSAs have values below 100.

The bigger the value of the measure, the more regionalized the metropolitan area. Scores ranged from a high of 147.81 to a low of 44.15. At the most regionalized end of the scale are Los Angeles-Long Beach-Anaheim, CA, Boulder, CO, Tampa-St. Petersburg-Clearwater, FL and Akron, OH MSAs. At the least regionalized end of the scale were Anchorage, AK, Baton Rouge, LA, Lafayette, LA and Springfield, MO MSAs.

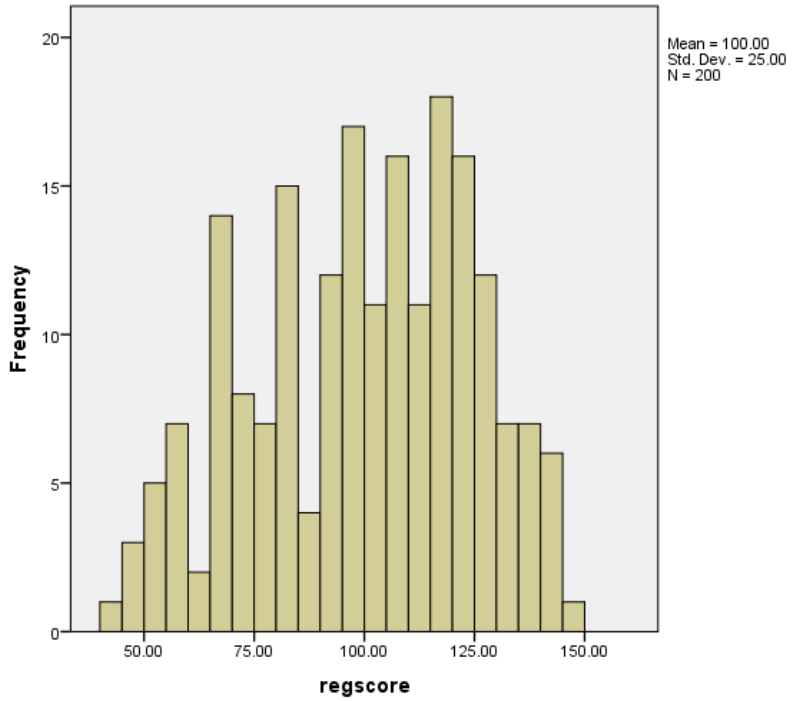

FIGURE 4. Histogram Distribution of the Regionalization Measurement

C. Conducting the Scatter Plot Analysis

Plotting the results of the fragmentation measure and regionalization measures on a Cartesian plane for all 200 MSAs reveals that most of the major metro regions load positively, falling in the upper two quadrants. Major regions that fall in the lower two quadrants—ones below 100—are exceptions, with unusually low fragmentation. These can be divided into two groups. For

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the first group, low fragmentation is due to the unusually small size of the MSA when measured by population or area, causing little need for multiple jurisdictions.

Low Fragmentation Score, Low Regionalization

These regions primarily fall into Quadrant III (-.-). Some examples are Anchorage, AK (population 395,000), or Spartanburg, SC (319,000) . The MSAs highlighted in Figure 5 are some of the largest populations of the regions that fell into this quadrant due to their very low scores on both fragmentation and regionalization. Many of these MSAs are in states that allow local municipalities to opt out of transit service, and score poorly on other variables as well. For example in Anchorage, AK, the only transit service is to the city of Anchorage itself, which makes up a 75.6% of the MSA population, so is weighted heavily in calculating the fragmentation and regionalization measures. Since much of the MSA is not in a transit agency, and there is only one transit agency in the MSA, there are no formal horizontal conjunctions to neighboring municipalities, since they provide no transit service, nor is there another agency to make formal agreements with. There is a vertical conjunction with City of Anchorage, providing some measure of coordination. Yet, since there are no other transit agencies besides the People Mover in Anchorage, there are no agreements between transit agencies (coded 0). There are also no laws against opting out of local funding, and no multijurisdictional funding, nor is there state transit service or funding, as is the case in many other states, This leaves most of these variables coded 1 for Anchorage, and 0 for other jurisdictions in the region, resulting in a very low score for regionalization. The exceptions are for several of the formal conjunction and interagency agreement variables, which were 0 because there was no agency to agree with. And for the NestTA variable, Anchorage was coded 2, because of the nesting between the People Mover and the City of Anchorage. At the same time, the region has a very low fragmentation score. This makes sense, given that Anchorage is a very compact city, containing over 70% of the MSA population, even as its land area contains only 6.4%, This does not mean that Anchorage is necessarily "high density," only that the area containing most of the region's population is not broken down into many jurisdictions—likely a product of the region's low population, since it is not big enough to be broken into many jurisdictional units. Many of the MSAs in Quadrant III share this characteristic, and do not require significant regionalization measures due to their small size.

As another example, in Spartanburg, SC, the only two jurisdictions that had transit service (Spartanburg city and Spartanburg unincorporated area) had, collectively, 83.5% of the MSA's population. They were the only jurisdictions providing local transit funding (though not multijurisdictional), and did not have any formal conjunctions in place, but were coded 1, rather than 2, since they had transit and it was possible to code for this variable. Meanwhile the rest of the region was coded 0 for most variables, except for the presence of conjunctions between the MPO & County and funding from the state for transit. While the region was not very fragmented, having only one transit agency, it also did not have strong regionalizing institutions in place, even in the population centers, while other areas were simply not able to be coded for most variables.

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Low Fragmentation Score, High Fragmentation Score

The second group of low-fragmentation regions actually has large populations, and fall into Quadrant IV (+,-). For example, single-jurisdiction Honolulu, or Las Vegas, NV both fall into Quadrant IV. Urban Honolulu, HI MSA has just one jurisdiction for a population of 984,000, covering 100% of the MSA population; while Las Vegas-Henderson-Paradise, NV MSA has six jurisdictions for 2.03 million people, with the transit system serving five of them and covering 99% of the MSA population. As such, both regions are unusually concentrated in just a few jurisdictions that cover most of the people, jobs and area. Honolulu, with just one jurisdiction, was definitely an anomaly, having 100% of the population within the city boundaries, and providing exceptionally strong weight to all variables. For this region, there were no conjunctions, nesting or interagency agreements, because there were no other general purpose local governments to make agreements with; however there was an MPO and a second transit agency, so these types of arrangements would be helpful for promoting service integration. On the other hand, since the region had just one jurisdiction, we counted it as 2 for MJ_Fund and EP_OptOut, since the region was aggregated, as was its sub-state funding (primarily coming from the City and County of Honolulu). All combined, the region had the lowest fragmentation score, but its regionalization was only above average—not the highest, largely because there was only a marginal need to overcome fragmentation, with all of the fragmentation being not across general purpose local governments, but across the region's two transit agencies, its MPO and its one general purpose local government.

Las Vegas is coded 2 for MJ_Fund, State_Fund and EP_OptOut for the entire MSA, and FCMPO+Ct for jurisdictions representing 55% of the population in the MSA; FCTA+M for 54.9% and FCTA+Ct for 99%, though many of the other variables were coded either 1 or 0 for many jurisdictions, leading to an above average regionalization score, though other regions scored higher.

