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Provider Concentration in Markets for Physician Services for Patients with Traditional Medicare*

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Abstract

The geographic extent of markets for physicians is an important but little-explored issue for antitrust. Using patient flow data from a 2009 20% sample of Medicare beneficiaries, we define physician specialty-specific geographic markets for selected communities and calculate concentration within these markets. We find considerable variation in geographic market size by physician specialty and evidence of substantial concentration within physician markets, especially for specialists in smaller geographic areas. Additionally, given that our market definition methodology has been shown to define overly expansive markets, our concentration measures likely reflect a lower bound.

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1. Introduction

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Geographic market definition has been a key issue for antitrust analysis in the health care industry. There is a considerable literature on the extent and level of concentration in inpatient hospital markets (Frech and Mobley 2000; Capps, Dranove and Satterthwaite 2003; Gaynor and Vogt 2003; Gaynor, Kleiner and Vogt 2011). However, despite long-standing concerns about anticompetitive behavior in physician markets by the antitrust authorities (FTC/DOJ 2004) and recent anticompetitive concerns associated with the creation of Accountable Care Organizations (ACOs) (FTC/DOJ 2012), the geographic scope and level of concentration in physician markets has been a largely unexplored topic (Gaynor and Town 2011).

It has been widely argued that geographic markets for physician services are relatively local and segmented by specialty (Brasure et al. 1999; American Bar Association (ABA) 2003). Against this background, we seek to draw on the literature on hospital market definition to consider two questions: First, what is the geographic extent of physician markets and how may it differ by specialty? Second, what is the degree of concentration within such markets?

In the hospital literature four main approaches have been used to define geographic markets.

1. Define markets using geopolitical units such as counties or census divisions such as Metropolitan Statistical Areas (MSAs) or Health Services Areas (Romeo, Wagner and Lee 1984; Dranove, Shanley and Simon 1992; Lynk 1995).
2. Define markets using a fixed or variable radius around a particular hospital (Robinson and Luft 1985; Melnick et al. 1992; Gruber 1994).
3. Infer geographic market boundaries using data on patient inflows and outflows (Frech, Langenfeld and McCluer 2004).
4. Use structural and semi-structural approaches to model patient choice and firm behavior and evaluate market power using data on patient flows and hospital profitability or prices to directly estimate patient preferences and examine the implications for provider profitability and prices (Capps, Dranove and Satterthwaite 2003; Gaynor and Vogt 2003).

Market definition using geopolitical units or fixed-radius models are attractive because they do not require patient flow or provider financial data, which are often lacking. Reflecting this, the only published study of which we are aware that examines physician market power is Schneider et al. (2008), who define markets using counties, while ongoing work by Baker, Bundorf and Royalty (2012) and Dunn and Shapiro (2012) respectively define markets using MSAs and fixed travel time radii. However, geopolitical units and fixed-radius models may be arbitrary. Using patient flow data allows for the definition of markets using information on actual patient choices, but markets defined using these methods are likely to be overly large and may not accurately reflect heterogeneous patient preferences (Capps et al. 2001; Elzinga and Swisher 2011; Gaynor, Kleiner and Vogt 2011). Structural methods afford a richer recognition of the relevant impacts across heterogeneous patients and local areas, and in practice, often predict much smaller markets than patient flow techniques (Capps, Dranove and Satterthwaite 2003; Gaynor, Kleiner and Vogt 2011). Structural methods, however, require data on price or profitability that is not readily available and may not be computationally tractable for markets with a large number of providers.

Because of these data and computational issues, any general application of structural methods is difficult. While we acknowledge the limitations of using patient flow techniques to define geographic markets, the use of a commonly employed market definition technique developed by Elzinga and

Hogarty (EH) (1973) offers a potential advance over defining markets using geopolitical units, and may provide a reasonable lower bound indicator of the level of market concentration in physician markets. In this research, we utilize EH techniques and Medicare Part B fee-for-service claims data to define geographic markets for five physician specialties in 29 communities. We use this analysis to examine the geographic scope of physician markets and how they may differ in size by specialty and then assess concentration within these markets following FTC and DOJ merger guidelines (2010) and using physician practices versus individual physicians as the unit of analysis.[1]

We find that the size of our EH physician markets vary by specialty. Markets for specialists tend to be larger than those for primary care, while there is not a consistent relationship between EH market estimates and MSAs. We find evidence of substantial concentration for specialists, especially in smaller markets. To the extent that our EH markets may be overly large, these estimates may be useful as lower bound indicators of the potential for exercise of market power.

