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# Back to the Future: Re-Incorporation of ‘Metropolitan Character’ in U.S. Core-Based Statistical Area Delineations

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## Abstract

The U.S. Office of Management and Budget (OMB) has maintained the urban core population cutoff of a central county of a Metropolitan Statistical Area from 1950 through 2010 at 50,000 despite the U.S. population more than doubling over that time. This article uses a simple application of demand threshold techniques to measure evolution in the distribution of business establishments between 1980 and 2016 across core-based statistical areas. Extrapolating to 1950 and 2020, these techniques suggest a new population cutoff of 100,000, which is exactly consistent with a 2021 proposed rule change by the OMB. Given changing functional relationships between urban cores and rural peripheries, OMB’s simple cutoff delineations may need to be re-evaluated; but in the absence of such a change –and with the goal of maintaining the original goal of these metropolitan cutoffs –this simple application of demand thresholds indicates OMB’s proposal is sensible.

## 1 Introduction

Each decade, the U.S. Office of Management and Budget (OMB) adopts updated standards for delineating core-based statistical areas (CBSAs). Since 2003, delineations for these core-based statistical areas have been absent a formal element of “metropolitan character” found in the previous decades (Office of Management and Budget, 1998, 2000). In 2020, with the upcoming Decennial Census to be released, OMB proposed new guidelines that would increase the threshold urbanized area population from 50,000 to 100,000 from which the central county of a Metropolitan Statistical Area (MSA) would be defined (Office of Management and Budget, 2021). Given the increasing number of federal programs that use metropolitan status to either include or exclude eligibility in funding, the proposal will likely spark controversy. This controversy is enhanced when much of the policy and practitioner community treat the nonmetropolitan U.S. as the de facto definition for rural America and that population would change overnight.

At the same time, the character of metropolitan areas has evolved since 1950. Scholars such as Goetz et al. (2018) argue that agglomeration thresholds for economic activity have increased and delineation of these areas should take these scale effects into account. This article argues that Central Place Theory (CPT) and associated demand threshold techniques, which have a long history in regional science, represent a potentially useful proxy for measuring metropolitan character, metropolitan areas, and rurality. A demand threshold is defined as the minimum market size required to support a particular type of business and still yield a rate of return such that the business owner will continue to operate (Berry and Garrison, 1958a,b; Carpenter et al., 2021c; Parr and Denike, 2016). As we review in the next section, demand threshold techniques capture factors important to defining a functional relationship in core-based statistical areas (e.g., population, population density, the local economy, regional metro and micro adjacency, and commuting patterns). Thus, this article uses the evolution of demand threshold measurements (business establishment count and distributions), to

capture and weigh these factors, and then compare results to the suggested updated population definitions that would maintain the original goals of the OMB with its core-based statistical areas.

Pursuant to the objective of testing the stability of the OMB definitions over time using demand threshold techniques, this article proceeds as follows. In the next section, we provide a history of metropolitan delineations dating back to their pre-World War II origins. Then, we review CPT, which underpins demand threshold techniques, emphasizing the aspects most useful for understanding and defining regions and delineating the evolution of demand threshold techniques. This delineation helps justify how simply measuring demand thresholds in counties captures many aspects important to defining urban and rural places. Next, in the results section, the article describes the evolution of the distributions of business establishments between 1980 and 2016 across metropolitan, micropolitan, and non-core counties.<sup>1</sup> We then conclude by extrapolating the results to 2020 and suggesting new population cutoff definitions of 100,000 and 25,000, depending on the goals of the core-based statistical area delineations, and also noting the related implications for federal appropriations.<sup>2</sup> Finally, we suggest future research related to the potentially broader shortcomings of the current CBSA delineation rules.

## 2 Back to the Past: Historical Definitions of Metropolitan Statistical Areas

The debate about the threshold for a MSA did not start in 2020 with the draft rules for core based statistical areas from the OMB. The concept of metropolitan in the 20th century goes all the way back to 1910 and the early concept of Metropolitan Districts. The original Metropolitan District definition required an initial threshold population of 200,000 (Office of Management and Budget, 1998). The metropolitan rules in 1950 (and kept similar through the 1990s) maintained the concept of the Metropolitan District with a core city population of 50,000 as well as an outlying periphery that met rules of commuting and “metropolitan character.” In the 1950s, metropolitan character definitions included population density and percent of nonagricultural worker thresholds evaluated at the county level. By the 1980s and 1990s, the nonagricultural population thresholds were dropped from metropolitan character and replaced with a percent of the outlying area that was urban (Office of Management and Budget, 1990). By 2000, final rules for delineation of MSAs were streamlined and the “metropolitan character” dimension of the rules were dropped in the outlying counties (U.S. Census Bureau, 2018).

While there are some small variations in these rules for a MSA, they were simplified to a threshold population for a central urbanized area and a threshold commuting percentage of outlying county employed residents into the central county (Office of Management and Budget, 2000). An urbanized area was based on a combination of contiguous 1,000 persons per square mile and 500 persons per square mile Census tracts that summed up to at least 50,000 with the periphery meeting a minimum 25% commuting threshold into the central county.<sup>3</sup> Since the functional commuting relationship occurs irrespective of state boundaries, a single MSA may incorporate geographically multiple states. This is one of the reasons why MSAs in geography are referred to as functional regions as opposed to states as administrative regions (Johnson, 1993).

The major challenges to these existing thresholds have come from several constituencies. The first were smaller urbanized places that exhibited similar core periphery patterns to those slightly larger urbanized areas that were included in the metropolitan definitions. Micropolitan Statistical Areas were created to address this challenge (Office of Management and Budget, 2000). Second, Isserman (2005) showed where successful nonmetropolitan areas witnessed measurable population growth, they would change in classification to metropolitan. Nonmetropolitan success then gets counted as metropolitan success and only the counties remaining with slow/stagnant population growth remain in nonmetropolitan status.

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<sup>1</sup>This article follows the U.S. Census Bureau convention of using the term “establishment” to refer to a physical location or “address” where economic activity takes place, and the term “firm” to refer to a collection of one or more establishments under a common ownership structure.