High Fragmentation Score, High Regionalization Score

Turning to the regions with high fragmentation scores (i.e. fragmentation is not very problematic), the first quadrant we examine has high fragmentation scores and high regionalization, and is populated largely by regions with county-level transit agencies, like those in California, Florida and Georgia, as well as state-level transit agencies, like those in the Northeast and Mid-Atlantic states. For example, the Los Angeles and San Francisco MSAs both fellinto Quadrant I (+,+), along with many other regions in California,due to both their high levels of fragmentation, but also their strong presence of their regionalizing institutions for overcoming that fragmentation, especially their transit governance at the county level. Looking first at their fragmentation, it is plain why these regions had high levels of it. Only two of the Los Angeles-Long Beach-Anaheim MSA's 124 cities, and only two of the San Francisco-Oakland-Hayward MSA's 69 cities had over five percent of their MSA's total population, indicating that their populations were not particularly concentrated in a single city. And high concentration into the regions' counties, particularly Los Angeles County (76% of MSA population), was counted as a form of regionalization, since it ties local cities together.

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Many of Quadrant I's regions have multiple states, municipalities, and transit agencies, but also have substantial state transit funding, interagency agreements, formal conjunctions, and county (or multicounty) sales taxes. Between Los Angeles and San Francisco MSAs, almost every jurisdiction is part of a transit service area of some kind, increasing regionalization scores substantially. In the San Francisco Bay Area and Philadelphia, they also have multicounty/state road tolls that support transit. The California regions also have local option sales taxes covering the entirety of the counties in the MSA, substantially boosting their MJ_Fund and EP_OptOut scores, since no jurisdiction was left out. While these taxes are not in place in all counties in the region's *MPOs,* (e.g. Solano County in the Bay Area or Ventura County in Los Angeles), these counties were not within the core commuting area, and were outside the MSA boundaries. Consequently we counted them as separate MSAs in our calculations (Vallejo-Fairfield & Oxnard-Thousand Oaks-Ventura MSAs). While this is likely to increase the regionalization scores for some MSAs, the scores reflect the fact that the core area of the region has strong structures in places to connect transit agencies across entire counties, provide service and multijurisdictional funding to almost the entire population, with no opportunity for cities to opt out because those services are governed and funded at the county level of governance (see section V.E for further explanation).

As mentioned above, Quadrant I also includes a large cluster of East Coast MSAs, which are highly compact (e.g. the city of Philadelphia alone has 25% of the MSA population), and which have a a high portion of their services governed and funded directly by either a single state, or a collection of states. (E.g. Delaware Transit Corporation, Maryland Transit Administration, Massachusetts Bay Transportation Authority, SEPTA, New Jersey Transit Corporation, Philadelphia, Port Authority, Port Authority Trans-Hudson Corporation, Rhode Island Transportation Authority, Washington Metropolitan Area Transit Authority). While these regions are not covered as thoroughly with transit service areas as the ones in California, since they are not governed at the county level. Therefore they leave certain jurisdictions out of the system. However the regions still score highly on regionalization, in part because the parts with a high population of their region's employment are well covered. Therefore the scores for other factors like interagency agreements, formal conjunctions or nesting are weighted heavily, and these regions tend to do well on these variables as well. Even so, the lack of uniformity of coverage (and more areas not coded for lack of service) helps explain why Philadelphia and other regions in this East Coast cluster come out with lower regionalization scores than those in the West cluster, despite their reputation for better transit in the East. Since this is a measurement of governance and not service, it indicates that transit governance and finance is provided more uniformly in California than in East Coast MSAs (even when weighted for population, jobs and area). However this by no means suggests that the transit *service* California transit agencies provide is uniform, only that their institutions allow it to be so..

High Fragmentation Score, Low Regionalization Score

Quadrant II (-,+) represents regions that have high fragmentation scores, but low levels of regionalization—for example, Dallas and Detroit, which are discussed further in our map Section V. D. Like Quadrant I (+,+), these regions have high levels of fragmentation, but do not have as

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many formal institutions in place to overcome fragmentation. In many cases, high percentages of the populations or areas of these regions are not served by any transit agency at all, due to the fact that they allow jurisdictions to opt out of participation in transit agencies. For example, much of the St Louis (36.6% of the population), Detroit (27.6%) and Dallas (41.9%) live in jurisdictions lie outside the service area of a transit system , largely due to municipalities' ability to opt out of transit services and/or funding in these states. This leaves much of these regions without any service at all, and absence of regionalizing measures like interagency agreements, multijurisdictional funding, and formal conjunctions for much of the region. Nor do state governments govern the transit agencies in most of these regions. [5]

Additionally, this Quadrant includes multistate regions that did not successfully establish institutions to ensure equal levels of service on both sides of the state line. For example, Portland, OR, though often lauded for its excellent transit system, leaves 9% of its population outside its transit agency service areas, while a full 28% lies outside the service area for the region's well-regarded TriMET transit system, along with very low nesting, and very few types of formal conjunctions; though the region scores higher on interagency agreements. Additionally, while the region has a multijurisdictional payroll tax for the TriMet service area, it, like the service itself, does not apply to jurisdictions serving 9.4% of the MSA population, failing to act as a force of regionalization for these areas. The combination of the region's inability to assemble a larger percentage of the population into the same transit agency, and its failure to overcome this with more cross-agency connections

[5] With the exception of the Bi-State Development Authority in St. Louis. In this case, Missouri appoints its commissioners, while Illinois counties appoint the ones from their side. However much of the funding for transportation services, including capital and operations, is determined at the county level or through multi-city taxing districts like the St. Clair County Transit District in MO or the Metro East Transit District in IL.

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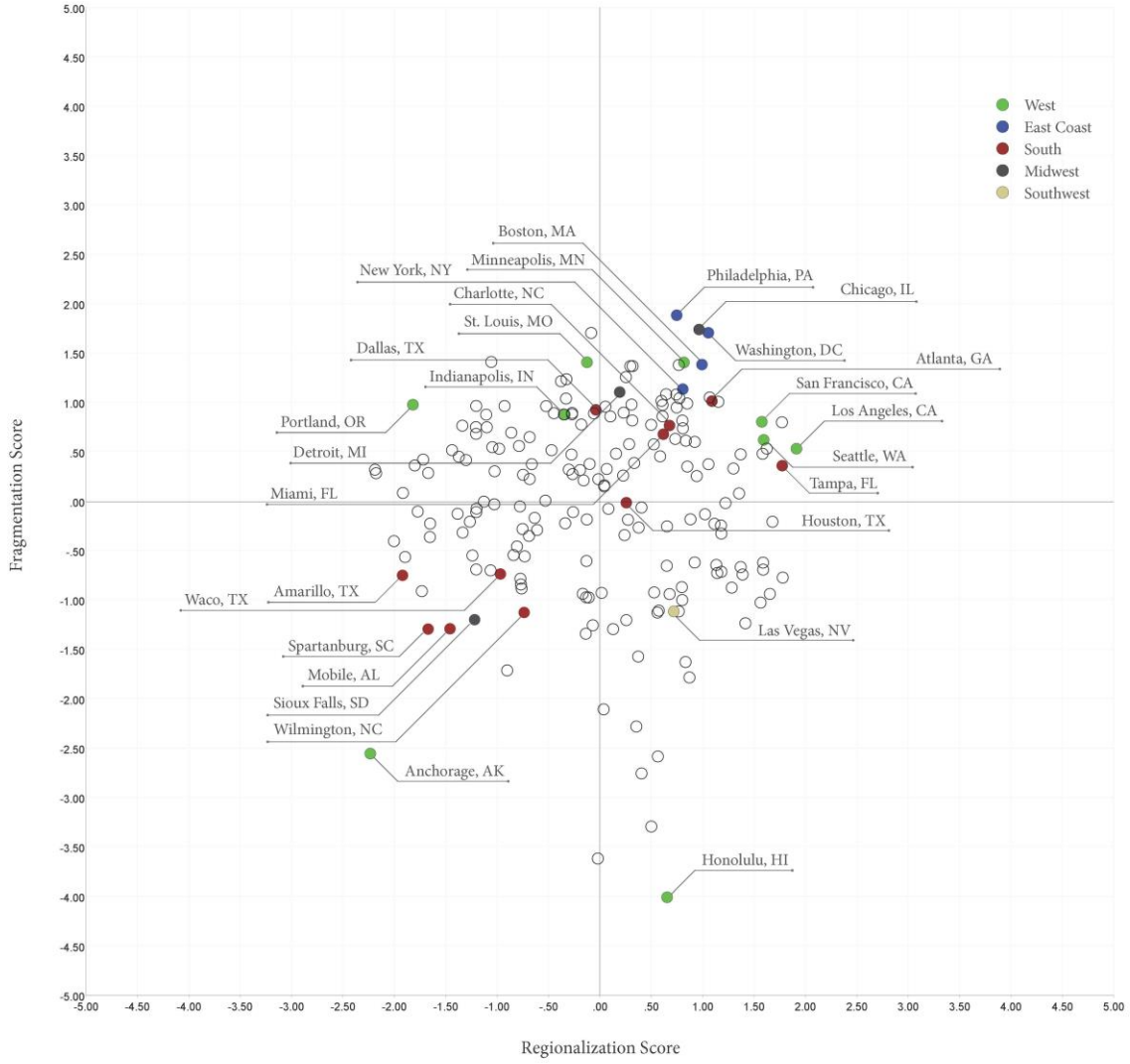

