The Influence of the Degree of Rurality on EMR Adoption, by Physician Specialty

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Objective. To explore the influence of varying degrees of remoteness on practice-level electronic medical record (EMR) adoption, including whether the effect differs across practice specialty.

Data Sources. Survey data on over 270,000 office-based physician practices (representing over 1,250,000 providers) collected by SK&A information services during 2012.

Study Design. This study examined differences in EMR adoption by practices located across the nine-category rural–urban continuum. Logistic regressions and associated marginal effects are used to assess how much a move up or down the rural–urban continuum code impacts the likelihood of EMR adoption, after controlling for characteristics likely to affect EMR adoption such as practice size and specialty.

Principal Findings. Overall practice-level EMR adoption rates generally increase with the degree of rurality and range from 47 percent in the most urban counties to over 60 percent in the most rural. Moving from the most urban county to the most rural corresponded to a 7 percent increase in the likelihood of EMR adoption ($p < .01$).

Conclusions. EMR adoption rates do vary significantly across nonmetropolitan counties, and they generally increase as a practice becomes more rural. From a policy perspective, this suggests that *urban* practices may in fact be the lowest hanging remaining fruit for increasing EMR adoption rates.

Key Words. Electronic medical records, rural, EMR adoption

Electronic medical records (EMRs) have become increasingly common in medical practices across the country, with physician-level adoption rates increasing from 17 percent in 2002 to 78 percent in 2013 (Hsiao and Hing 2014). However, trends associated with their adoption have changed. While early studies found lower adoption rates in rural practices compared to their urban counterparts (Menachemi et al. 2006), more recent data suggest that the opposite is now true. In fact, one recent study suggests that at the

national level, overall practice-level EMR adoption rates were significantly higher in rural areas (56 percent) versus those in urban locations (49 percent) (Whitacre 2015). Other studies confirm this shift to higher adoption rates in rural practices across the country (King, Furukawa, and Buntin 2013; Whitacre and Williams 2015). Significant praise has been given to the Regional Extension Centers (RECs) created by the Office of the National Coordinator for their role in assisting medical providers with adopting and meaningfully using EMRs in underserved areas, including those in rural locations (Hsaio et al. 2013; King, Furukawa, and Buntin 2013; Samuel et al. 2013; Lynch et al. 2014; Whitacre 2015). Recent evidence indicates that a higher proportion of rural primary care providers enrolled with an REC (52 percent) when compared to all primary care providers (44 percent) (Lynch et al. 2014). However, the binary rural–urban distinction can mask significant differences that exist among rural areas; in particular, some health outcomes and technology utilization rates have been seen to vary by degree of rurality (Hawley et al. 2002; Auger et al. 2009; Okrah et al. 2012). The existing EMR literature lacks any formal review of how the technology has been adopted across “rural” (defined as nonmetropolitan) counties. We know very little about whether the shift toward higher EMR adoption in rural areas is being driven by practices in highly rural locations or by those that are on the outskirts of more urban areas. In particular, there may be notable adoption differences between nonmetro counties that are highly rural in nature and those that are closer to (and more likely to be influenced by) metropolitan neighbors. This paper addresses that gap by explicitly detailing EMR adoption rates across rural–urban continuum codes and using logistic regressions to estimate the marginal impact of changing specific codes on the likelihood of EMR adoption. Recent evidence suggests that EMRs have benefits for the structure and process of physician offices (Holroyd-Leduc et al. 2011). EMR adoption is also associated with improved patient outcomes, as 78 percent of physicians with EMRs report that EMR use enhanced patient care and 65 percent indicated that they alerted them to a potential medication error (King et al. 2014). As the federal REC effort comes to a close, the role of the degree of rurality on EMR adoption should be assessed in order to develop more effective adoption-oriented programming in the future.

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DATA

Rural–Urban Classification Schemes

Historically, many health researchers have used the county-based scheme developed by the U.S. Office of Management and Budget to differentiate between metropolitan and nonmetropolitan areas. Metropolitan (or “urban”) counties are those that contain a metropolitan statistical area (MSA), which has a population of at least 50,000, as well as those that are economically linked to MSAs (defined by the percent of workers who commute to the MSA). The remaining, nonmetropolitan counties are considered “rural.” This dichotomous and straightforward classification has been widely used due to its simplicity of application; however, many studies have shown that characteristics within rural counties can vary widely. This includes demographics such as the proportion of elderly or percentage uninsured, and also access to specific types of health services and even health outcomes (Ricketts, Johnson-Webb, and Taylor 1998; Hawley et al. 2002; Auger et al. 2009; Okrah et al. 2012). Most EMR studies to date that have looked at the rural influence on adoption have used the simplistic metro/nonmetro definition (King, Furukawa, and Buntin 2013; Whitacre 2015; Whitacre and Williams 2015).

