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I. Introduction

In 2018, there were approximately 75 percent more primary care physicians (PCPs) per capita in metropolitan areas than rural counties. The supply of specialists in the United States is even more concentrated in metropolitan areas than PCPs¹. As a result, rural primary care providers face two distinct challenges: there are fewer primary care physicians to provide services to a population that is generally older² and in poorer health³, and PCPs may have to treat a broader range of conditions that includes specialty care due to lower specialist supply in their community^{4,5}. As a result, family physicians in rural areas tend to provide more comprehensive care,⁶ a greater volume of care and a wider range of services including emergency, surgery, and maternity care,⁵ and they are more likely to provide acute injury services and services related to treating pain.⁷

This study used bivariate analysis and multivariate regressions to investigate the clinical service patterns of over 65,000 family medicine physicians. Using Medicare claims data, we examined how the *range* and *focus* of services provided to patients varied between family medicine physicians practicing in rural and urban areas. The *range* in scope of care refers to the number of different types of services provided by an individual physician, whereas the *focus* dimension measures the relative share these diagnoses make up of a physician's practice.

Figure 1 provides an illustration of how these two dimensions of practice could combine to produce different archetypes of physician practices. We frame our results within the broader concept of *plasticity* which provides a framework to understand how variation in the volume and types of conditions seen by a physician depends on the numbers and specialties of other physicians in their community, the physician's demographic characteristics, the amount of time elapsed since they finished training, their practice setting and their geographic location.⁹

Figure 1: Physician Archetypes across Range and Focus Dimensions

		Range	
		High	Low
Focus	High	Physician who sees relatively wide range of diagnoses that are uniformly distributed across their practice (archetype: a specialist who provides generalist care)	Physician who sees relatively fewer diagnoses that are uniformly distributed across their practice (archetype: specialist)
	Low	Physician who sees relatively wide range of diagnoses that are uniformly distributed across their practice (archetype: generalist)	Physician who sees relatively fewer diagnoses that are uniformly distributed across their practice (archetype: generalist physician with a specialized practice)

II. Methods

Sample

This study used Medicare claims data to assess differences in the numbers of services (*range*) provided by PCPs in rural and urban areas and the share these services made up of their practice (*focus*). Using a retrospective cross-sectional study design, we identified the individual- and organizational-level factors associated with variation in a physician's focus and range of practice. The study includes physicians who reported a specialty of "Family Medicine" in the 2017 American Medical Association Physician Masterfile. Excluded from the analysis are family medicine physicians whose certification data from the American Board of Medical Specialties included any other subspecialization certificate (e.g., sleep medicine, sports medicine).

This subset of family medicine physicians was merged with the 100% Medicare fee-for-service claims data file in 2017. We joined the physician data using the National Provider Identifier (NPI) from the AMA

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Masterfile to the performing NPI listed in the Carrier and Outpatient claims files. For each claim, the principal ICD-10 code was categorized into one of 136 clinically distinct groups using the Agency for Healthcare Research and Quality Clinical Classification Software (CCS) Level 2 grouper.¹ Once joined, we excluded physicians who provided services to fewer than 100 Medicare beneficiaries to ensure adequate sample size for our method of calculating concentration of services.

Physicians were categorized as practicing in an urban or rural location using the billing ZIP code listed in claims, which was cross walked with county FIPS. Rural-Urban Continuum Codes (RUCC) categorized each physician's county as being rural (RUCC ≥ 4) or urban (RUCC < 4). Finally, the Area Health Resource File was used to merge county characteristics based on FIPS codes.

The study's analytic file was aggregated to the physician level, with both individual physician characteristics and county characteristics. For each of the 136 CCS diagnosis groups, we calculated each physician's share of their claims with primary diagnosis codes in each group. *The final analytic sample consisted of 60,957 physicians, of which 9,940 practiced in rural areas (16.3%) and 51,017 practiced in urban areas (83.7%).*

Dependent variable

To characterize the focus and range of a physician's services, we utilized methods from industrial organization economics. The primary dependent variable was the Herfindhal index, which has previously been used to measure the concentration of a provider's services.^{10,11} It is calculated as the sum of squared shares, where the shares are the proportion of all visits to a physician for each CCS group. Higher values indicate a more concentrated (higher focus, lower range) scope of services; the index approaches zero ($0.0073 = 136 * (1/136)^2$) for a physician that provides an equal number of visits in each of the 136 CCS categories and is 1.0 for a physician that provides visits from only one CCS group.