<sup>2</sup>The levels of population required for counties to be considered micropolitan or metropolitan are frequently referred to as population “thresholds,” but this article uses the term “cutoffs” to avoid confusion with demand “thresholds.”

<sup>3</sup>While modification of the aggregation rule of outlying counties to the central county by using commuting thresholds may have made the selection process easier, it can also lead to the Modifiable Areal Unit Problem. See Openshaw (1984) for a discussion of the problem.

## 2.1 Bringing Back Metropolitan Character

As stated by the Federal Register Notice highlighting the work by the MASRP, in 1949, cities were an easily understood built environment that “were densely settled centers of population activity set against a backdrop of sparsely settled territory” (Office of Management and Budget, 1998, p. 70534). Consequently, “metropolitan character” has been maintained from the 1950 delineations through the 2010 delineations for the urban core with only the population size (and later commuting patterns).<sup>4</sup> However, questions remain related to if the metropolitan character of the urban core should be reevaluated and if there should be other elements than simply a large collection of densely populated Census tracts.

Goetz et al. (2018) suggest due to increases in agglomeration thresholds over time, the 50,000-threshold defined in 1950 may no longer measure the same “urban” that it once did. Many economic functions that once were available in smaller areas are now only available in larger cities. They point to alternative strategies such as the link community method (Han and Goetz, 2019). At the same time, they call for additional research on updated concepts of urbanization and economic integration to address the delineations of these areas.

This research takes up the call by bringing a classic method, demand threshold analysis, to assist in creating a consistency in definition of metropolitan character of the central urban core of core-based statistical areas. Through its application, the intent is to create a sustainable approach that can evolve to the economic activity in an urban core over time so that metropolitan character is held constant.

## 3 Central Place Theory and Demand Thresholds

A demand threshold is defined as the minimum market size required to support a particular type of retail or service business and still yield a rate of return such that the business owner will continue to operate (Berry and Garrison, 1958a,b; Parr and Denike, 2016). In addition to academic insight, past research provides advice to chambers, local development authorities and firms on the probable feasibility of new establishments in an area (Foust and Pickett, 1974; Wensley and Stabler, 1998). Threshold analysis has a long and ongoing history of use in Regional Science, and traditionally focuses on retail trade analysis (Chakraborty, 2012; Deller and Ryan, 1996), which we maintain in this article. This section emphasizes that demand threshold techniques implicitly capture a number of factors important to defining a functional relationship in core-based statistical areas including population, population density, the local economy, regional metro and micro adjacency, and commuting patterns (Carpenter et al., 2021b; Van Sandt et al., 2021a). All of these factors (and others) affect the size of a demand threshold.

Demand threshold analysis is rooted in CPT, which predicts that the key determinants of a good’s range, i.e., the spatial radius of a market, are both the demand for the good and the cost of supplying that good (Christaller, 1966; Lösch, 1954). Spatial equilibrium is achieved when the dollar volume under the demand structure is just sufficient to cover operating costs and allow an acceptable rate of return. This work spawned long history of valuable research on demand thresholds (Chakraborty, 2012; Henderson and Wallace, 1992; Henderson et al., 2000; Shonkwiler and Harris, 1996). Though there are numerous other demand threshold analyses in regional science journals, this section attempts to focus the review of demand thresholds on articles that directly emphasize the usefulness of the concept towards measuring changes in rurality over time, as understanding demand thresholds in smaller rural and remote settings provides a greater context for evaluating core-based statistical definitions at the boundary between the core and periphery.

Mushinski and Weiler (2002) explore the importance of allowing for spatial interdependencies between central places and their surrounding rural areas when estimating demand thresholds for retail industries. While many lower-ordered retailing establishments may exist in both central places as well as adjacent rural areas, the prevalence of some higher-ordered retailing establishments in rural areas may decrease the need for them in the central place, or vice versa. Mushinski and Weiler (2002) find that retail industries display these supply-side interdependencies. In addition to these supply-side interdependencies, retail establishments also

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<sup>4</sup>Metropolitan character in historical OMB delineations was always explicitly defined for outlying counties of Metropolitan Statistical Areas. It was not mentioned in describing the core. The statement by MASRP was a recognition that a city of 50,000 in 1949 was a center of population activity so easily understood at the time to not have its metropolitan character questioned.

display demand-side interdependencies. Demand-side interdependencies arise from increases in an areas' population leading to more of these establishments locating in the central place. Partridge and Rickman (2008) relatedly examine how spatial agglomeration and leakages vary given the regional context of an area and the effect thereof on establishment counts. Mushinski and Weiler (2002) and Partridge and Rickman (2008) are germane to the current context because they emphasize how establishment counts depend on the nature of the good or service they provide and their sensitivity to the regional context of a particular place.

In recent decades, Krugman (1991, 2011) and New Economic Geography (NEG) received relatively more attention than CPT in academic literature, but the complementarity between the two makes CPT and demand threshold analysis ripe for a reemergence. Indeed, Mulligan et al. (2012) note that for several reasons, CPT is ripe for reemergence and that New Economic Geography (NEG) complements CPT, rather than contradicts it. Thus, the analysis herein uses concepts derived from NEG, like agglomeration economies into the service industries, to help justify the use of retail threshold analysis as a proxy for the character of cores of core-based statistical areas. Furthermore, past work expands to predict that a community can sustain given its existing socio-economic characteristics (Chakraborty, 2012; Wensley and Stabler, 1998). This article uses the number of establishments in a certain industry to help motivate our examination of the changing distribution of the number of business establishments in counties. Taken together, CPT and demand threshold research in regional science emphasize the applicability of demand threshold techniques in capturing a number of aspects relevant to measuring urban cores and rural places, including the local and regional demographic and socio-economic context.