Alternatively, the rural–urban continuum (RUC) codes provided by the U.S. Department of Agriculture’s Economic Research Service (ERS) are county-level classifications that allow for differentiation of nonmetropolitan counties by their degree of urbanization and their adjacency to metropolitan areas. (Note that “urbanization” refers to the percentage of the county population that resides in “urban” cities, that is, above the 2,500 rural population threshold.) It also allows for differentiation of metropolitan counties based on the size of their MSA (Table 1).

The only study to date to use similar lower level rural classifications in observing EMR adoption rates was based on 2007–2008 data and was focused solely on primary care offices (Singh et al. 2012). At that time, no significant differences in adoption rates across rurality were found. Given the substantial increase in EMR adoption rates since 2007–2008 (particularly in rural areas) and the varying EMR adoption rates seen across specialty practices, this study represents an important update to the Singh et al. (2012) study.

Table 1: 2013 Rural–Urban Continuum Codes as Defined by ERS

<i>Code</i>	<i>Description</i>	<i>No. of Counties (2010)</i>	<i>Percentage of Population (2010)</i>
<i>Metro counties</i>		1,167	85.0%
1	Counties in metro areas of 1 million population or more	432	54.6%
2	Counties in metro areas of 250,000 to 1 million population	379	21.3%
3	Counties in metro areas of fewer than 250,000 population	356	9.2%
<i>Nonmetro counties</i>		1,976	15.0%
4	Urban population of 20,000 or more, adjacent to a metro area	214	4.4%
5	Urban population of 20,000 or more, not adjacent to a metro area	92	1.6%
6	Urban population of 2,500 to 19,999, adjacent to a metro area	593	4.8%
7	Urban population of 2,500 to 19,999, not adjacent to a metro area	433	2.7%
8	Completely rural or less than 2,500 urban population, adjacent to a metro area	220	0.7%
9	Completely rural or less than 2,500 urban population, not adjacent to a metro area	424	0.8%

Source: Economic Research Service (2013).

EMR Data

Data on EMR adoption were purchased from SK&A, a publicly held company that maintains a nationwide listing of ambulatory health care physicians and practices. Their 2012 database includes over 1,250,000 physicians across over 270,000 unique practices. The SK&A database is put together by compiling information from state licensing information, trade publications, and an array of corporate directories (SK&A 2015). An SK&A employee contacts each entry by phone to verify the existing data and also add information such as the number of doctors at the office, the specialty of the practice, the typical daily volume of patients, and whether or not the practice accepts Medicare or Medicaid. Ownership of the practice by a hospital and the presence of an affiliation with a health system are also noted in the data. One data item that is of particular importance for this study is the physical location of the practice (street address), which, when combined with the associated county, allows for assignment of a specific rural–urban continuum code designated by the ERS. The SK&A data have been used in several recent papers on EMR adoption (King, Furukawa, and Buntin 2013; Lynch et al. 2014; Whitacre 2015;

Whitacre and Williams 2015) and are used by the Office of the National Coordinator to estimate the total number of health care providers in each state and county (Office of the National Coordinator for Health Information Technology 2015).

The SK&A data include a series of questions relating to EMR adoption and the types of capabilities that the installed EMR system has. “Adoption” of an EMR system for the purposes of this study was defined by whether or not a practice had EMR technology installed. Other questions allow for more insight into how the EMR system is actually used; two examples are whether the EMR was used for viewing laboratory results or for e-prescribing. This paper uses practice-level adoption data (as opposed to individual physician-level) because the data suggest that 98 percent of physicians who work for a practice that has an EMR will be users of the system themselves.

Given the wide variation in EMR adoption, even among practices in nonmetro counties, this paper attempts to estimate the impact on the likelihood of adoption by moving to a specific RUC code. This is done for specific types of ambulatory practices (including the most popular specialties) and allows for more detailed insight into the role that rurality plays in the EMR adoption decision.