When used to describe concentration in the types of services provided by a physician, the Herfindhal index represents an aggregate measure of both a physician's focus and range and range of practice. To disaggregate this measure into its component parts, we used the Adelman decomposition¹² of the Herfindahl index to examine differences in the underlying dimensions of concentration separately: (a) the **range** of services provided by a family medicine physician measured by the number of diagnoses seen and (b) the **focus** of their practice measured by the relative share that each of 136 diagnoses comprised of their practice. To do so, we rewrote the Herfindahl index as $(CoV+1)^2/n$, where CoV is the coefficient of variation and n is the total number of CCS categories represented (i.e., number of categories with at least 1 claim) for a given physician. The numerator -- $(CoV+1)^2$ -- captures the unevenness in shares of services across diagnoses such that higher values mean stronger focus. The denominator -- n -- is simply the count of distinct diagnosis categories which represent range. We take the natural logs of each component (log HHI, log numerator, log denominator) as three different dependent variables to examine the relationships between our covariates and each of the dimensions of concentration separately.

Figure 2 demonstrates this principle graphically for three hypothetical physicians A, B, and C. Physician A sees two diagnoses and has an equal share of both. Physician B sees two diagnoses and has 70 percent of one and 30 % in the other. The range (N) and focus (CoV^2+1) are shown for each physician. Physicians A and B have identical Range (2) but B has more focus. Physicians B and C have similar focus but C has more range.

Independent variables

The primary variable of interest was whether the physician practiced in a rural or urban location. We also controlled for the following individual physician characteristics as reported in the AMA Masterfile: number of years since graduating medical school, sex, their employment setting (office-based practice vs other), and their practice type (self-employed in solo practice, group practice or other).

We controlled for county characteristics related both to the structure of the local healthcare market and sociodemographic characteristics of the population, including:

- whether the county was considered a whole county Primary Care Health Professional Shortage Area (HPSA)
- hospital beds per 100,000 population
- the percent of population less than 65 without health insurance, percent in poverty, percent eligible for Medicare, and the unemployment rate
- average Medicare hierarchical condition category (HCC) score and per capita Medicare cost

We also controlled for the number of medical specialists, surgical specialists, nurse practitioners, and physician assistants per 100,000 population in the physician's county of practice. We hypothesized that the supply of medical specialists, PAs, and NPs in a county could affect a family medicine physician's scope of practice based on previous work suggesting that family medicine physicians who work with NPs and PAs see a higher number of patients and wider range of diagnoses¹³. We also hypothesized that family medicine physicians' practice patterns would be uncorrelated with surgical specialists because there is less substitutability of services between them.

Statistical analysis

We conducted bivariate analyses, including t-tests for continuous variables and chi-squared tests for categorical variables to examine unadjusted differences by urban/rural location. Then, we estimated separate multivariable regressions with three dependent variables: 1) the Herfindahl index as used in previous studies as a measure of overall measure of concentration of a physician's practice; 2) the focus of services provided (the numerator of the Herfindahl index) by a family physician; 3) the range in the number of CCS diagnoses seen by the physician (the denominator of the Herfindahl index). All dependent variables were converted to their natural log to allow interpretation as a percentage difference and to ensure the subcomponents sum to the overall Herfindahl index (aggregate concentration); the sign of the denominator was converted so that positive values for both coefficients implied higher focus or higher range. Each regression used ordinary least squares, controlled for the individual and county characteristics listed above, and clustered standard errors by county to account for within-county correlation.

III. Findings

Table 1 shows that of the 60,957 physicians providing at least 100 visits to Medicare FFS beneficiaries, 9,940 (16%) provided care in rural counties and 51,017 (84%) in urban counties. FM physicians differed by rurality on all measured characteristics. Notably, relative to urban FM physicians, rural FM physicians had larger average volume of Medicare visits, were more likely to be male, less likely to be office-based, and less likely to practice in a medical group. The mean Herfindahl was 0.092 among urban FM physicians and 0.087 among rural FM physicians suggesting that on an unadjusted basis, rural FM physicians had less concentrated portfolios of diagnoses. FM physicians also had, on average, 60.27 diagnosis categories represented across their Medicare panel compared to 57.26 for urban physicians. However, while statistically significant, the difference of about 0.005 in the Herfindahl index and the 3.01 difference in the number of CCS categories is likely not meaningful in terms of describing different practice patterns between rural and urban physicians.