## 4 The Evolution of Retail Establishment Distributions over Time

This section evaluates and describes the distribution of county-level retail sector establishments. The focus herein remains on retail due to the historical focus of demand thresholds on retail industries (Carpenter et al., 2021b; Chakraborty, 2012; Henderson and Wallace, 1992; Shonkwiler and Harris, 1996). Throughout this article, we use county-industry data from the U.S. Census Bureau's County Business Patterns with annual 1998-2016 counties imputed using WholeData (Bartik et al., 2018; Isserman and Westervelt, 2006) and with 1980 and 1990 imputed using public methods (Autor et al., 2013; United States Bureau of the Census, 1980, 1990). Carpenter et al. (2021d) show that WholeData, while imperfect, is generally preferable to alternative U.S. county-level industrial employment data. In general, we document a secular decline in retail establishments across county types.<sup>5</sup>

Table 1 documents the decline in the median and mean number of retail establishments in counties. The decline holds true for retail establishments in general, though there are retail sub-sectors, for which the decline appears less linear. However, interpretation of these subsectors before 2002 should be viewed with caution because data prior to 2002 uses Standard Industrial Classification (SIC) system crosswalked to North American Industrial Classification System (NAICS) classifications (Autor et al., 2013; Bartik et al., 2018); the subsectors in the two codes are overlapping and thus their crosswalk is necessarily imperfect, with crosswalking increasingly difficult with the older SIC classifications in 1980 and 1990. (See Table A1 for a list of both a NAICS and SIC Retail Sector list.)

In terms of movement within the 1950 population cutoff definitions, figure 1 graphs the decline in mean retail establishments for each category (greater than 50,000, 10,000-50,000 and less than 10,000).<sup>6</sup> Figure 1 indicates that the decline in mean establishment counts 1980-2016 generally held for this 1950 population category. Figure 2, which presents kernel densities of the distributions of county retail establishment counts, show how the distributions of retail establishment counts within each categorization have skewed left over time. If the goal of these categorizations is to consistently hold constant "metropolitan character", the 1950 population cutoff appears to increasingly fail over time. In the following section, we develop an approach for straightforward estimates of the necessary cutoff changes that would be needed to maintain the distribution

<sup>5</sup>County geographies change over time, with county infrequently splitting. Throughout the analysis in this article, we aggregate counties (and their data) to their largest historical geography to maintain a consistent geography using templates commonly used in county-level research (Johnson et al., 2005; Nucci and Long, 1995; Tolbert et al., 2009).

<sup>6</sup>Note that counties can move between 1950 county definitions/cutoffs. That is, for a particular point, "metro population" includes all; counties with more than 50,000 population in that year. Similarly, for "micro population" and "rural (non-core) population."

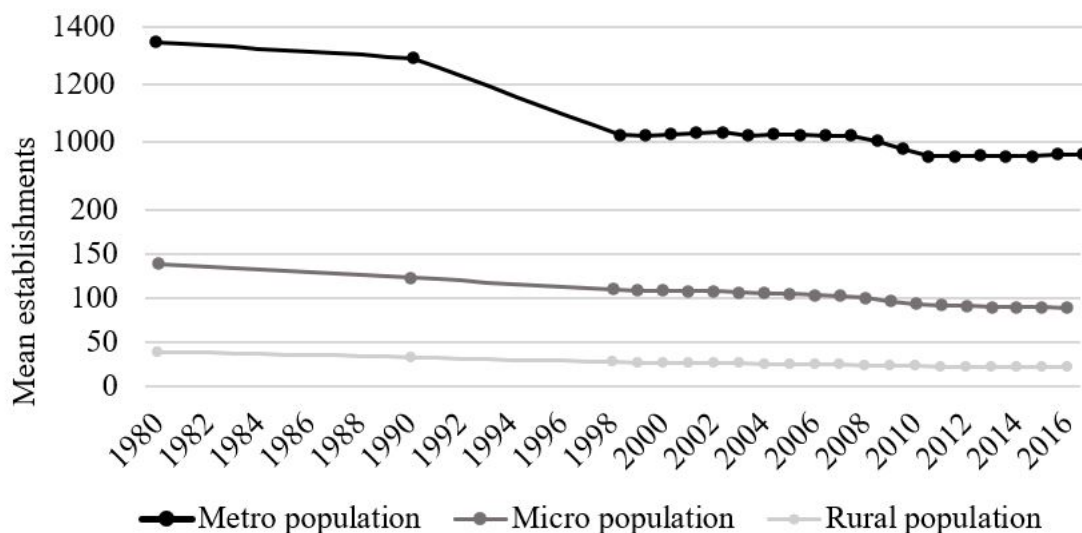
Table 1: Establishment Means and Medians by NAICS Retail Sector

NAICS	Mean			Median		
	1980	1998	2016	1980	1998	2016
44	424	355	341	128	109	91
441	47	39	38	16	15	13
442	28	21	16	7	5	3
443	73	14	13	13	3	2
444	63	30	24	20	12	10
445	73	47	49	22	14	10
446	16	26	31	6	6	6
447	38	40	36	14	18	16
448	39	48	46	10	8	5
451	16	22	15	5	4	2
452	12	12	17	6	5	7
453	13	42	35	2	11	8
454	16	14	22	8	4	4

Notes: Unit of observation is the county. Data is from U.S. Census Bureau County Business Patterns with 1998-2016 counties imputed using WholeData (Bartik et al., 2018) and 1980 and 1990 are imputed using public data and methods (Autor et al., 2013). Data prior to 2002 uses SIC classifications crosswalked to NAICS classifications (Autor et al., 2013; Bartik et al., 2018).