METHODS

Simple *t*-tests on summary statistics allow for comparisons of practice-level characteristics (including EMR adoption rates) across the nine RUC codes. To model the relationship between these characteristics and the likelihood of EMR adoption, a basic logistic regression is used. This regression takes the form:

$$y_i^* = \hat{\beta}' X_i + \hat{\delta}' R_i + \varepsilon_i$$

where y_i^* is an unobserved measure of the costs/benefits related to EMR adoption for practice i , X_i is a vector of practice characteristics (such as specialty or patient volume) that may influence the adoption decision, R_i is a vector of eight dummy variables relating to the RUC code (from 2–9, leaving RUC = 1 as the reference category) for the physical location of the practice, $\hat{\beta}$ and $\hat{\delta}$ are parameter estimates, and ε_i is the associated error term. y_i^* is not formally observed, as no values are quantified for the costs and benefits of adoption. Instead, the data only show whether adoption occurs ($y_i = 1$; $y_i^* \geq 0$) or does not ($y_i = 0$; $y_i^* < 0$).

The explanatory variables are generally those that have been suggested by the literature on EMR adoption and include most of the characteristics discussed above. The type of practice has been shown to influence EMR adoption, so the vector of practice characteristics includes dummy variables for the four types of primary care categories (family practice, internal medicine, OB/GYN, and pediatrician) and also the eight most common types of specialties that arise in the data (multispecialty practices, psychiatry, ophthalmology, orthopedic surgeon, cardiology, general surgery, and radiology). The default category for practice type is then “all other specialties.” EMR adoption rates are also known to vary across practice size and volume, so a series of dummy variables attempt to account for these measures. Dummy variables for practices with 2–3 physicians and 4 or more physicians are included relative to the base category of a solo practice. Similarly, dummies for daily patient volume (50–100 patients and more than 100 patients) are used relative to the default of less than 50 patients. Although it may seem intuitive that patient volume and number of physicians at a practice are collinear, the correlation between the two is only 0.62—suggesting that both categories can be included without multicollinearity problems. Recent research has shown that the Medicare and Medicaid incentive payments were influential on increasing EMR adoption—particularly for rural practices. Unfortunately, the SK&A data do not disclose whether or not a practice participated in these programs; however, dummy variables on whether a practice accepts this type of payment are included. Affiliation of the practice with a health system and ownership of the practice by a hospital are also included via dummy variables as these factors have been shown to increase the likelihood of EMR adoption. Finally, the employment of nurse practitioners (NPs) and physician assistants (PAs) or doctors of osteopathy (DOs) at a particular practice is also included.

Of particular interest for this regression will be the adjusted odds ratio and statistical significance associated with the RUC code dummy variables. By leaving RUC = 1 as the default, the odds ratios for RUC dummies 2 through 9 show the relative change in odds associated with a move from the most urban category to the appropriate RUC code. Statistically significant changes in adjusted odds ratios are not easy to interpret; instead the marginal effect of the RUC change is used. Marginal effects give the impact to the likelihood of EMR adoption *for a specific change* in percentage point terms, holding all other variables at their means. Marginal effects associated with RUC shifts are also gathered for the four primary care categories and the eight most common specialties in the data.

RESULTS

Table 2 provides a wide array of summary descriptive statistics at the practice level, with entries for each of the nine RUC codes. To observe discrepancies across RUC codes, the means in each of the metro categories (RUC codes 1–3) are compared to the *metropolitan* average, while the means in the nonmetro categories (RUC codes 4–9) are compared to the *nonmetropolitan* average. Statistically different means in the nonmetro categories demonstrate the widely recognized concept that ambulatory practices across rural areas are quite heterogeneous. Nearly all types of specialties are less likely in the most rural counties, although *multispecialty* practices are slightly more common in comparison to the nonmetro average. In terms of practice size and volume, solo practices and lower patient volume are more common in the most rural counties. Also of note is that the percentages of practices made up solely of NPs or PAs increases from only 9 percent in RUC = 4 counties to 25 percent in RUC = 9 counties. Practices in more rural counties (RUC = 8 or 9) are more likely to accept Medicare or Medicaid, and these “very rural” practices are also more likely to be affiliated with a health system or owned by a hospital in comparison with their counterparts in counties with RUC codes of 4 or 5.

Table 2 also provides EMR adoption rates for three different categories of adoption (EMR installed, use of the EMR to prescribe, and use of an EMR to view lab results). The metro–nonmetro gap in EMR adoption has been documented previously (Whitacre 2015); however, the varying rates of adoption across nonmetro counties are striking. In particular, the most rural counties have practices with adoption rates that are higher than the nonmetro average, while the relatively urban and adjacent nonmetro counties (RUC = 4) have rates close to those in smaller metro areas (RUC = 3). These trends hold regardless of the type of EMR adoption considered. It is interesting, however, that the adoption rates for definitions for “use” are typically 12–13 percentage points lower than the simple definition of having an EMR installed.