Table 2 displays the top ten diagnosis groups seen by rural and urban family medicine physicians and the percent these visits comprise of all visits. The data show no major differences in the types of conditions seen or the ranking of diagnoses seen between the two groups. Comparing the top 10 diagnosis reveals urban physicians are more likely to see patients with complicated diabetes and lipid disorders while rural physicians see more chronic obstructive pulmonary disease and back problems.

After controlling for physician and practice characteristics (Table 3), overall concentration for rural FM physicians was not statistically different from their urban counterparts—a difference of 1.3% (95% CI (-.038, .013)). The lack of a difference in total concentration, however, masks differences in the two dimensions of practice which move in opposite directions:

- ***Focus:*** Rural physicians' services were 4.2% *less* focused across disease categories ($p < 0.001$) compared to urban physicians
- ***Range:*** Rural physicians provided 3.0% greater range of services than their urban counterparts ($p < 0.05$).

That is, rural FM physicians were more likely to specialize less (have more uniform shares across the services they provide) and provide more unique services.

Physician and county characteristics showed distinct patterns on focus and range. Physicians that graduated medical school longer ago were more concentrated (95% CI: .005, .006) due to more focus. Females had more concentrated services overall, due on balance to having 9.7% higher range but 5.6% less focus. Office-based physicians had higher concentration due to more focus, but had similar number of distinct diagnoses (i.e. range). Self-employed solo practitioners had higher concentration due to more focus, although their range was lower. Family medicine physicians practicing in areas with higher supply of medical specialists or physician assistants had lower range but higher focus.

IV. Discussion

Contrary to our hypotheses, after adjusting for demographic, practice and geographic factors, rural and urban family medicine physicians appear to have similar overall degrees of concentration of diagnoses. On an unadjusted basis, the differences were small but statistically significantly different. Rural family physicians saw a broader number of CCS categories and had a lower Herfindahl index (Table 2). However, after adjusting for practice characteristics, the difference was statistically insignificant (Table 3). Our analysis of Medicare fee for service claims showed that there was no difference in the average concentration of services between rural and urban FM physicians.

While previous studies^{10,11} have used concentration measures to evaluate differences in the scope of services provided by physicians, an important contribution of this analysis is showing that the concentration measure masks important differences in the range and focus of services provided by physicians. Existing metrics for comprehensiveness of care—defined as “the provision of integrated, accessible health care services by clinicians who are accountable for addressing a large majority of personal health care needs”¹² are largely based on the “range” dimension -- *whether* the physician ever provides the service¹⁴. The additional dimension of focus examines *how often* the physician provides that service in practice. In this study, the focus of services by rural physicians was lower than that of urban physicians but rural physicians provided care for a broader range of diseases in their practice. Also interesting is that many of the coefficients on focus and range in the regression had different signs suggesting that that the demographic, practice and geographic factors influencing family medicine physicians’ practice have diverging effects on the range of services they provide and the degree to which they focus on particular diagnoses.

The results suggest that family medicine physicians practicing proximate to more medical specialists provided a 1.4% lower range of services. This finding is consistent with the core theory of plasticity: when specialists are scarce (as in many rural counties), FM physicians inherently broaden their focus into niche areas but must still concentrate on fewer overall categories.

Physicians’ demographic and practice characteristics are related to the range and focus of services provided. Female physicians had less focused practices but they provided a higher range of services compared to their male counterparts. Physicians in office-based practices (vs hospital and other settings), and physicians in self-employed solo and group practices had more focus but provided a lower range of services compared to other practice types. Consistent with literature showing that scope of practice narrows over a physician’s career¹⁵, physicians who have been out of medical school longer had more focused practices.

V. Policy Implications

Rural and urban family physicians face different local ecosystems. Fewer primary care physicians, and many fewer specialists practice in rural settings. This may influence primary care physician practice behaviors. For example, rural family physicians may see a wider range of diagnoses because fewer specialists are available and they may have less concentrated practices (e.g. they see just a few cases of everything). Decomposing a common used measure of concentration into two dimensions of practice: 1. range (how many different diagnoses) and focus (the degree to which diagnoses are seen in different volumes) allows us to assess each of these elements of physician practice separately.