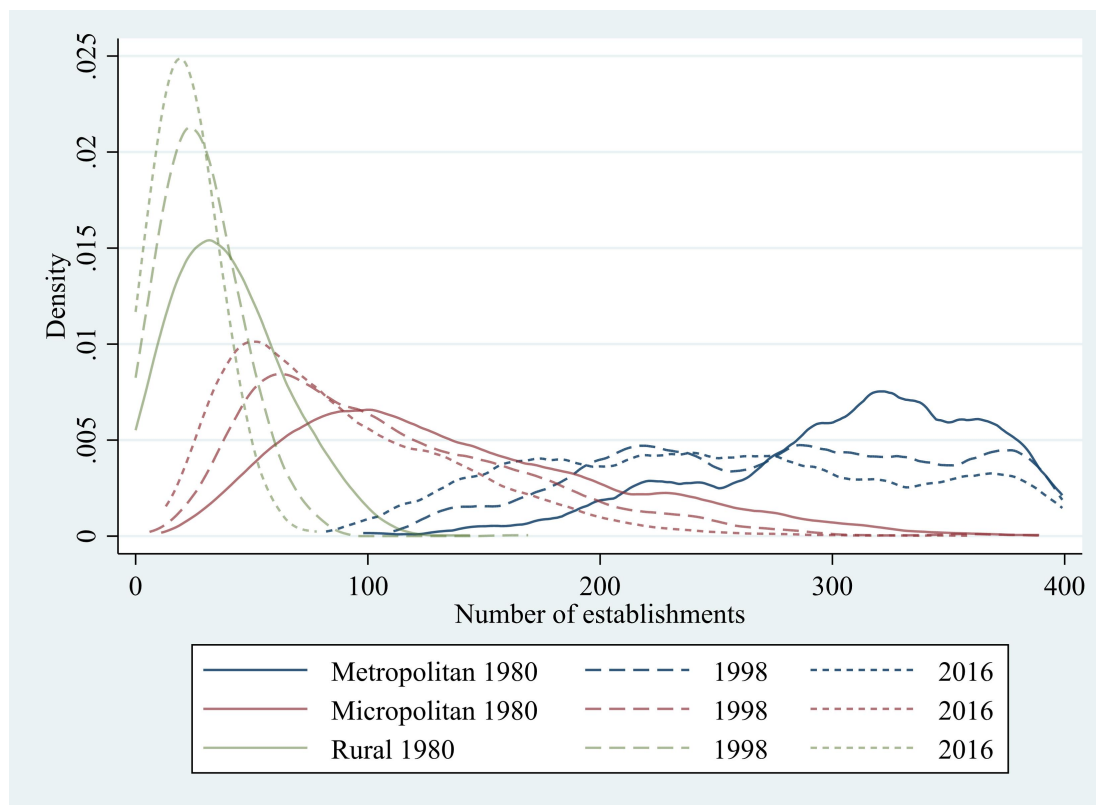
of establishments more closely over time.

Figure 1: Mean Retail Sector Establishment Trends by Population Group



Notes: Unit of observation is the county. Counties can move between 1950 county definitions/cutoffs. That is, for a particular point, “metro population” includes all counties with more than 50,000 population in that year. Similarly, all counties for “micro population” and “rural (non-core) population.” Data is from U.S. Census Bureau County Business Patterns with 1998-2016 counties imputed using WholeData (Bartik et al., 2018) and 1980 and 1990 are imputed using public data and methods (Autor et al., 2013). Data prior to 2002 uses SIC classifications crosswalked to NAICS classifications (Autor et al., 2013; Bartik et al., 2018).

Figure 2: 1980, 1998, and 2016 Retail Sector Distributions by 1950 Population Cutoffs



*Note:* These kernel densities show the distribution of retail establishments in each population category for 1980, 1998, and 2016, all while maintaining the 1950 (10,000 and 50,000) population cutoffs. Data is from U.S. Census Bureau County Business Patterns with 1998-2016 counties imputed using WholeData (Bartik et al., 2018) and 1980 and 1990 are imputed using public data and methods (Autor et al., 2013). Data prior to 2002 uses SIC classifications crosswalked to NAICS classifications (Autor et al., 2013; Bartik et al., 2018).

## 5 Application of Demand Threshold Methods

As emphasized in the review of CPT and demand thresholds, establishment counts might indeed provide a relevant proxy for defining the cores in core-based statistical areas because they depend on the nature of the good or service they provide and their sensitivity to the regional context of a particular place, which is why establishment counts are often used in demand threshold analyses (Mushinski and Weiler, 2002; Partridge et al., 2008). To leverage these counts for estimating changes since the 1950s, cutoffs necessary to maintain consistent establishment counts, we create 10% “bands” around the 10,000 and 50,000 cutoffs (i.e., 9,000-11,000 and 45,000-55,000 population, respectively).<sup>7</sup> We then inflate these bands sufficiently to maintain mean establishment count consistency. Figures 3 and 4 track the mean establishments in various retail sectors for counties within 10% bands of key population cutoffs in 1998-2016 for 3-digit NAICS.<sup>8</sup>

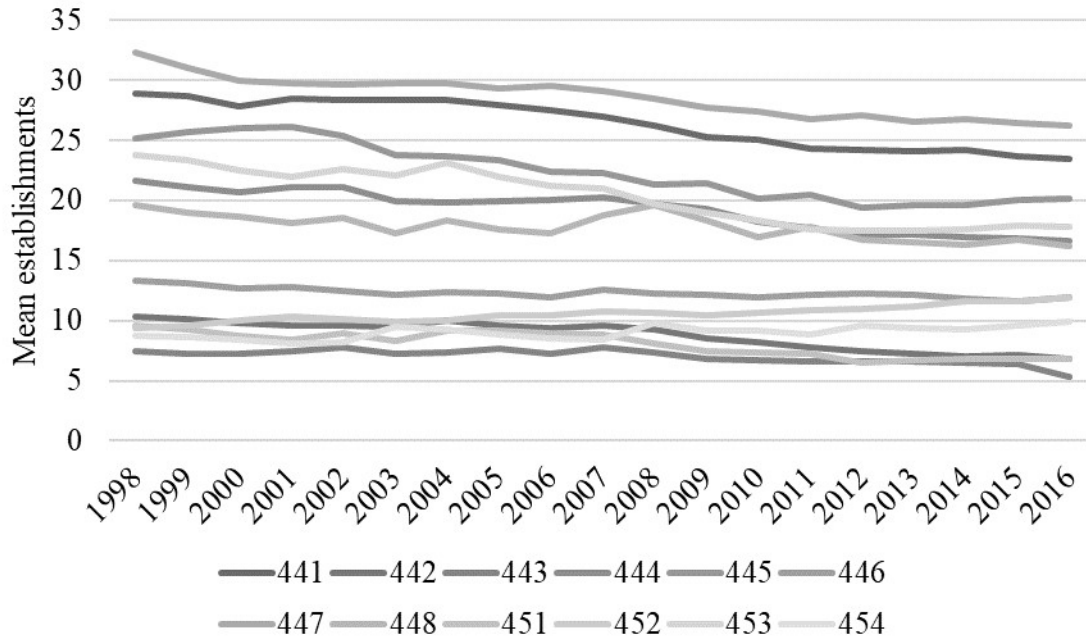
First, we identify the average population for the retail sector required in 2016 to support the same number of establishments that were there in 1998.<sup>9</sup> We then generalize this approach by averaging the 2016