FIGURE 5. Scatterplot of Fragmentation & Regionalization Scores, Coded by Region

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D. Conducting the Mapping Analysis

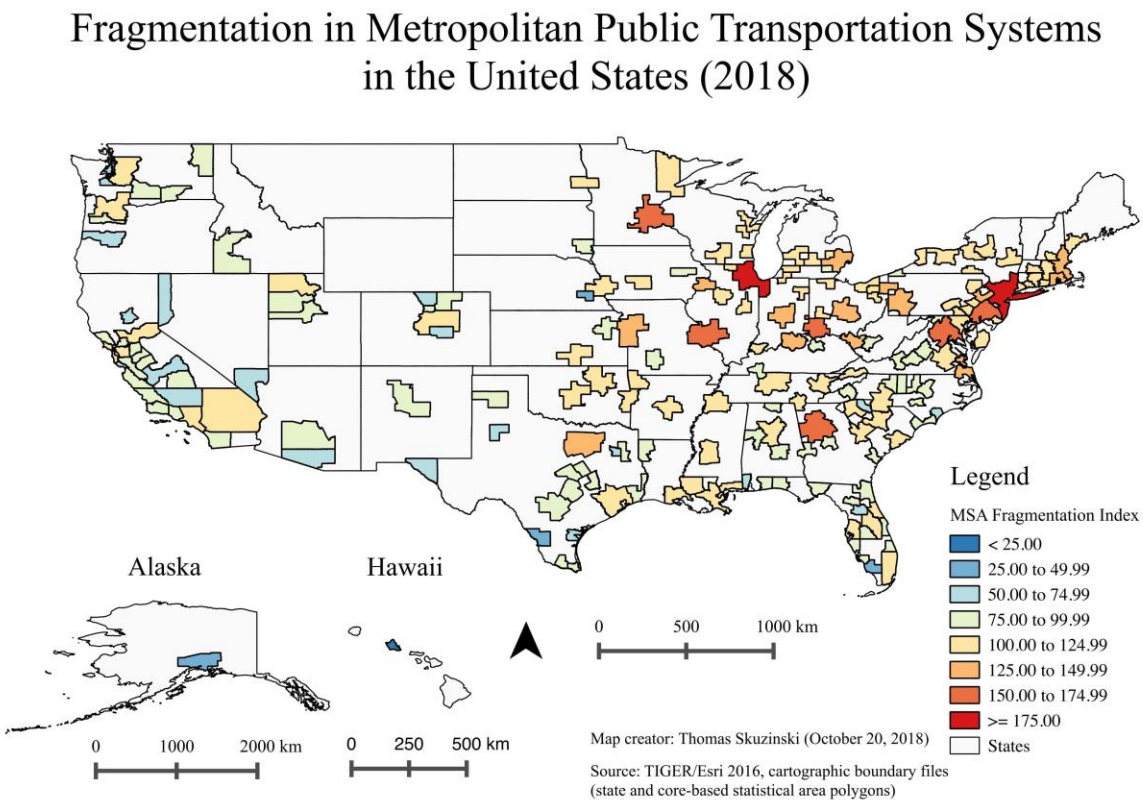

FIGURE 6

We can see in the map of the fragmentation index that visual clustering of higher than average fragmentation scores occurs in those metropolitan statistical areas in the northeast, midwest, and southeast. This is consistent with the literature on variation in state systems of local government, and gives us some confidence in our fragmentation index. States in these parts of the country tend to have (or had) liberal incorporation laws, strong local autonomy through home rule and enabling statutes that make incorporation attraction, and limitations on annexation and consolidation that might allow for the erasure of boundaries over time. The paradigmatic small suburban jurisdiction is a creature of these laws, as is—by extension—the polycentric, sprawling conurbation with a landlocked core city. Because the fragmentation index is driven in large part by HHI concentration measures using population, employment, and area shares, we would expect older Rust Belt metropolitan regions—the metropolitan statistical areas for Chicago, New York, Pittsburgh, Cincinnati, St. Louis, Minneapolis, and their ilk—to rank especially high, and they indeed to. In the southeast, the driver of fragmentation is the abundance of counties and the existence of large areas of unincorporated land for which the county is the only general-purpose local government. Atlanta's 29 counties—plus a core city that had become bound in by growing suburbs over whom annexation could not be readily exercised—allow it to stand out in this part of the country.

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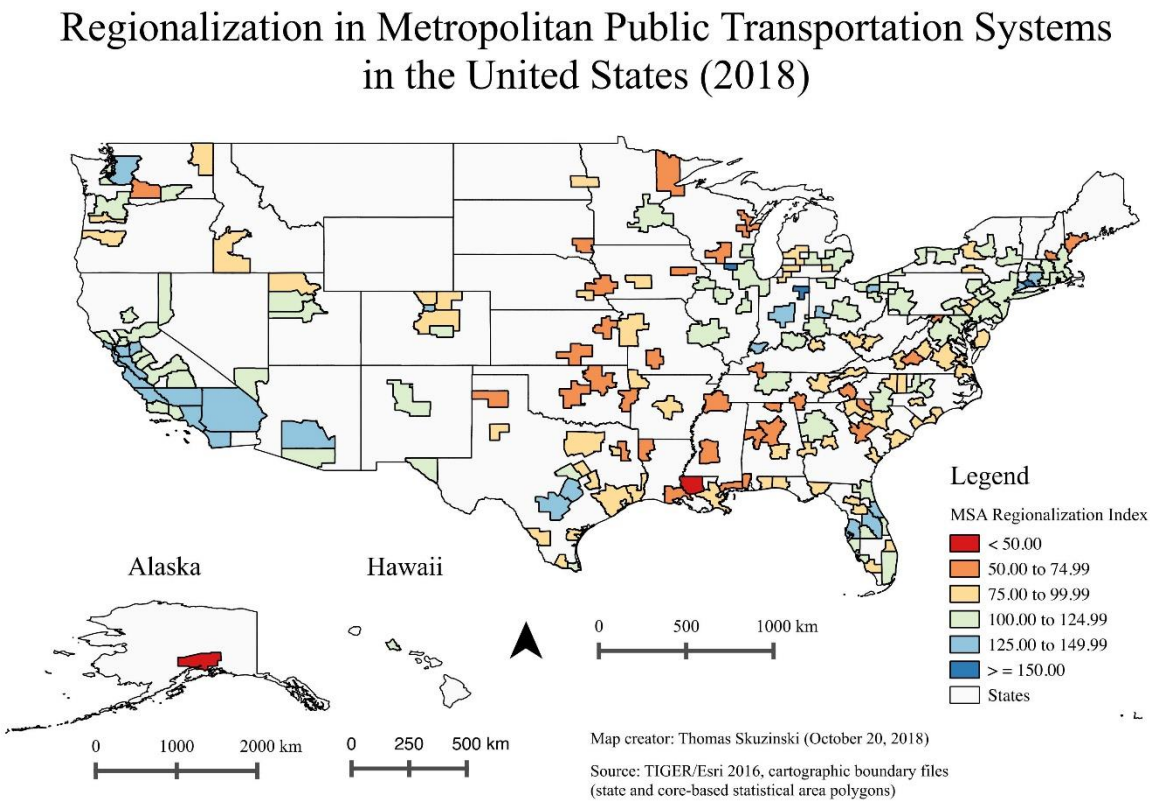