2. Methods

The basic notion behind EH analysis is that a geographic area can be deemed a market for a service if both: 1) the share of services used by residents that is obtained locally is high; and 2) the share of services produced for local use is high. Specifically, to define a geographic market, Elzinga and Hogarty (1973) recommend that both shares meet a threshold of 0.75 for a "weak market" and 0.90 for a "strong market."

To implement an EH framework, we use 5-digit ZIP codes as our geographic unit of analysis. In each of the geographic areas of interest, we select a starting ZIP code using the ZIP code with the largest number of total physician claims in our data. We then use a contiguous area algorithm similar to that developed by Frech, Langenfeld and McCluer (2004) to expand on this ZIP code based on patient flows for the services of the specific specialty we are examining. This process is continued until we reach a 0.75 "weak market" threshold, which we select because, as noted by Frech, Langenfeld and McCluer (2004), convergence is often difficult at the 0.90 level. To keep our analysis computationally tractable, the set of ZIP codes that can be potentially added is limited to those in the same state as the starting ZIP code, which poses potential problems particularly for geographic areas close to state borders. (See Appendix A for details on our EH method.)[2]

Patient flows may be measured by the number of patient claims ("unweighted" claims) or patient claims weighted by revenue ("weighted" claims), defined as claims weighted by Medicare allowed payments. While unweighted claims provide a measure of the number of patient visits to a provider, they do not reflect the intensity of the services provided. Because the current FTC and DOJ antitrust guidelines call for use of revenues in assessing market shares, we report results for weighted claims and compute for each individual specialty market a "supply-side" Herfindahl-Hirschman Index (HHI), where

[1] Until the 1980s, solo and two-person practices were the dominant form of physician practice organization, but the trend since has been towards larger group practices. Reflecting this, Kletke, Emmons and Gillis (1996) estimate that in 1984, 71% of physicians were in one or two physician practices, but in 2004-5, Liebhaber and Grossman (2007) estimate only 33% of physicians were in solo and two-person practices with the balance in groups of 3 or more.

[2] Without this restriction, we would need to consider all ZIP codes nationally.

following Frech, Langenfeld and McCluer (2004), this HHI is defined as the sum of the squared market shares for services supplied by each physician practice located within the market area.[3]

3. Data

Patient-level data in this research come from 2009 Research Identifiable Files (RIF) Medicare Part B data files for a 20% sample of final action claims submitted by non-institutional providers for traditional fee-for-service beneficiaries. These data files include information on diagnosis and procedure codes, Medicare allowed reimbursement amounts, the specialty of billing physicians, and 5-digit ZIP codes for both beneficiary residence and provider location. In addition, data include provider Tax Identifiers (IDs) for each claim, which we use to identify physician practice affiliations, following previous studies of physician groups and Medicare demonstration projects (Pham et al. 2007; CMS 2010, CMS 2011). For multi-specialty practices, practice size for each specialty is separately assigned based on the number of physicians of that specialty within a practice.

We examine five physician specialties within four broad categories delineated by Cantor et al. (2005): Primary care, where we combine general practice, family practice and general internal medicine physicians;[4] medical subspecialties, where we separately examine cardiologists and oncologists; surgical specialties, where we examine orthopedists; and hospital-based specialties, where we examine radiologists.[5]

Estimating EH markets is computationally intensive and we limit our analysis to a total of 29 geographic areas. While not necessarily statistically representative, we select these areas to be illustrative of a range of locations and population sizes. As shown in Table 1, we include areas in all four census bureau regions (Northeast, South, Midwest, West), where for the Northeast region, we focus mostly on New York State. We include small (population < 250,000), medium (250,000 < population < 750,000) and large (population > 750,000) metro areas (defined using either metropolitan or micropolitan areas), and also three rural areas as defined by the Community Tracking Study (Center for Studying Health System Change 2001).

[3] Results using unweighted claims data are available from the authors upon request.