<sup>7</sup>While the micropolitan population cutoff (10,000) was not originally delineated as a core-based statistical area until 2000, they were paired with the metropolitan cutoffs, which were created in 1950; hence, we treat the cutoff for a Micropolitan Statistical Area as though it were also created in 1950, for sake of consistency and interpretation.

<sup>8</sup>As noted above, when examining 3-digit NAICS prior to 2002 and especially for the older 1980 and 1990 data is of dubious quality due to the SIC/NAICS crosswalk. Table A1 in the appendix contains the definitions of the 3-digit NAICS categories as well as the previous 2-digit SIC codes that mostly correspond to their NAICS sector counterparts. While there are small differences in some of the detailed sectoral breakdowns, one of the biggest differences is that SIC retail trade included Eating and Drinking Places and NAICS excluded this category.

<sup>9</sup>We again choose these dates for analysis involving 3-digit NAICS due to data quality concerns in the older data at 3-digit

Figure 3: Mean Establishments for Retail NAICS in 45,000-55,000 Population Band



Notes: This figure tracks the mean establishments in 3-digit NAICS retail sectors for counties within a 10% band (45,000-55,000) of the 50,000 metropolitan population cutoff from 1998-2016. 3-digit NAICS data prior to 2002 is subject to error due to the SIC/NAICS crosswalk, especially for the older 1980 and 1990. Table A1 in the appendix contains the definitions of the 3-digit NAICS categories. Data from U.S. Census Bureau County Business Patterns with missing values imputed using (Bartik et al., 2018) .

population across all retail sectors analyzed (weighted by the national size of the retail sector) to identify the 2016 population required to hold the retail establishment counts constant. Next, we examine a bundle of 3-digit NAICS retail sector population thresholds to provide a measure of “metropolitan character.” The population required to maintain establishment counts serves as a threshold index allowing for population inflation in the CBSA core population cutoffs. We use this approach to create an index around a constant “metropolitan character.” We conduct the same exercise with the micropolitan cutoff. Tables 2 and 3 display the establishment counts and employment values that lead to the creation of this 1998-2016 inflation index (and the inflation values) for the metropolitan and micropolitan cutoff inflation, respectively. The tables indicate that the 3-digit NAICS employment-weighted index and simply using the 2-digit NAICS produce similar results.

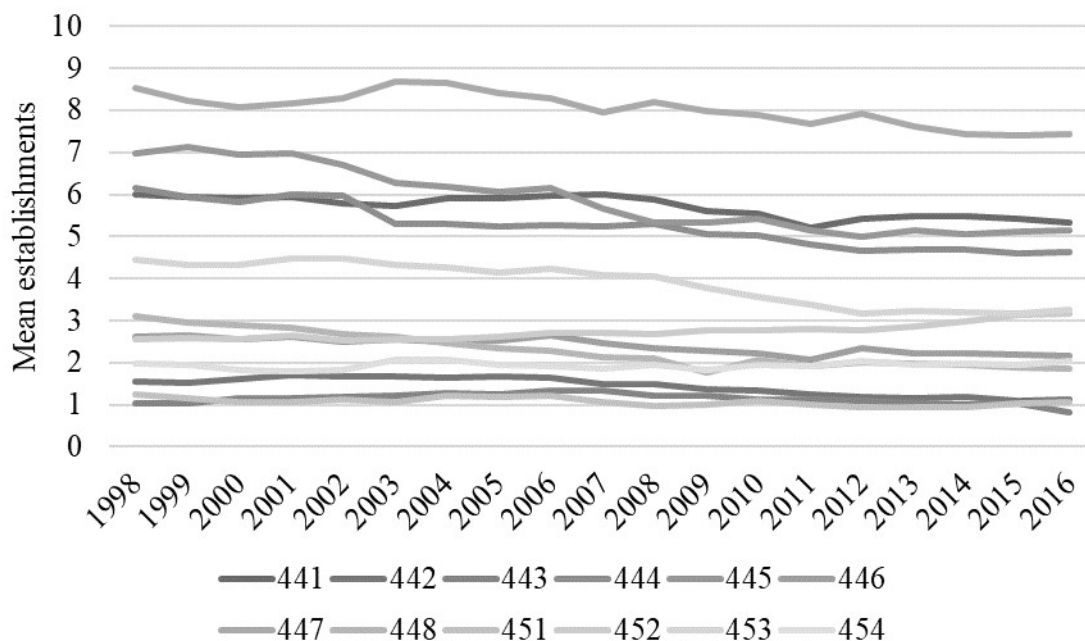
Specifically, looking at retail as a whole (NAICS 44/45), the metropolitan 50,000-population cutoff would need to be inflated to 61,291 population (22% increase, 1.22% per year) to maintain the 1998 retail establishment counts in 2016. Using an index weight by national employment in the 3-digit retail sectors, that number is 58,561 population (17% increase, 0.94% per year). Similarly, the micropolitan 10,000-population cutoff would need to be inflated to 13,940 population (39% increase, 2.17% per year) to maintain the 1998 retail establishment counts in 2016. Using an index weighted by national employment in the 3-digit retail sectors, that number is 13,028 population (30% increase, 1.67% per year).