FIGURE 7

The regionalization index, to remind the reader, is based on several measures of vertical and horizontal regionalization. It should capture, roughly, the degree to which institutions exist that should promote operational decisions that are at a regional rather than local scale. The presence of agreements among transit agencies, the representation of a local government on a multijurisdictional body, the involvement of the state government, and other characteristics would, when analyzed together across an entire metropolitan region, allow us to discern which metropolitan statistical areas' public transportation systems are governed in the most regionalized way. Not surprisingly for scholars who acknowledge the possibility of a metropolitan political economy in which governance can rescale to match policy problems (as detailed earlier in section III), many of those metropolitan statistical areas that are the most fragmented are also among those that perform above average on this index. But this is not universally true, and it is not the case that a strong correlation exists between fragmentation and regionalization. Many of the west coast regions, for example, are at best mildly fragmented, but have institutions of governance in place that would suggest even this weak fragmentation has been overcome to a larger degree than in other regions. Several regions in the heartland are relatively highly fragmented, and lack boundary-spanning or boundary-mitigating institutional arrangements that would indicate they have a regionalized system.

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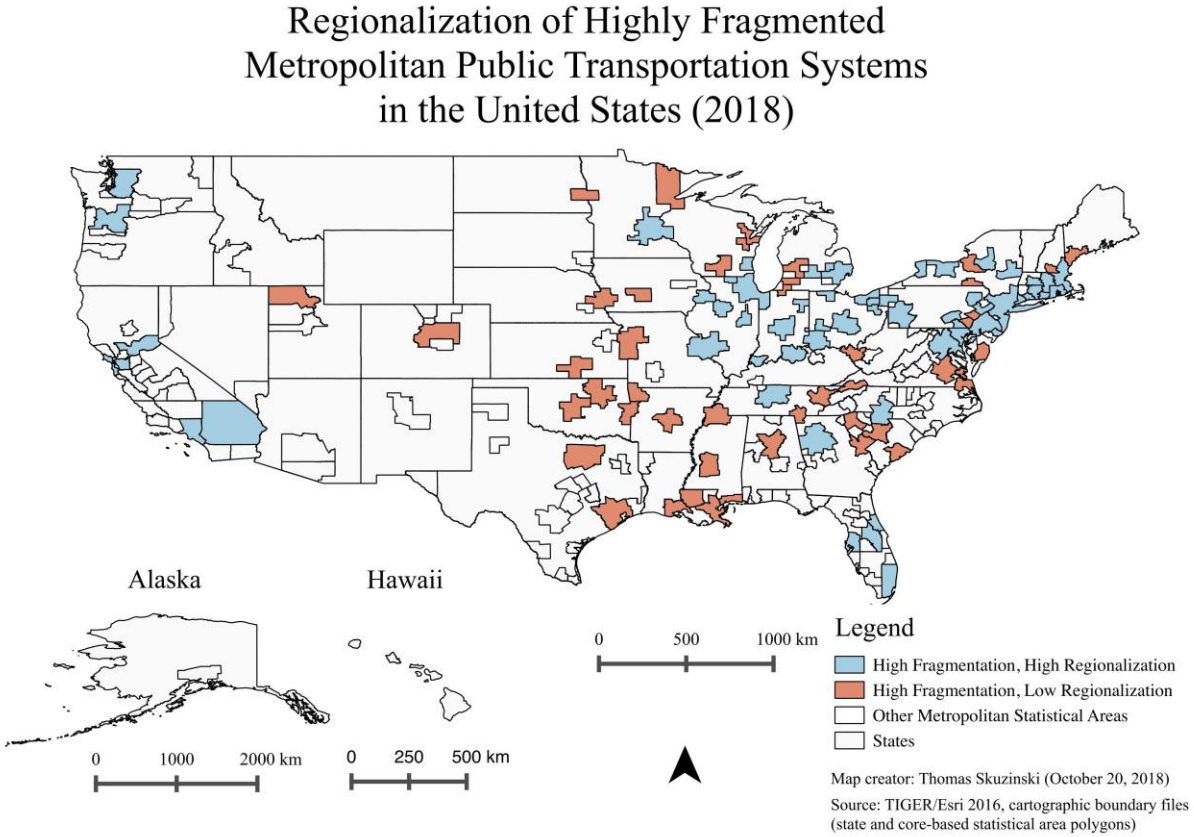

Figure 8

By isolating those metropolitan statistical areas that score above average on fragmentation, we can show more clearly those that are also above average on regionalization—a result that speaks to the capacity of some metropolitan public transportation systems for regional governance—and those that score below average on regionalization in which the institutional contexts largely reifies their fragmented structure. Here, the Rust Belt regions are highlighted for their ability to mostly overcome, at least in theory, their potential boundary problems. We do not offer an explanation for why this might be, as such investigation was outside the scope of our study, but we intend to explore these patterns more in future work.

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E. Strengths and Limitations of the Analysis

Below, we discuss four cases with high levels of fragmentation to show how the measurement translates into conditions on the ground, and to clarify our measures' strengths as well as limitations that will need to be overcome in future research.