[4] We eliminate Primary Care specialties that cannot be reasonably analyzed using Medicare claims data (e.g. Pediatrics, Obstetrics)

[5] Specific Medicare specialty codes used in our analysis are Cardiology (06), FP/GP/Internal Medicine (01,08,11), Oncology (83,90,91,92,98), Orthopedics (20), Diagnostic Radiology (30). No specialties are included from Cantor et al.'s (2005) "other" category, a grouping of somewhat unrelated specialties (e.g. Psychiatry, Emergency Medicine etc.).

Table 1: Analysis Areas

Small Metro Area (MSA Population <250,000)	**Large Metro Area** (MSA Population >750,000)
Elmira, NY	Bakersfield-Delano, CA
Ithaca, NY	Tulsa, OK
Watertown-Fort Drum, NY*	Tucson, AZ
Glens Falls, NY	Rochester, NY
Jamestown-Dunkirk-Fredonia, NY*	Oklahoma City, OK
Kingston, NY	San Antonio-New Braunfels, TX
	Denver-Aurora-Broomfield, CO
Medium Metro Area	Minneapolis-St. Paul-Bloomington, MN
(MSA Population 250,000-750,000)	Seattle-Tacoma-Bellevue, WA
Binghamton, NY	Phoenix-Mesa-Glendale, AZ
Utica-Rome, NY	
Charleston, WV	**Rural Areas**
Mongomery, AL	Northwest WA
Spokane, WA	West Central AL
Modesto, CA	Eastern ME
Madison, WI	
Des Moines-West Des Moines, IA	
Syracuse, NY	
Poughkeepsie-Newburgh-Middletown, NY	

* denotes micropolitan area

4. Results

Geographic Markets for Specialty Services: Size and Comparison to MSAs

To provide an indicator of market sizes, Table 2 reports the number of ZIP codes included in each specialty-specific geographic market. By this measure, primary care physicians have the smallest geographic markets for 24 of our 29 areas. EH markets constructed using oncologist claims are the largest in 11 of our selected areas, followed by radiology (largest in 8 areas) and cardiology (largest in 7 areas), while orthopedists have the largest markets in 6 areas. Generally, market areas for larger metro areas are larger, although EH markets are quite expansive for our rural areas and also, in some cases, for smaller metro communities.

Table 2: Number of ZIP Codes in EH Markets

	Number of ZIP Codes				
	Cardiology	Primary Care	Oncology	Orthopedics	Radiology
Small MSA					
Elmira, NY	29	29	10	27	64
Ithaca, NY	16	97	13	137	243
Watertown-Fort Drum, NY	205	26	53	42	33
Glens Falls, NY	38	34	184	42	181
Jamestown-Dunkirk-Fredonia, NY	9	6	179	46	10
Kingston, NY	145	70	40	223	98
Medium MSA					
Binghamton, NY	28	18	28	23	306
Utica-Rome, NY	43	31	37	36	37
Charleston, WV	249	101	119	126	165
Mongomery, AL	70	52	96	59	82
Spokane, WA	106	37	49	56	49
Modesto, CA	33	41	25	41	57
Madison, WI	111	47	106	119	96
Des Moines-West Des Moines, IA	255	79	139	199	296
Syracuse, NY	90	51	91	77	76
Poughkeepsie-Newburgh-Middletown, NY	148	45	61	61	179
Large MSA					
Bakersfield-Delano, CA	28	23	27	29	24
Tulsa, OK	143	112	407	116	141
Tucson, AZ	63	54	60	63	54
Rochester, NY	124	53	146	70	79
Oklahoma City, OK	209	96	455	152	135
San Antonio-New Braunfels, TX	122	90	136	118	98
Denver-Aurora-Broomfield, CO	131	122	143	144	317
Minneapolis-St. Paul-Bloomington, MN	212	170	174	202	206
Seattle-Tacoma-Bellevue, WA	73	110	93	228	74
Phoenix-Mesa-Glendale, AZ	180	135	180	172	180
Rural Areas					
Northwest WA	46	36	46	194	144
West Central AL	420	89	425	423	121
East Maine	340	36	364	186	204