Extending back to 1980, we cannot use the 3-digit NAICS establishment count data to test robustness to the bundle index, but that the employment-weighted index producing similar results to 1998-2016 provides some evidence that the results would be similar. As table 4 shows, if rather than 1998, 1980 is the base, the 2016 inflated population cutoffs to maintain the same number of retail establishments would be 78,616 (57% increase, 1.58% per year) and 18,312 (83% increase, 2.3% per year), for metro and micro, respectively. This is a similar rate observed between 1998 and 2016.

Figure 5 presents kernel densities similar to figure 2, but rather than holding the population cutoffs NAICS.



Figure 4: Mean Establishments for Retail NAICS in 9,000-11,000 Population Band



Notes: This figure tracks the mean establishments in 3-digit NAICS retail sectors for counties within a 10% band (9,000-11,000) of the 10,000 micropolitan population cutoff from 1998-2016. 3-digit NAICS data prior to 2002 is subject to error due to the SIC/NAICS crosswalk, especially for the older 1980 and 1990. Table A1 in the appendix contains the definitions of the 3-digit NAICS categories. Data from U.S. Census Bureau County Business Patterns with missing values imputed using (Bartik et al., 2018).

Table 2: Metropolitan Cutoff (50,000) Band Population Inflation

NAICS	Cutoff band mean		2016 national employment	Industry weight	2016-inflated population cutoff	Threshold inflation 1998-2016
	1998	2016				
44	210.30	173.18	15,827,730		<b>61,291</b>	<b>1.22</b>
441	28.87	23.48	1,960,692	0.124	59,375	1.19
442	10.39	6.79	450,441	0.028	74,155	1.48
443	7.44	5.28	375,575	0.024	70,493	1.41
444	21.70	16.68	1,320,852	0.083	71,349	1.43
445	25.12	20.17	3,147,708	0.199	63,098	1.26
446	13.35	11.90	1,048,661	0.066	55,236	1.10
447	32.30	26.21	942,321	0.060	66,029	1.32
448	19.58	16.17	1,717,438	0.109	62,893	1.26
451	9.62	6.85	563,561	0.036	69,522	1.39
452	9.37	11.94	2,904,592	0.184	36,668	0.73
453	23.78	17.81	772,662	0.049	69,824	1.40
454	8.78	9.90	623,256	0.039	46,620	0.93
Index	19.38	16.45			<b>58,561</b>	<b>1.17</b>

Notes: Appendix table A3 contains the population ranges for each cutoff. Cutoff presented here is mean of that range. Original cutoff band around 10,000 calculated as 10%

constant, inflates the cutoffs from 1980. That is, 1980 uses the 10,000 and 50,000 population cutoffs, 1998 uses 13,940 and 61,291, and 2016 uses 18,312 and 78,616 as population cutoffs to categorize counties. Comparing figures 2 and 5 (figure 2 represent the distributions using the consistent 10,000 and 50,000 cutoffs)

Table 3: Micropolitan Cutoff (10,000) Population Inflation

NAICS	Cutoff band mean		2016 national employment	Industry weight	2016-inflated population cutoff	Threshold inflation 1998-2016
	1998	2016				
44	46.20	38.08	15,827,730		<b>13,940</b>	<b>1.39</b>
441	6.00	5.33	1,960,692	0.124	12,299	1.23
442	1.54	1.14	450,441	0.028	14,584	1.46
443	1.03	0.83	375,575	0.024	12,337	1.23
444	6.15	4.64	1,320,852	0.083	15,828	1.58
445	6.98	5.16	3,147,708	0.199	15,909	1.59
446	2.61	2.17	1,048,661	0.066	11,501	1.15
447	8.54	7.44	942,321	0.060	12,661	1.27
448	3.09	1.85	1,717,438	0.109	15,613	1.56
451	1.24	1.08	563,561	0.036	13,677	1.37
452	2.57	3.16	2,904,592	0.184	8,237	0.82
453	4.46	3.25	772,662	0.049	14,464	1.45
454	1.98	2.05	623,256	0.039	9,780	0.98
Index	4.55	3.78			<b>13,028</b>	<b>1.30</b>

*Notes:* Appendix table A2 contains the 2016 population ranges in which the 1998 establishment counts would be replicated. Cutoffs presented here is the mean of that range.

Table 4: 1980 Population Cutoff Band Inflation

Original population band	Cutoff establishment means		1980-2016-inflated population cutoff	Threshold inflation 1980-2016
	1980	2016		
50,000	276.33	173.18	<b>78,616</b>	<b>1.57</b>
10,000	63.04	38.08	<b>18,312</b>	<b>1.83</b>

*Notes:* Appendix table A2 contains the 2016 population ranges in which the 1998 establishment counts would be replicated. Cutoffs presented here is the mean of that range. Data is from U.S. Census Bureau County Business Patterns with 1998-2016 counties imputed using WholeData (Bartik et al., 2018) and 1980 and 1990 are imputed using public data and methods (Autor et al., 2013). Data prior to 2002 uses SIC classifications crosswalked to NAICS classifications (Autor et al., 2013; Bartik et al., 2018)

highlights the efficacy of increasing the cutoffs in maintaining the distribution of establishments over time and thereby maintaining “metropolitan character.”