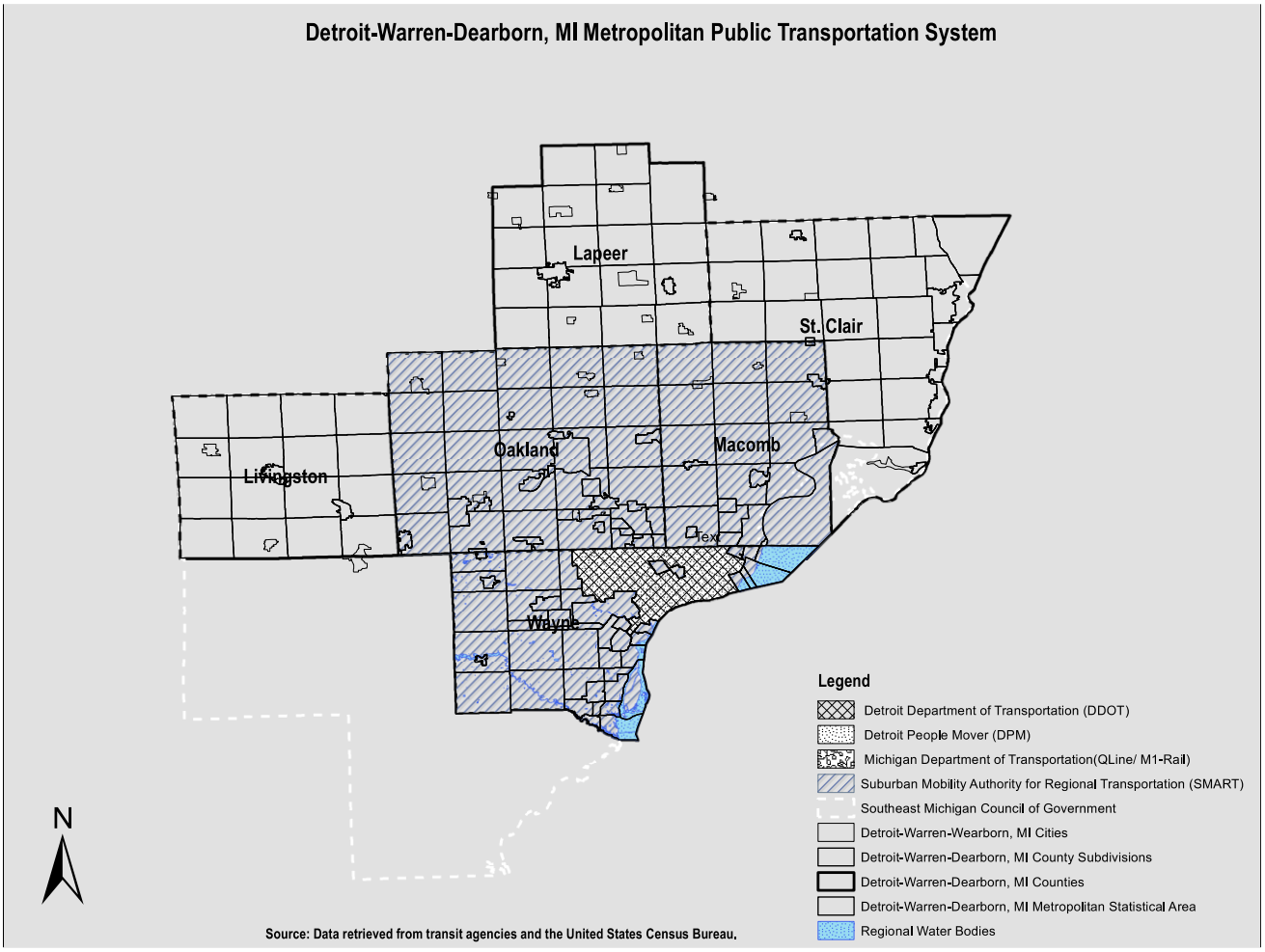

FIGURE 9.

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TABLE 13. Scores of Case Regions

MSA	Fragmentation (fragscore)	Regionalization (regscore)	Percent MSA Population Not Covered by Transit	Percent MSA Employment Not Covered by Transit
Detroit-Warren-Dearborn, MI Metro Area	127.57	104.82	27.6%	20.3%
Dallas-Fort Worth-Arlington, TX Metro Area	123.09	99.01	41.9%	30.3%
San Francisco-Oakland-Hayward, CA Metro Area	120.05	139.39	0.54%	0.19%
Los Angeles-Long Beach-Anaheim, CA Metro Area	113.24	147.81	0%	0%

We further discuss the regions that fell into Quadrant I and Quadrant II in Section V.C. Both these areas have high levels of fragmentation, with fragscores over 100, but fell into different quadrants due to their divergent regionalization scores (regscore): Detroit and Dallas both have regionalization scores between 99-104, while San Francisco and Los Angeles have scores between 139-147. Detroit and Dallas both have regionalization scores well below Los Angeles, San Francisco and many other MSAs in California, Florida and other states where transit governance occurs at the county level. This stands in contrast to Michigan and Texas, where cities can easily opt out of the service, leaving many holes in the system (discussed more in V.C), thus leading to the high portions of the MSA population not served by transit in Detroit and Dallas . Indeed, both Detroit and Dallas have many islands without service, in addition to entire counties that are not served (Figures 9 & 10 show just how much of these areas are outside the service boundaries). Places like Arlington, Frisco, TX, Bloomfield Hills, MI, Rochester Hills, MI, or entire counties like Livingston County, MI. For the rider, this means pockets in the transit system where service either cannot go through (like Grand Prairie, TX), job centers service cannot reach (e.g. Frisco, TX), collectively, leaving jurisdictions containing over 30% of the region's jobs out of the region's transit districts (Table 13).

While these two regions both suffer from state laws allowing local jurisdictions to exit, they still come out differently in their regionalization scores due to other institutions. Detroit has a higher regionalization score than Dallas because they have significantly more connections between agencies and governments. Detroit has a transit agency nested in a city (Detroit Department of Transportation is a department of the Detroit city government). Detroit also has scores higher on interagency agreements than Dallas. Formal conjunctions go both directions, with each region ahead in different categories; however Detroit has a high score for formal conjunctions between

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the transit agency and a county government. Both regions have low numbers for state governance, though again, Detroit is higher, due in part to the higher percentage of the population living in jurisdictions with transit service that is governed. Both regions also have moderately high numbers for multijurisdictional funding, likely since they both have multijurisdictional transit agencies, though the same jurisdictions opting out of the transit agencies are not participating in multijurisdictional funding methods. Much of the population lives in transit that is not multijurisdictional—e.g. DDOT is a single jurisdiction agency funded by the City budget, and the City of Detroit was left out of the SMART taxing district, which serves downtown Detroit, but does not make intermediate stops within it, due to its membership status. The arrangement also creates two separate transit services in the same region—one for Detroit, one for the suburbs, requiring commuters to transfer between the two, since only 24% of the MSA's jobs lie in the DDOT service area.

Dallas-Fort Worth showed nesting in Fort Worth and Denton, but not in Dallas. It exhibits strong regionalization in Dallas Area Rapid Transit (DART) and Fort Worth Transportation Authority (FWTA), with interagency agreements for operating the Trinity Rail Express commuter train jointly by DART and FWTA, and formal conjunctions between cities and counties with transit agencies. The area had strong formal conjunctions between cities and counties with the MPO, as would be expected. However as in Michigan, there was no state governance of transit, and while there were multijurisdictional transit funding sources (DART's 1 cent sales tax, and ½ cent sales taxes in Tarrant and Denton Counties, funding FWTA and DCTA, respectively. In Dallas-Fort Worth-Arlington MSA, the regionalization score ultimately comes out similar to that in Detroit. In Dallas-Fort Worth, large portions of the area are not in the system at all. The areas that are served have succeeded in establishing multi-city transit governance and funding structures, but cities don't have to join them, and they do not cross very far outside of their core county, requiring interagency agreements to provide connections. Even in the case of DCTA, their commuter train only goes to the county line, requiring passengers to transfer to DART trains to go the rest of the way to Dallas.

People in the region often refer to it as the "DFW Metroplex," but the transit institutions have not advanced since the days when it was known as separate regions for Dallas or Fort Worth, and the institutional connections between them are tenuous, even as the jobs have spread around the region. This is a slightly different problem from what is seen in Michigan—where the distances between transit agencies are less, but the effect on the rider is the same—jobs across agency boundaries, that are difficult to access due to weak institutional connections.