To relate our constructed markets to a commonly used geopolitical boundary, we compare the relative size of our EH markets and MSAs. Specifically, Table 3 summarizes the percentage of markets by specialty in which our EH markets are smaller than their associated MSAs (i.e. fall completely within their MSA boundaries). Results vary depending on market size. For markets located in smaller MSAs, the share of EH markets that are smaller than MSAs is low. Specifically, only 17% of cardiology, oncology and orthopedics markets are fully contained in their respective MSAs, and for primary care and radiology, only 33% of markets fall within the MSA boundary. In the case of medium MSAs, the

percentage of markets completely contained within an MSA remains small for specialists (20% to 30%), but is 60% for primary care. For markets located in large MSAs, more EH markets are contained within an MSA. Some 70% of primary care markets are smaller than associated MSAs and 60% of cardiology and orthopedics markets are also smaller, while the share for oncology and radiology is the lowest at 40%.

Table 3: Percentage of EH Markets that are Strictly Smaller than the MSA

	Cardiology	Primary Care	Oncology	Orthopedics	Radiology
Small MSAs	17%	33%	17%	17%	33%
Medium MSAs	20%	60%	30%	20%	20%
Large MSAs	60%	70%	40%	60%	40%

To illustrate one example of the variations in market size between specialties and MSA boundaries, Figure 1 in Appendix B maps EH markets for the primary care specialties, oncology, orthopedics, and radiology for Des Moines, Iowa. In Des Moines, the market for primary care specialties is the smallest and radiology is the largest. Except for primary care physicians, a weak EH market necessitates including a number of neighboring MSAs, and for radiologists the EH market extends into ZIP codes bordering Missouri.

Number of Physicians and Practice Size within Geographic Markets

Table 4 reports the total number of physicians, the total number of practices and average practice size by specialty in each market.[6] Total numbers of physicians and practices are relatively large for primary care. Even in our smallest EH market (Jamestown-Dunkirk-Fredonia) there are 34 primary care physicians grouped into 18 practices. In contrast, the number of physicians and practices in EH markets for specialty care is typically relatively small. In medium metro areas in our sample, as few as 3 oncologist practices provide services, while 6 out of 10 of these medium markets have 7 or fewer oncologist practices. Even in large metro areas, the number of practices may be low—only 6 oncology practices are shown in our data to serve the Tulsa market, 7 cardiology practices serve our Seattle-Tacoma market, and 7 radiology practices serve Bakersfield-Delano. Interestingly, the number of physicians and practices is fairly large across all categories for our rural EH markets. Practice size varies considerably both across and within specialties. Overall median practice size ranges from 3.3 for orthopedists to 9.6 for radiologists, while within specialty variation is substantial—e.g., average practice size for radiologists is 5.1 in Des Moines IA, but 28.5 in Minneapolis-St. Paul.

[6] Note: Table 4 assigns physicians to practices based on tax IDs. Because some physicians have more than one ID due to multiple practice affiliations, call agreements etc., the average number of physicians in panel 3 can be larger than those implied by panels 1 and 2, due to the existence of physicians who are assigned to multiple tax identifiers within the same market. Consistent with this, Nyweide et al. (2009) finds that nearly 20% of primary care physicians match to multiple practices.

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Table 4: Physician/Practice Characteristics