Using 2017 data we found that compared to their urban counterparts, rural family physicians, on average, saw more unique diagnoses with a more uniform distribution in their practice. This means they saw a fair amount of a lot of diagnoses, rather than a lot of some diagnoses and a little of many.

Although the differences are small, there are some implications of the findings. For example, the broader and less concentrated scope suggests differential training strategies may be appropriate depending on the setting where the physician will practice. There may be implications for payment policy; rural family physicians may be less likely to hit volume targets in specific diagnoses but may be more likely to hit multiple target areas. Finally, practice structure was important: physicians in solo practice were more focused and had lower range, indicating that setting is an important driver of the scope of services available to local community members and is related to where physicians in the community are employed.

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APPENDIX

Table 1. Descriptive statistics

Characteristic	Urban n=51,017	Rural n=9,940	P- value*
Total visits, mean (SD)	902.86 (989.34)	1082.47 (1145.95)	<0.001
Herfindahl index	.092 (.091)	.087 (.084)	<0.001
Years since graduating med school, mean (SD)	22.97 (11.51)	23.40 (11.87)	<0.001
Gender, n (%)			
Male	30757 (60.29%)	6946 (69.88%)	<0.001
Female	20260 (39.71%)	2994 (30.12%)	
Employment Setting, n (%)			
Other	5268 (10.33%)	1237 (12.44%)	<0.001
Office-based	45749 (89.67%)	8703 (87.56%)	
Practice type, n (%)			
Other	14883 (29.17%)	3070 (30.89%)	<0.001
Self-employed solo	7897 (15.48%)	1724 (17.34%)	
Group practice	28237 (55.35%)	5146 (51.77%)	
Whole-county HPSA, n (%)	683 (1.34%)	1191 (11.98%)	<0.001
Number of CCS categories represented, mean (SD)	57.26 (17.51)	60.27 (19.32)	<0.001
Log Herfindahl index, mean (SD)	-2.56 (0.52)	-2.62 (0.52)	<0.001
Log numerator, mean (SD)	1.43 (0.42)	1.42 (0.43)	<0.001
Log denominator, mean (SD)	-3.98 (0.40)	-4.03 (0.41)	<0.001

*Statistical testing performed using chi-squared tests for categorical variables and two sample t-tests for continuous variables

Table 2. CCS Rankings

Urban			Rural		
Rank	CCS category	% of visits	Rank	CCS category	% of visits
1	Hypertension	9.30%	1	Hypertension	10.10%
2	Diseases of the urinary system	8.30%	2	Diseases of the heart	9.00%
3	Diseases of the heart	8.10%	3	Factors influencing health care	6.20%
4	Factors influencing health care	5.50%	4	Diseases of the urinary system	6.20%
5	Diabetes mellitus without complication	3.80%	5	Diabetes mellitus without complication	4.60%
6	Non-traumatic joint disorders	3.40%	6	Respiratory infections	3.90%
7	Diabetes mellitus with complications	3.10%	7	Symptoms; signs; and ill-defined conditions	3.30%
8	Respiratory infections	3.00%	8	Non-traumatic joint disorders	3.30%
9	Symptoms; signs; and ill-defined conditions	3.00%	9	Chronic obstructive pulmonary disease and bronchiectasis	2.90%
10	Disorders of lipid metabolism	2.70%	10	Spondylosis; intervertebral disc disorders; other back problems	2.90%