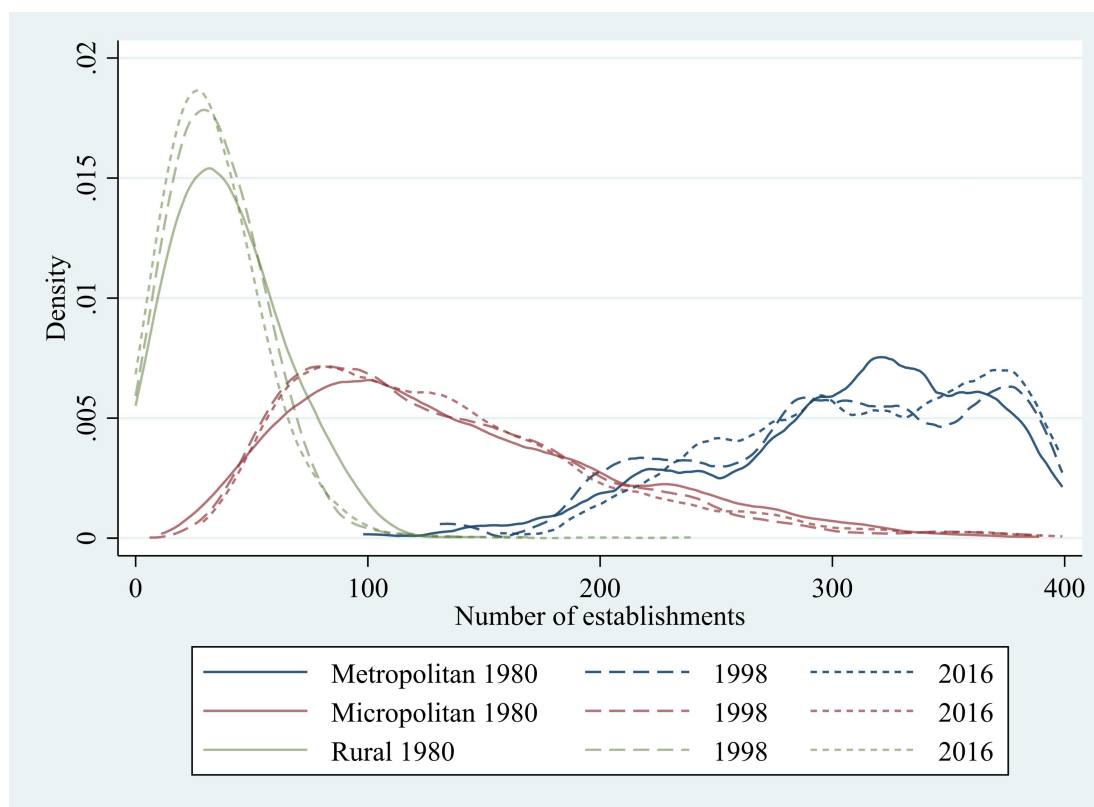
Finally, we cannot directly measure inflation from before 1980 because county business data is not available, but the original Metropolitan Statistical Area definition was not created in 1980; it was created in 1950. As table 5 shows, if we project the threshold trends linearly backwards to 1950 when the cutoffs were originally established, 2016 population cutoffs would need to be 98,174 (increased 96%) for Metropolitan and 23,524 (increased 135%) (Micropolitan). Extrapolating these to 2020 would equate to almost exactly 100,000 and 25,000 population, respectively.

Table 5: 1950 Population Cutoff Band Inflation

Original population band	Cutoff establishment means				1950-2016-inflated population cutoff	Threshold inflation 1980-2016
	1980	1980	1998	2016		
50,000	362.43	276.33	210.30	173.18	<b>98,174</b>	<b>1.96</b>
10,000	83.74	63.04	46.20	38.08	<b>23,524</b>	<b>2.35</b>

*Notes:* Metropolitan and micropolitan cutoff inflation needed to maintain the same number of retail establishments in 2016 using 1950 as the base year. Linear fitted value using 1980, 1998, and 2016 to impute 1950 cutoff. Metro linear regression coefficient is 2.87 and annual micro linear regression coefficient is 0.69. Data is from U.S. Census Bureau County Business Patterns with 1998-2016 counties imputed using WholeData (Bartik et al., 2018) and 1980 and 1990 are imputed using public data and methods (Autor et al., 2013). Data prior to 2002 uses SIC classifications crosswalked to NAICS classifications (Autor et al., 2013; Bartik et al., 2018)

Figure 5: Mean Establishments for Retail NAICS in 9,000-11,000 Population Band



*Notes:* These kernel densities show the distribution of retail establishments in each population category, while inflate the respective population cutoffs from 1980. That is, 1980 uses the 10,000 and 50,000 population cutoffs, 1998 uses 13,940 and 61,291, and 2016 uses 18,312 and 78,616 as population cutoffs to categorize counties. Data is from U.S. Census Bureau County Business Patterns with 1998-2016 counties imputed using WholeData (Bartik et al., 2018) and 1980 and 1990 are imputed using public data and methods (Autor et al., 2013). Data prior to 2002 uses SIC classifications crosswalked to NAICS classifications (Autor et al., 2013; Bartik et al., 2018).

## 6 Conclusions and Potential Implications for Policy

Using CPT and simple demand threshold techniques, this article suggests that the 1950 50,000-person threshold for urban cores in MSAs is outdated. Specifically, if the goal is to maintain a consistent “metropolitan character,” as was the original intent of the metropolitan definitions, population cutoffs would need to be inflated to 100,000 (25,000 for micropolitan) in 2020 to more closely match the 1950 business establishment distributions. Both the review committee charged by OMB to propose updated standards and our analysis came to the same number for an urban core threshold (100,000) but from different approaches. The review committee’s primary argument was growth of the overall U.S. population whereas our approach held the retail function (and implicit determinants thereof like density and commuting) of metropolitan character constant.

This paper makes an important contribution to both literature and policy analysis. First, the paper highlights how Central Place Theory can be used to create and index of the change in functional relationships of places over time. The creation of a population inflation index for holding the mean number of retail establishments constant to an index base year allows for researchers to model CPT in ways not previously considered. That is, a CPT index for a given category would be a way to “deflate” nominal establishment counts when CPT is an underlying theory in hypothesis testing.

Second, this paper creates a template for policymakers to evaluate CPT connected regions for other economic and non-economic core-periphery relationships. For example, the last decade has brought about decline in the number of retail brick and mortar establishments as online retailers outside of one’s own region

market and sell products. At the same time, the digital economy has created more service sector opportunities in the “gig economy.” This approach allows an understanding of these services sector establishments and the changing population thresholds they require. Further, we see non-economic metrics such as social and cultural capital indices that use business establishments as a proxy for their growth and change. This paper provides a way to create a baseline value for identifying a potential threshold level of social and cultural capital and evaluate how much more or less population is needed to maintain the establishments necessary for these capital investments to generate community outcomes.