	Total Physicians Providing Service					Total Practices Providing Service					Mean Number of Physicians in a Practice				
	Cardiology	Primary Care	Oncology	Orthopedics	Radiology	Cardiology	Primary Care	Oncology	Orthopedics	Radiology	Cardiology	Primary Care	Oncology	Orthopedics	Radiology
Small MSA															
Elmira, NY	22	146	5	16	50	3	22	3	3	6	7.3	7.7	2.3	5.3	9.8
Ithaca, NY	5	384	2	55	182	2	79	1	18	29	2.5	5.7	2.0	3.5	10.1
Watertown-Fort Drum, NY	84	48	3	10	7	28	22	2	3	3	5.3	2.5	1.5	3.7	6.3
Glens Falls, NY	20	137	79	20	111	4	40	23	10	23	6.5	4.0	3.4	2.1	10.4
Jamestown-Dunkirk-Fredonia, NY	4	34	93	7	6	2	18	25	4	1	2.5	2.6	4.2	1.8	6.0
Kingston, NY	60	251	8	72	72	13	116	6	21	13	4.6	2.3	1.5	3.8	8.1
Median Across Small MSAs	**21**	**142**	**7**	**18**	**61**	**4**	**31**	**5**	**7**	**10**	**4.9**	**3.3**	**2.2**	**3.6**	**9.0**
Medium MSA															
Binghamton, NY	20	200	14	18	225	7	21	5	5	33	7.1	10.8	3.0	3.6	10.5
Utica-Rome, NY	21	155	8	12	29	7	55	4	4	6	3.1	3.3	2.0	3.0	8.0
Charleston, WV	47	249	16	24	41	26	131	5	9	8	3.0	2.4	3.2	2.7	5.1
Mongomery, AL	23	216	19	23	40	9	96	3	8	5	3.7	2.6	6.3	2.9	9.8
Spokane, WA	64	585	48	58	105	12	75	8	10	8	7.9	8.2	7.0	6.0	21.5
Modesto, CA	28	340	13	35	65	7	157	11	24	12	4.1	2.6	1.5	1.8	5.7
Madison, WI	88	508	69	90	156	12	21	6	21	11	9.8	25.4	12.0	4.4	26.7
Des Moines-West Des Moines, IA	70	316	33	55	70	12	58	7	19	26	9.6	5.7	4.7	3.1	5.1
Syracuse, NY	80	598	55	50	101	18	89	18	10	16	7.6	8.0	3.5	5.1	13.1
Poughkeepsie-Newburgh-Middletown, NY	117	236	23	29	162	43	90	12	12	30	3.4	2.8	2.0	2.6	8.4
Median Across Medium MSAs	**56**	**283**	**21**	**32**	**86**	**12**	**82**	**7**	**10**	**12**	**5.6**	**4.5**	**3.4**	**3.0**	**9.1**
Large MSA															
Bakersfield-Delano, CA	28	270	16	28	35	25	140	8	21	7	1.6	2.3	2.0	1.7	5.3
Tulsa, OK	83	718	129	86	125	33	191	34	28	32	3.7	4.3	4.3	3.2	5.8
Tucson, AZ	82	620	60	76	131	23	148	6	25	16	7.8	4.8	10.2	3.2	8.4
Rochester, NY	88	699	62	73	140	23	188	19	22	13	5.0	4.3	4.1	3.6	13.2
Oklahoma City, OK	123	523	129	120	152	49	226	30	46	39	3.7	2.8	4.9	2.7	5.5
San Antonio-New Braunfels, TX	150	965	88	111	223	47	351	22	50	28	5.2	3.0	4.3	2.3	11.4
Denver-Aurora-Broomfield, CO	140	1,341	135	189	372	29	364	39	52	42	9.6	4.2	3.8	4.0	13.6
Minneapolis-St. Paul-Bloomington, MN	266	2,406	167	253	375	31	147	17	35	26	12.9	19.0	11.8	8.1	28.5
Seattle-Tacoma-Bellevue, WA	40	1,053	41	288	108	7	233	9	48	17	5.9	4.9	5.2	6.5	10.8
Phoenix-Mesa-Glendale, AZ	340	1,694	175	252	525	111	681	47	131	55	4.0	2.9	4.1	2.2	13.2
Median Across Large MSAs	**106**	**842**	**109**	**116**	**146**	**30**	**209**	**21**	**41**	**27**	**5.1**	**4.2**	**4.3**	**3.2**	**11.1**
Rural Areas															
Northwest WA	47	405	37	293	405	11	54	14	44	41	5.3	7.9	3.5	6.9	15.5
West Central AL	158	194	114	189	64	36	83	24	61	7	5.3	3.2	5.2	3.3	9.4
Eastern ME	101	183	82	68	95	27	39	24	18	15	7.3	5.9	3.9	4.2	6.7
Median Across Rural MSAs	**101**	**194**	**82**	**189**	**95**	**27**	**54**	**24**	**44**	**15**	**5.3**	**5.9**	**3.9**	**4.2**	**9.4**
Median Across All Areas	**67**	**328**	**45**	**57**	**107**	**16**	**90**	**10**	**20**	**16**	**5.2**	**4.2**	**3.8**	**3.3**	**9.6**

We note that because our practice size statistics in panel 3 assign physician practices based on tax identifiers, the average number of physicians in panel 3 can be larger than those implied by in panels 1 and 2, due to the existence of physicians who are assigned to multiple tax identifiers with the same market. Such cases may occur due to physician affiliation with multiple practices, and call-sharing across physician practices. Consistent with this, Nyweide et al. (2009) finds that nearly 20% of primary care physicians match to multiple practices.