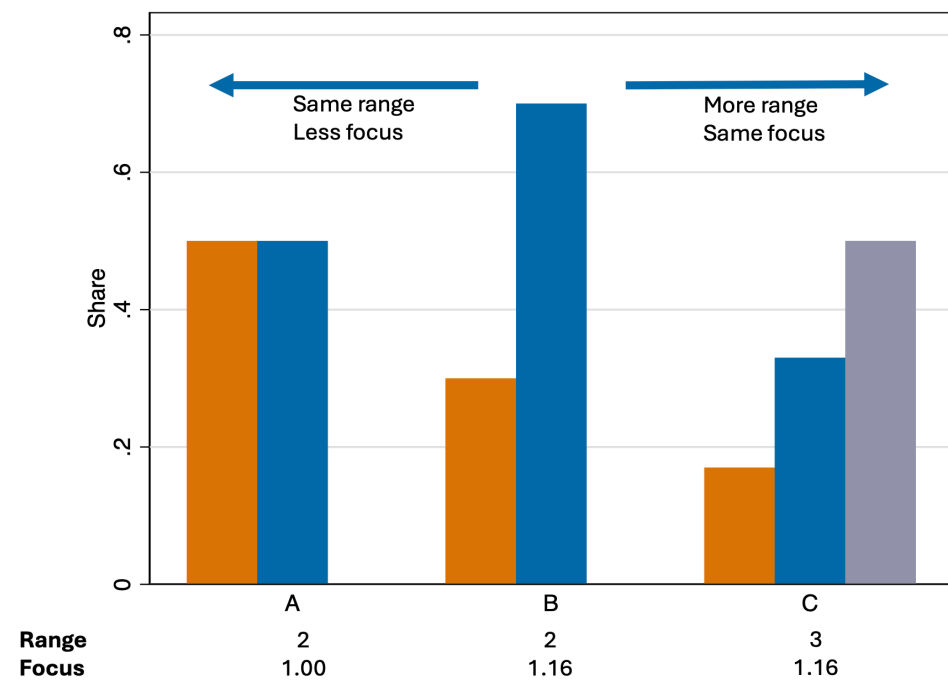
Table 3. Regression

	Overall concentration [+ means more concentrated]	Focus [(+ means more focus]	Range [+ higher range]
Rural	-0.013 [-0.038,0.013]	-0.042*** [-0.065,-0.020]	0.030** [0.009,0.050]
# years since graduating medical school	0.005*** [0.005,0.006]	0.006*** [0.005,0.006]	-0.000* [-0.001,-0.000]
Female	0.040*** [0.031,0.049]	-0.056*** [-0.063,-0.048]	0.097*** [0.090,0.104]
Office-based	0.066*** [0.047,0.084]	0.071*** [0.057,0.085]	-0.005 [-0.018,0.007]
Self-employed solo practice	0.057*** [0.040,0.075]	0.110*** [0.096,0.124]	-0.052*** [-0.065,-0.038]
Group practice	-0.009 [-0.023,0.004]	0.068*** [0.058,0.079]	-0.079*** [-0.089,-0.068]
Whole-county HPSA	-0.002 [-0.040,0.035]	-0.062*** [-0.094,-0.029]	0.058*** [0.025,0.091]
# of medical specialists per 10k population	0.006* [0.001,0.010]	-0.004* [-0.008,-0.001]	0.010*** [0.007,0.014]
# of surgical specialists per 10k population	-0.005 [-0.015,0.005]	0.008* [0.001,0.016]	-0.014*** [-0.021,-0.007]
# of nurse practitioners per 10k population	-0.003 [-0.007,0.001]	-0.002 [-0.006,0.001]	-0.001 [-0.004,0.002]
# of physician assistants per 10k population	0.001 [-0.003,0.005]	-0.005* [-0.010,-0.001]	0.006** [0.002,0.010]
# of hospital beds per 10k population	-0.000 [-0.001,0.000]	0.000 [-0.000,0.001]	-0.001** [-0.001,-0.000]
% < 65 without Health Insurance	0.000 [-0.003,0.004]	-0.002 [-0.005,0.000]	0.003 [-0.000,0.005]
% Persons in Poverty	0.000 [-0.003,0.003]	0.001 [-0.002,0.003]	-0.000 [-0.003,0.002]
% eligible for Medicare	-0.015 [-0.242,0.212]	0.310** [0.106,0.515]	-0.316** [-0.522,-0.110]
Unemployment Rate, 16+	0.006 [-0.003,0.016]	0.014*** [0.006,0.022]	-0.008* [-0.015,-0.000]
Medicare FFS Beneficiary Average HCC Score	0.439*** [0.274,0.604]	0.143 [-0.015,0.301]	0.296*** [0.193,0.400]
Standardized,Risk-Adjusted Per Capita	0.000	0.000*	-0.000

Medicare Cost			
	[-0.000,0.000]	[0.000,0.000]	[-0.000,0.000]
Constant	-3.286*** [-3.486,-3.086]	0.869*** [0.690,1.049]	-4.153*** [-4.303,-4.002]
R^2	0.046	0.108	0.046

* <0.1 ; ** <0.05 , and *** <0.001

Figure 2. Example of Relationship between Focus and Range for Three Physicians



ⁱ For example, in the 2025 CCS version, Typhoid fever, unspecified ('DIG001') is grouped Level 2 as "Bacterial Infection", and Typhoid meningitis ('NVS001') is classified as "Meningitis".