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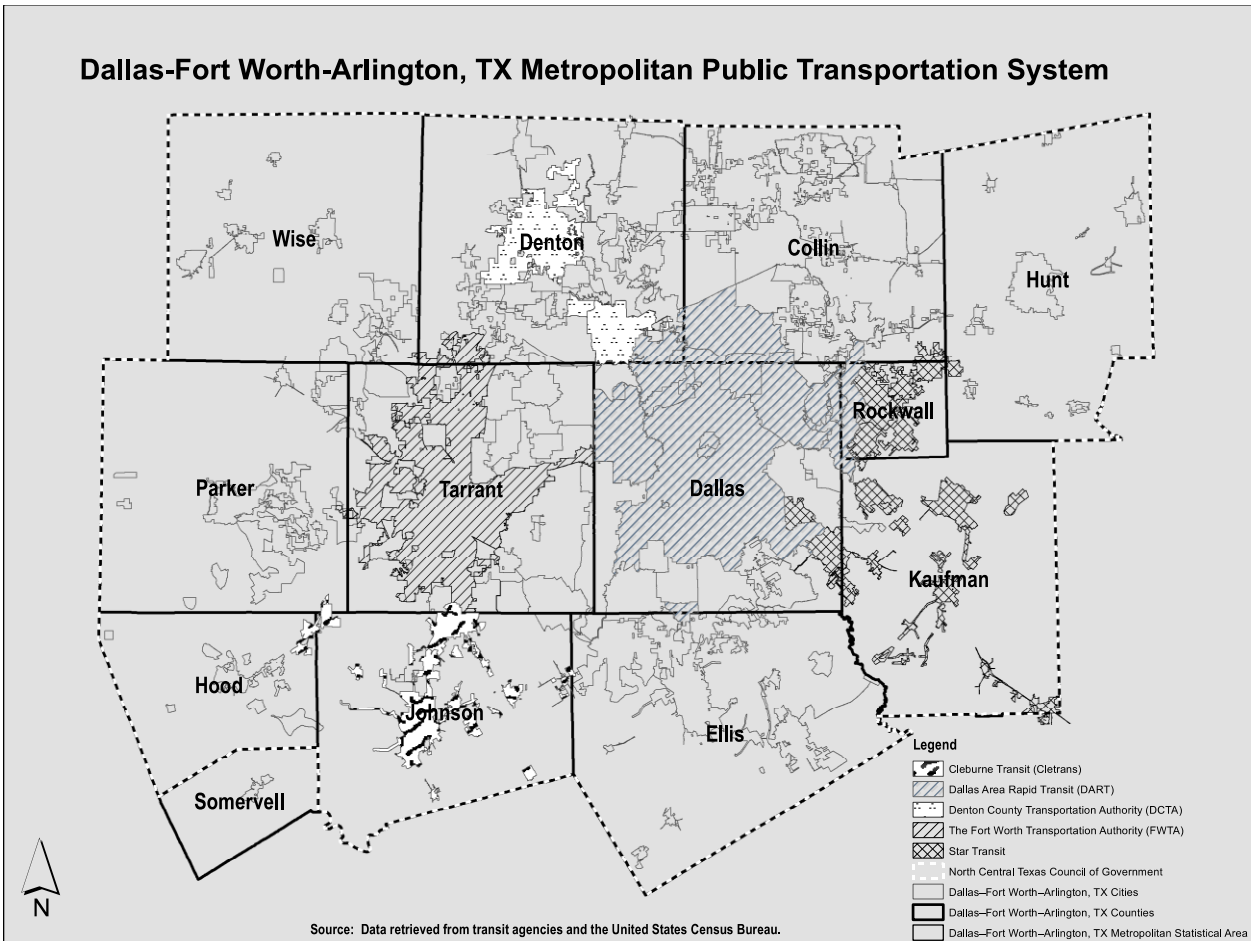

FIGURE 10.

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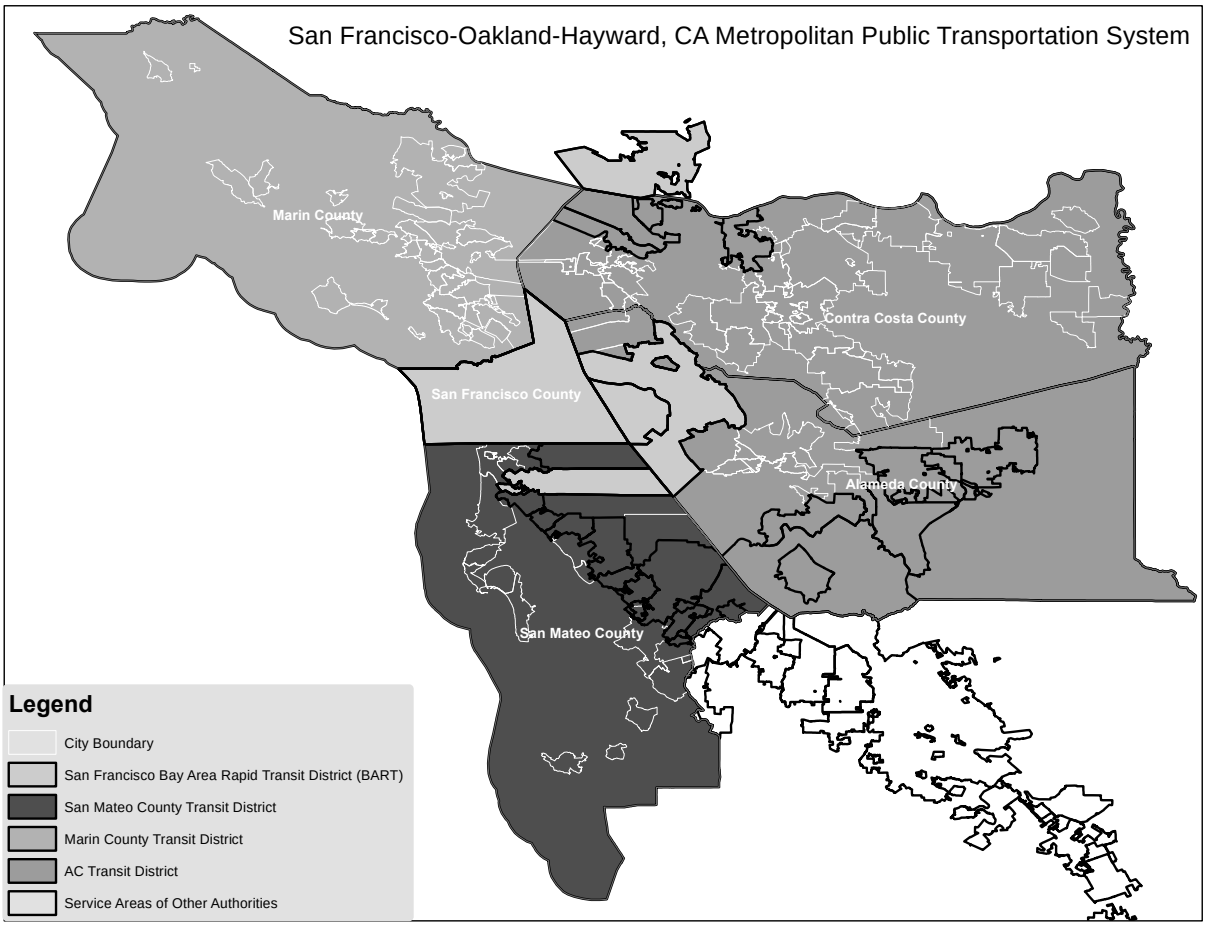

FIGURE 11.