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Market Concentration

To examine concentration, we analyze three measures: the market share for the largest practice in a specialty, the market share for the two largest practices in a specialty, and the specialty-specific, practice-level HHI. Table 5 reports medians by specialty-market size category. As shown, the overall median market share for primary care for the largest practice is 0.20, while in small, medium and large MSAs, it is 0.22, 0.21 and 0.13 respectively. However, it is considerably higher for specialists. Overall, the median shares for the largest single practice in cardiology, oncology, orthopedics and radiology are 0.39, 0.56, 0.36 and 0.38 respectively. Further, the median shares of the largest practices in small MSAs are 0.64 for cardiologists, 0.74 for oncologists, 0.49 for orthopedists, and 0.34 for radiologists, while these shares can be substantial even in larger markets—e.g., 0.56 in both medium markets and large markets for oncology.

Table 5: Market Concentration for Physician Practices

	Market Share for Largest Practice					Market Share for Two Largest Practices					Physician Practice HHI				
	Cardiology	Prim. Care	Oncology	Orthopedics	Radiology	Cardiology	Prim. Care	Oncology	Orthopedics	Radiology	Cardiology	Prim. Care	Oncology	Orthopedics	Radiology
Median Across Small MSAs	0.64	0.22	0.74	0.49	0.34	0.94	0.40	0.83	0.77	0.54	5316	1157	5701	3616	2092
Median Across Medium MSAs	0.40	0.21	0.56	0.39	0.40	0.63	0.33	0.82	0.68	0.64	2841	793	4076	2818	2652
Median Across Large MSAs	0.28	0.13	0.56	0.30	0.29	0.47	0.23	0.71	0.43	0.51	1645	524	3469	1437	1880
Median Across Rural Areas	0.39	0.22	0.34	0.26	0.42	0.67	0.36	0.63	0.44	0.57	2392	1046	2328	1472	2247
Median Across All Areas	0.39	0.20	0.56	0.36	0.38	0.58	0.33	0.72	0.49	0.57	2370	761	3606	1751	2190

Panel 2 of Table 5 shows that the market shares for the two largest practices is quite substantial. While the median market share for the two largest primary care practices is approximately 0.33, in all but orthopedics, the median market share for the two largest practices in each specialty exceeds 0.5. These shares are especially large in small MSA and medium-sized MSAs, with a median two-practice market share of over 0.5 for all specialties. While the median market share of the two largest practices is smaller in large MSAs, it is still quite high in these areas, for example, oncologists and radiologists exhibit median two-practice shares of 0.71 and 0.51 respectively.

Turning to HHIs, the FTC and DOJ Merger Guidelines (2010) classify a market as unconcentrated for HHIs under 1500, moderately concentrated for HHIs between 1500 and 2500, and highly concentrated for 2500 and above. For primary care markets, both the overall median HHI (761), and median HHI in each size category fall below the unconcentrated threshold of 1500. In contrast, overall median HHIs for specialists are 2370, 3606, 1751, and 2190 respectively for cardiology, oncology, orthopedics and radiology, suggesting moderate or high levels of concentration. For both small and medium MSAs, the median specialty practice is highly concentrated, while for large MSAs, all but the orthopedic specialties are moderately to highly concentrated. Our 3 rural markets show a similar pattern, with an unconcentrated median practice-level HHI for primary care and orthopedics, but moderately concentrated markets for cardiology, oncology and radiology.

5. Discussion

Our analysis uses EH techniques and patient flow data to provide some of the first evidence on the geographic extent of physician markets and the degree of concentration in these markets. As

previously discussed, based on a comparison with structural estimates for hospital inpatient markets, a general limitation is that EH estimates of geographic markets may be too large (Capps et al. 2001; Capps, Dranove and Satterthwaite 2003; Gaynor, Kleiner and Vogt 2011). Our analysis also has several specific limitations. First, while useful for purposes of illustration, our sample size (29 geographic areas per specialty) is relatively small. Second, we use data for traditional fee-for-service Medicare patients. These patients are not subject to the financial steering associated with managed care, and their travel patterns, disease prevalence and patient preferences may differ from patients with other types of insurance, affecting the generalizability of our results. Third, we rely on Tax IDs to identify physician practice affiliations. If organizations utilize more than one Tax ID, our estimates could underestimate concentration.