At the same time, our results do not suggest the proposed rule change will serve the best interest of the research community, statistical community, or places impacted by the changes based on its use by federal agencies in funding formulas. Core-based statistical areas define a core-periphery regional relationship. However, the economic, social, and environmental functions in this relationship are not homogeneous for every core-periphery region defined. In some micropolitan regions, there may be more cows in outlying counties that are marketed in the urban core than people that live in that same periphery and commute to the urban core. But this type of commuting patterns would affect the size of demand thresholds and are implicit in this article’s application. Retail trade, trade in intermediate goods, and consumption of non-rival and/or non-excludable amenities are all ignored in a 1950s era conception of core-periphery regions.

One approach to make the connection between core and periphery more comprehensive would be to create a basket of functional relationships between areas similar to the basket of goods that the Bureau of Labor Statistics uses in their calculation of the Consumer Price Index (CPI). This approach would allow for multiple functional relationships (labor market commuting, trade, etc.) to be included in deciding how individual counties are organized into statistical areas. A less ambitious approach would take the comprehensive retail establishment demand threshold approach applied here and adjust it by identifying the subset of retail (and potentially service) sectors that are less impacted by remote online-retail supply competition (e.g., Amazon) and track their population threshold changes.

Further, we know the relative influence of the core on the periphery and vice versa is heterogeneous across regions. For example, Dabson et al. (2009) highlight the relative importance of periphery influence on urban cores by the relative size of rural exports to the urban core. Their findings along with ours suggest that federal agencies should think twice about the implications of using OMB-defined core-based statistical areas. If a federal agency needs a region based on a functional relationship of threshold settlement density combined with labor market commuting, then OMB’s Metropolitan and Micropolitan Statistical Areas may still hold value. If not, leveraging the increasing availability of secondary and administrative data to customize agency-specific regions to match agency-specific missions may be more optimal.

Despite the practical nature of this article, it is not without limitations that present opportunities for future research. First, CPT and demand thresholds are not without criticisms (Parr and Denike, 2016). Nonetheless, we argue that CPT’s long history in regional science and its ripeness for reemergence Mulligan et al. (2012) make it a useful and policy-relevant exercise. Second, the data is imputed and thus imperfect, especially the 1980 and 1990 county-industry data, which also crosswalked from old SIC codes to NAICS codes in addition to more extensive imputations. Future research may want to use unsuppressed annual data, which is available in the Federal Statistical Research Data Center System with the Business Register or Longitudinal Business Database 1976-present (Carpenter et al., 2021d; Jarmin and Miranda, 2002). This article only examines employer establishments, despite nonemployer establishments potentially also being of interest. Though nonemployer establishments have historically been excluded from demand threshold analyses in regional science and historical public data on nonemployer business establishments is similarly (and often more) limited, recent efforts are underway to extend analyses to nonemployers and to other industries (Carpenter et al., 2021a,d; Van Sandt and Carpenter, 2021; Van Sandt et al., 2021a,b).

Third and finally, the simple demand threshold techniques and tests around the cutoff bands is useful for explicability to policymakers, which is of interest to this journal, but it could be that the within-category distributions are also of interest and therefore examining within-cutoff means is insufficient to capture the evolution of metropolitan character (though figure 5 seems to indicate this may not be a concern). Nonetheless, as research techniques become more complicated, their usefulness to policymakers can diminish. We argue that the simple methods utilized in this article are useful because they remain relatively explicable to policymakers. However, future research may examine the robustness and accuracy of the results herein to other types of distributional analyses as a complementary extension of this analysis.

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## Appendix

Table A1: Retail NAICS Sector Definitions

NAICS	Definition	SIC	Definition
44-45	Retail Trade	G	Retail Trade
441	Motor Vehicle and Parts Dealers	52	Building Materials, Hardware, Garden Supply and Mobile Home Dealers
442	Furniture and Home Furnishings Stores	53	General Merchandise Stores
443	Electronics and Appliance Stores	54	Food Stores
444	Building Material and Garden Equipment and Supplies Dealers	55	Automotive Dealers and Gasoline Service Stations
445	Food and Beverage Stores	56	Apparel and Accessory Stores
446	Health and Personal Care Stores	57	Home Furniture, Furnishings and Equipment Stores
447	Gasoline Stations	58	Eating and Drinking Places
448	Clothing and Clothing Accessories Stores	59	Miscellaneous Retail
451	Sporting Goods, Hobby, Musical Instrument, and Book Stores		
452	General Merchandise Stores		
453	Miscellaneous Store Retailers		
454	Nonstore Retailers		

*Notes:* 2016 NAICS definitions

Table A2: Metropolitan Inflated Cutoff Ranges

NAICS	Inflated cutoff ranges					
	1950-2016		1980-2016		1998-2016	
44	98,123	98,226	78,420	78,812	61,290	61,293
441					59,357	59,393
442					74,118	74,191
443					70,009	70,976
444					71,329	71,369
445					63,096	63,100
446					55,202	55,270
447					65,907	66,151
448					62,852	62,934
451					69,424	69,619
452					36,668	36,668
453					69,639	70,009
454					46,598	46,642

*Notes:* This table describes the range of population values for which the inflation yield identical county categorization. In text we use the mean of this range. 3-digit NAICS data only reliable after 1998, so we exclude it from the 1980 and 1950 cutoffs.

Table A3: Micropolitan Inflated Cutoff Ranges

NAICS	Inflated cutoff ranges					
	1950-2016		1980-2016		1998-2016	
44	23,512	23,535	18,281	18,342	13,934	13,945
441					12,284	12,314
442					14,581	14,586
443					12,320	12,354
444					15,823	15,833
445					15,905	15,913
446					11,438	11,563
447					12,659	12,662
448					15,580	15,646
451					13,626	13,727
452					8,234	8,240
453					14,446	14,482
454					9,758	9,802

*Notes:* This table describes the range of population values for which the inflation would yield similar results. In text we use the mean of this range. 3-digit NAICS data only reliable after 1998, so we exclude it from the 1980 and 1950 cutoffs.