San Francisco/Oakland and Los Angeles/Orange County, both being in California, are in a similar legal environment, and are thus interesting to compare. Fragmentation in the Bay Area is less than the other three regions, but fragmentation in San Francisco is comparable. Nevertheless, regionalization is ten points higher for Los Angeles than it is for San Francisco, making it the MSA on the medium-high fragmentation list with the highest regionalization score. This highlights the limitations of our analysis. Los Angeles is less fragmented than the San Francisco Bay Area (see V.C above), with 76% of the Los Angeles-Anaheim population concentrated in Los Angeles County—the most populous county in the nation, while in the Bay Area, Alameda County had the highest population share at only 34%.The Los Angeles Area also had higher scores for most formal conjunction categories, including FCTAMPO_sum. Our measures also capture fragmentation in the transportation system, with both regions coming in exceptionally high, at 21 transit agencies.

Some elements of regionalization are difficult to measure when examining formal institutions, and will require further research into regional norms of transit governance. This is illustrated well by additional differences between Los Angeles and San Francisco. For example, the regionalization score does not reflect the *strength* of the MPO, thus leaving aside the MPO's ability to act, though we know from prior research that the Bay Area's MPO is more than the MPO in Southern California, due to its access to toll

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bridge revenue through the Bay Area Toll Authority (Sciara & Wachs, 2007; Weinreich, 2016; Bollens, 1997). Instead, our regionalization score shows that a formal conjunction exists between cities or counties and the MPO. Both regions have extensive state and multijurisdictional funding, covering all jurisdictions in each of the two regions, which local municipalities cannot opt out of. This exceptional coverage is due to the fact that at least one county-level transit agency exists in every county in the region, though sometimes city agencies exist too, and sometimes county agencies do not coordinate well across county lines. The current measure needs to be further refined to capture these subtleties, which are reflected now in their level of formal conjunctions and interagency. Additional coordination is reflected in the relationship between transit agencies and general purpose local governments, which can be useful for coordinating transit and land use decisions, among others. However our measurements do not directly show how well these factors break down transit barriers, since norms would also be responsible for improving the coordination and operation of the system on factors like scheduling, fare payment and others (Rivasplata et al, 2012; Miller et al., 2005).

For example, Los Angeles County Metro and Orange County Transportation Authority have only minimal crossover of services from one county to the next. However both are (separately) coded as multijurisdictional. Nevertheless, each county covers a very large portion of the region, and the entire MSA is covered by these two agencies. On top of this, there is a regional commuter train connecting the two counties, but these measures are unable to show that the train only covers certain portions of each county, not providing the same level of coverage as the Bay Area's multicounty BART system. On the other hand, our measures are able to capture formal concrete relationships—for example, the joint powers authority established to manage Caltrain across San Francisco, San Mateo and Santa Clara Counties; or the multicounty taxing districts established to fund SMART, AC Transit, and BART in the Bay Area; or the three Regional Measures that voters have approved in the Bay Area to provide toll funds for regional transit; or the county local option sales taxes.that have passed in all the counties in these two MSAs, supporting cross-jurisdictional transit throughout their respective counties, but discouraging transit from one county to the next.

Since the measures are intended to reflect the institutions, not the services. what they show is *the presence of multiple agencies that have the formal structure to support cross-jurisdictional services if so chose.* By combining the fragmentation score with the regionalization score, it is possible to see the end effect of the many formal ties across jurisdictions. In California, there are extensive formal ties, facilitating cross-jurisdictional service, particularly across cities and unincorporated areas. However this system is not very successful at crossing county lines, particularly in Los Angeles-Anaheim, where the formal institutions supporting Metrolink (their cross-county service) are supported by an interagency agreement, but voluntary funding from each county's transit authority. Compare this to the Bay Area, where BART has its own property tax crossing three counties, providing a more stable long term funding source for operating the system, while Metrolink has to operate based on voluntary contributions from its member transit agencies. . This makes for more infrequent service and service that is uneven, with stronger frequencies in counties that are willing to pay for it, though of course the intracacies of these relationships require further study and interviews, the data collected here would provide a basic picture of the cross-agency relationship, that can be compared across a large number of metro regions.

In California, policy solutions seem eminently possible, due to the state's role in establishing the current system and creating the laws that govern it. Even though the various services cover the entirety of both MSAs, they still have a great deal of fragmentation from one county to another, and between city and county transit agencies, even though both are getting their funds from the same county sales taxes, or from the California's Transportation Development Act and its Local Transportation Fund (LTF). Our

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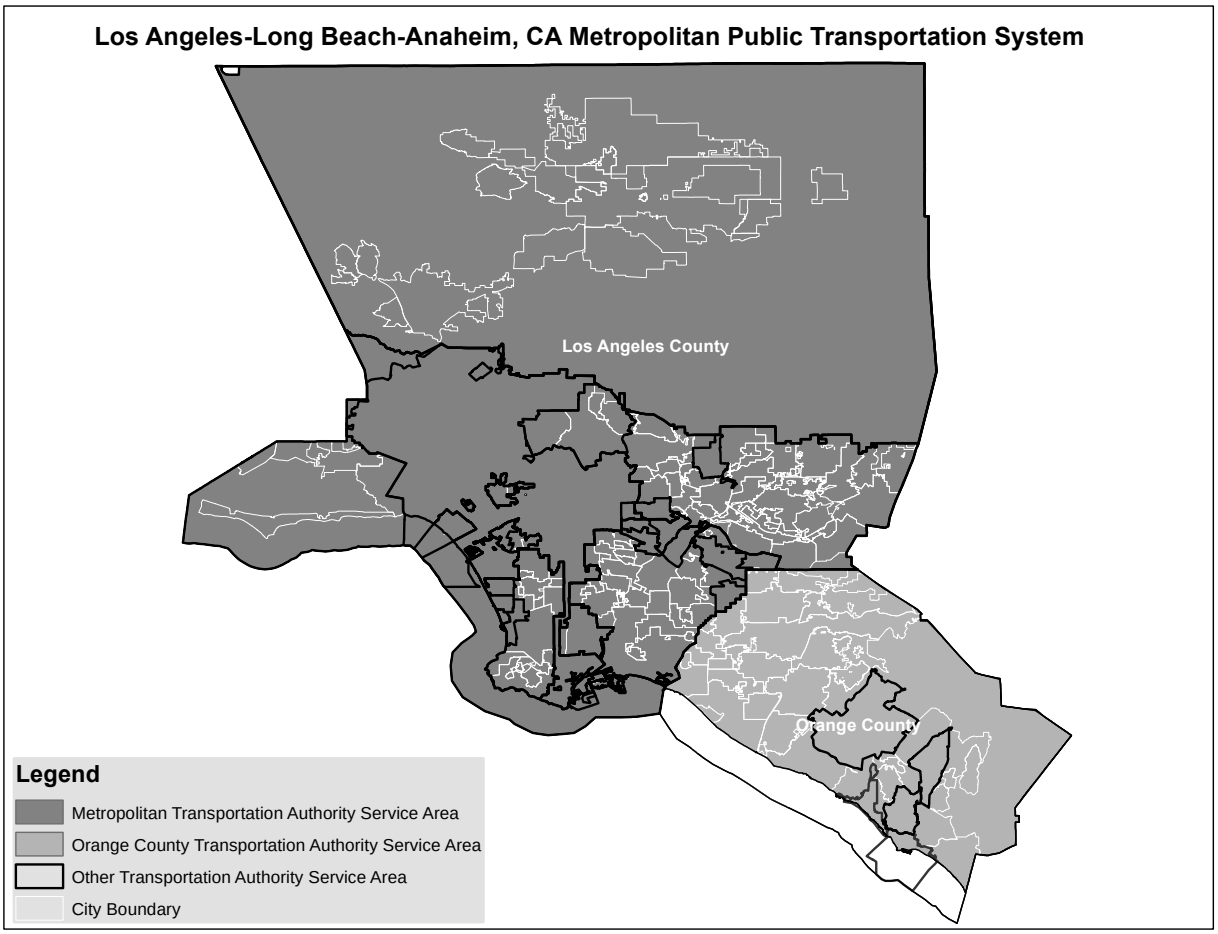
measure shows that This gives the state government a great deal of leverage through which they could require better cross-county coordination in order to get state funds, or to use state statutes that authorize county sales taxes. These are the kinds of changes that could be made based on the birds-eye view of finance and governance systems provided by these measures.