Bearing in mind these limitations, our analysis is still informative in providing evidence on patient flows in physician markets and, to the extent EH markets are too large, estimates of concentration may be useful as lower bounds. Specifically, our EH estimates suggest several conclusions. First, EH techniques produce estimates of physician markets that are relatively geographically compact. Our findings are broadly consistent with claims that physician markets are local and that patients tend to prefer nearby physicians. This suggests that it is plausible that local physician practices may be able to exercise substantial market power. Second, our findings are consistent with differences in the size of geographic markets by physician specialty, where our market estimates are smaller for primary care physicians than for specialists. This suggests that the ability to exercise market power may vary by physician specialty and, accordingly, supports examining possible anticompetitive behavior on a specialty-by-specialty basis. At the same time, we do not find a consistent relationship between our EH estimates and MSAs, raising questions about use of MSAs as proxies for geographic market areas for physicians.

Finally, our measures of concentration within market areas are consistent with the potential exercise of substantial market power by specialty physicians, especially in smaller markets. This raises policy concerns not only because of a general trend towards consolidation in physician markets, but because of proposals to promote coordination between practices and hospitals through ACOs. While we do not find evidence of concentration in the majority of the EH markets for primary care physicians we examined, to the extent that our results represent a lower bound on concentration, we cannot rule out the possibility of the potential for anticompetitive behavior in these markets.

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Appendix A: Estimation of Elzinga-Hogarty (EH) Patient Flow Market Areas

Elzinga and Hogarty (EH) (1973) define a geographic area for a good or service as a market based on two criteria.

- There is "little in from outside" (LIFO) of the good or service being imported into the area where LIFO is defined as:

$$\text{LIFO} = 1 - \{\frac{\text{patient outflows from area of interest into any other area}}{\text{total discharges from area of interest}}\}$$

- There is "little out from inside" (LOFI) of the good or service being exported from the area where LOFI is defined as:

$$\text{LOFI} = 1 - \{\frac{\text{patient inflows from other areas into this area}}{\text{total discharges from hospitals in this area}}\}$$

A geographic market is said to be a market if measures of LIFO and LOFI for the area both equal or exceed some threshold level.

We implement this analysis using postal ZIP codes as our basic unit of analysis and applying the following algorithm based on a contiguous search algorithm developed by Frech, Langenfeld and McCluer (2004):

1) Begin in iteration 1 with the 5-digit ZIP code within each area determined to provide the greatest total absolute number of Medicare Part B claims for physician services for all physicians regardless of specialty (the "core" provider 5-digit ZIP code).

2) For each iteration *i*, where *i*>1, identify 5-digit ZIP codes to be potentially added to the set of ZIP codes contained in the i-1 set of 5-digit ZIP codes within the set of ZIP codes in the state where our initial ZIP code is located based on the distance from the centroid of any of the 5-digit ZIP codes that are a member of the set of ZIP codes identified in iteration *i*-1. This distance is allowed to vary depending on the area of 5-digit ZIP codes.

3) Given the set of ZIP codes identified in step 2, LIFO and LOFI are separately recalculated using each of these ZIP codes, and the 5-digit ZIP code that contributes the greatest absolute amount to each of LIFO and LOFI are separately identified. They need not be the same ZIP code and in the event that there are two ZIP codes identified under this criteria, the ZIP code contributing the most to whichever value of LIFO or LOFI is lowest at that iteration is chosen as the ZIP code to add to the market.

4) The algorithm continues to add 5-digit ZIP codes using this method until both LIFO and LOFI are at least as large as the prescribed threshold where we use a "weak market" criterion of 0.75 as our threshold.