• FIGURE 12.

VI. CONCLUSIONS

The examples described above show the conceptual logic and operationalization of the fragmentation and regionalization measures for a single metropolitan statistical area, and across metropolitan areas.

By comparing MSA calculations to each other for both fragmentation and regionalization, these measures will allow policy makers in each region and state to compare their transit institutions to those in other regions.

Through a careful analysis of the institutionalist data, state governments, transit agencies, MPOs, and municipal policy makers will be able to pinpoint the places where they could improve. For example, in the two California MSAs we looked at, one could conclude that the state is advancing a significant share of the local transit funding, while state laws authorize the

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collection of many county-level sales taxes. Yet the state is doing very little to require transit agencies to coordinate with other state-funded or state-authorized transit agencies. In the Detroit and Dallas MSAs, the state plays a much smaller role than in California, do to its more limited financial support. However the state has helped create many of their problems through legislation leaving Detroit out of SMART, and allowing cities to opt out of the system entirely. These problems can be overcome by changing the rules or creating a new agency (as they have attempted to do with a new Regional Transit Authority), which would facilitate the implementation of services that can overcome jurisdictional barriers.

Studies that have taken an institutionalist perspective to transportation remain rare, and give a limited understanding of the ways state and local institutions shape transportation systems and policies, with most of them being limited in size and scope, and focusing on engineering, service management issues, or technological methods for overcoming barriers. To our knowledge, there has not been a comprehensive national study examining the institutions that lie beneath the necessary technological or management solutions, though we certainly identified localized case studies. This gap in the literature has encouraged transportation policies that focus on important engineering and technology challenges, but provides a weak understanding of the institutional challenges that skew infrastructure decisions, often making public transit costly and inefficient, while allowing many transit dependent riders who live in jurisdictional holes to simply slip through the cracks of the regional transportation network. As the current presidential administration encourages local governments to provide a higher share of transportation funding (The White House, 2018), the measures can help identify holes in the system, and jurisdictions that could be better served by the cross-jurisdictional governance and financing strategies identified in the fragmentation and regionalization measures.

The measures we calculate overcome past inadequacies in the literature by working with a large cross section of metropolitan areas. There is already research suggesting the potential for local financing mechanisms to limit integrated regional transportation planning, but it does not say to what extent local taxes, regulations, and other local powers might affect transit system integration, and other outcomes associated with it. This study makes further research into questions of this sort by collecting the data needed to correlate transit service quality and other factors like economic development with the institutions that support transit service.

This study does this by using a more nuanced measure of government fragmentation than in the past, one that does not conflate polycentrism with localism. Past research has often assumed that more government fragmentation is less functional, and this may be true in many cases, but there are also a number of reasons why local governments might decide to remain in a regional transportation system, and collaborate with their neighbors, making jurisdictional fragmentation an inadequate proxy for functionality and service quality. Our more nuanced approach views the number of local governments in a region as problematic *only to the extent those units use their autonomy to opt out of participation in regional initiatives*. Additionally, regionalization is helpful only if it helps overcome jurisdictional service gaps. We also depart from past studies by declining to measure autonomy through a single dimension, such as the presence or absence of home rule, because we recognize the local complexity and heterogeneity across states that belies this conception; furthermore, we recognize that only some elements of home rule may be relevant in the transportation policy arena, since many transit policies are made by independent special districts, making blanket concepts such as this wholly inappropriate for a specialized

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policy domain such as transportation. This study makes a first attempt to develop a methodology for analyzing transportation governance fragmentation.
Our approach has built on existing institutionalist literature to develop a nuanced approach that is targeted at the governance elements that are particularly important in shaping public transportation service.

Our work will lay the groundwork for future research that can test the relationship between transportation governance and finance methods and the quality of service provided—for example the level of connectivity, coverage and accessibility provided by transit service may be impacted by the level of fragmentation identified in the transportation governance measures. The measures outlined here provide initial results comparing governance characteristics across metro regions, offering transportation agencies, MPOs, COGs, state governments and others access to information that can identify regions where governance fragmentation is most acute, though surely there is far more analysis to do. With this work, the fragmentation and regionalization measures will be able to provide academics and policy makers with a tool to identify places for improvement of the institutions that support the transportation network, potentially providing avenues for system performance, increase economic growth, and equity of transportation service to the riders for whom system gaps make employment and education an impossibility.

VII. NEXT STEPS

This study will provide the foundation for additional work comparing relating fragmentation and regionalization to transit service provided. Additional work can be done that will do the same thing for variables representing capital construction funding and governance, or looking at roads rather than transit. The fragmentation and regionalization measures could further be refined by distinguishing the role played by municipalities and counties. Furthermore, more work needs to be done that will identify the role of norms in overcoming jurisdictional fragmentation. Ultimately, the authors recommend the establishment of more consistent, centralized and reliable data sources, which would expedite this process, and allow the same data to be collected over the long term. This would involve the creation of an annual survey for federally-funded transit agencies to fill out, which would identify their ability to overcome fragmentation. This could be collected over the course of years and decades, allowing researchers to analyze the impact of specific programs on regionalization in a similar manner to the way National Transit Database information is now collected.

Furthermore, as we noted, these measures are not designed to directly explicate the development of transit infrastructure—only the governance and finance of its development and operation, though certainly the formal institutions we measure are likely to have a serious impact on transit service integration across jurisdictions and agencies. The data we have collected will make possible further research into the connection between institutions, service and impact on riders. Examples might include research into the connection between transit fragmentation, regionalization and the presence of service gaps. We imagine future research identifying possible correlations between governance, service gaps and equity challenges for transit dependents, including low income riders, persons with disabilities and other medical situations that make it impossible or difficult to drive. Similar research could be done on paratransit or publicly-funded app-based, on-demand services, which present a new technology for overcoming

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institutional barriers—but only if we make the effort to ensure the institutions are established in ways that facilitate this goal.

Our measures could be significantly strengthened by including further exploration of the role played by norms in overcoming fragmentation, since this would help explain the connection between governance/finance and implementation of services (or lack thereof). Exploration of norms could include interviews and analysis of a specific case or a series of MSAs in a single state, which would focus on the relationships between transit agencies, cities, counties and MPOs, that allow them to overcome jurisdictional barriers. Our study suggests further exploration of the topic in California, which has a great deal of fragmentation, and high regionalization, but in many cases, still does not manage to provide service that crosses county lines. Additionally, it appears that California continues to create new transit agencies for new services, rather than expand old ones—which would result in better geographical and vertical connections as well as greater management experience. (Prominent new agencies created just since 2000 include WETA, SMART, and the California High Speed Rail Authority). Further exploration could reveal the incentives to keep creating new transit agencies to solve new problems, rather than entrust such problems to existing providers. Interviews could also identify ways that agencies work together to coordinate services or fill service gaps; or conversely, interviews could reveal why agencies simply choose to ignore one another.

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