This approach enables us to identify relatively compact market areas, but we note several limitations. First, ZIP codes are administrative units created for other purposes and as Frech, Langenfeld

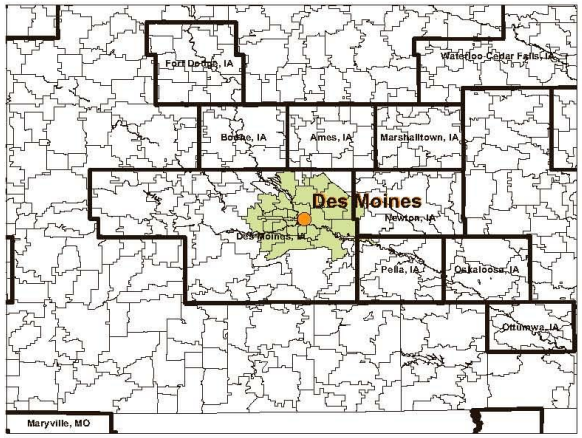
and McCluer (2004) note, analysis may be sensitive to the initial choice of ZIP code, where there may be an element of arbitrariness in the definition of ZIP codes from the perspective of analyzing patient flows.[7] A second limitation is that we expand markets based on ZIP code centroid distance rather than expanding by contiguous ZIP codes. Using contiguous ZIP codes would be desirable, but we lack a readily available file that enables identification of contiguous ZIP code borders. A third limitation is that for purposes of comparability, we specifically use the ZIP code with the greatest number of physician claims in an area regardless of specialty. This allows us to "center" all of our analysis of markets for individual specialties on the same ZIP code. If instead we used the number of specialty-specific claims, it is possible we might then start with different ZIP codes, making market areas difficult to compare. A fourth limitation is that in expanding around our initial choice of ZIP code, for reasons of computational tractability we limit the choice set to ZIP codes in the same state as the initial ZIP code.

[7] As an illustration, in our analysis our EH market for Seattle-Tacoma includes mostly the Tacoma area. This is an artifact of our EH algorithm starting ZIP code criteria and the particular configuration of ZIP codes in the Seattle-Tacoma market. Specifically, our starting ZIP code is a Tacoma ZIP code, and expansion around this ZIP code using our EH algorithm produces a weak EH market without encompassing large portions of Seattle proper. Inspection of the data indicates a concentration of major medical centers in one ZIP code in downtown Tacoma, whereas while there are a number of major medical centers concentrated in downtown Seattle, they are located in different ZIP codes.

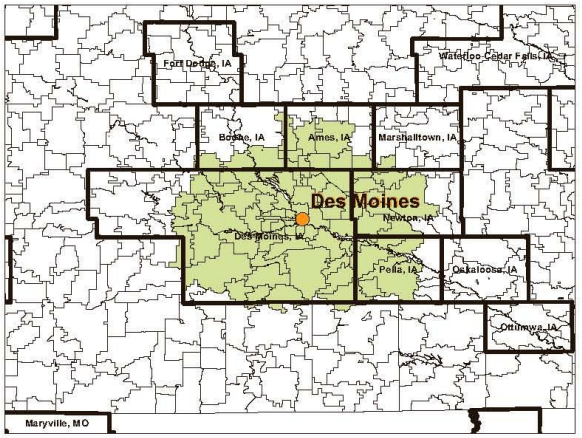
Appendix B: Elzinga-Hogarty Market Variation by Specialty for Des Moines, Iowa

Figure 1

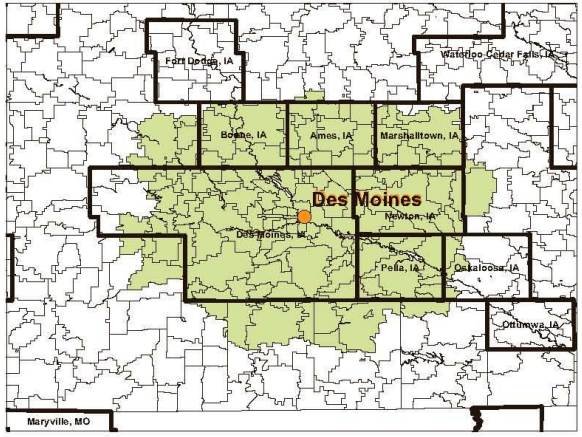
Des Moines, IA- Family Medicine and Internal Medicine



Des Moines, IA- Oncology



Des Moines, IA- Orthopedics



Des Moines, IA- Radiology