As Figure 1 demonstrates, EMR adoption increases from 47 percent in the most urban counties (RUC = 1) to a high of 60 percent in the most rural (RUC = 9). Perhaps the most striking feature of Figure 1 is the distinction between adoption rates in the most urban categories (RUC = 1&2) and the most rural (RUC = 8&9). While adoption rates in the RUC = 3 through RUC = 7 categories are quite similar, it is on the edges that the diversion is most clearly seen.

Table 2: Office-Based Practice Summary Characteristics by RUC Code (2012)

Type of Practice	Rural–Urban Continuum Code								
	Metro Categories			Nonmetro Categories					
	1	2	3	4	5	6	7	8	9
Primary care (%)	32.4	33.1 ^a	32.4	37.9 ^d	32.0 ^d	46.4 ^c	42.0	61.2 ^c	67.6 ^c
Family practitioner	9.7 ^b	13.8 ^a	15.6 ^a	20.0 ^d	16.1 ^d	30.2 ^c	26.9 ^c	50.5 ^c	55.2 ^c
Internal medicine	11.2 ^a	8.7 ^b	7.9 ^b	8.6 ^c	7.5	8.5	7.3 ^d	7.4	9.9 ^c
OB/GYN	5.9 ^a	5.6 ^b	5.0 ^b	5.1 ^c	5.0 ^c	4.1	4.3	1.2 ^d	1.5 ^d
Pediatrician	5.5 ^a	5.0 ^b	3.9 ^b	4.2 ^c	3.4	3.7	3.6	2.1 ^d	1.1 ^d
Specialist (%)	67.6	66.9 ^b	67.6	62.1 ^c	68.0 ^c	53.6 ^d	58.0	38.8 ^d	32.4 ^d
Multispecialty	10.6	10.7	11.0 ^b	10.1 ^d	11.8	12.5 ^c	13.5 ^c	14.7 ^c	13.8 ^c
Psychiatry	6.8	6.5 ^b	6.1 ^b	5.7	5.9	5.9	5.9	6.2	3.8 ^d
Ophthalmology	4.0	4.3 ^a	3.9	4.3 ^c	4.3	4.0	3.4 ^d	1.6 ^d	1.5 ^d
Podiatry	3.7 ^a	3.2 ^b	3.0 ^b	3.7 ^c	3.1	2.8	2.7	1.5 ^d	0.6 ^d
Orthopedic surgery	3.3	3.1	3.2	3.7	4.1 ^c	3.3	3.8	1.2 ^d	1.1 ^d
Cardiology	3.2	2.8 ^b	2.9 ^b	2.9 ^c	3.0 ^c	2.1 ^d	2.2 ^d	1.5 ^d	1.3 ^d
General surgery	2.5 ^b	2.7 ^a	3.1 ^a	3.8	3.5	4.1	4.4 ^c	1.5 ^d	2.0 ^d
Radiology	2.5 ^b	2.8 ^a	2.8	2.8 ^c	3.3 ^c	2.1 ^d	2.6	1.3 ^d	0.9 ^d
Other specialty	31.19	30.70 ^b	31.83	25.09 ^c	28.92 ^c	16.91 ^c	19.64	9.26 ^d	7.45 ^d
Practice size (%)									
1	54.0 ^a	50.8 ^b	52.6 ^b	57.6	56.2 ^d	59.0	58.8	61.2 ^c	60.6 ^c
2–3	25.7 ^b	26.0	26.4 ^a	27.6	26.4	27.4	26.7	26.6	29.3
4+	20.3	23.1 ^a	21.0	14.8	17.4 ^c	13.6 ^d	14.5	12.3 ^d	10.1 ^d
Daily patient volume (%)									
0–50	80.3 ^a	74.7 ^b	74.9 ^b	78.4 ^d	76.7 ^d	80.4 ^c	79.8	82.5 ^c	84.6 ^c
51–100	14.6 ^b	18.2 ^a	18.0 ^a	16.7	17.3 ^c	15.4 ^d	15.9	15.6	14.2 ^d
100+	5.1 ^b	7.1 ^a	7.1 ^a	4.9	6.0 ^c	4.3 ^d	4.3	2.0 ^d	1.2 ^d

continued

Table 2. Continued

Type of Practice	Rural–Urban Continuum Code									
	Metro Categories					Nonmetro Categories				
	1	2	3	4	5	6	7	8	9	
Providers (%)	75.0 ^a	66.2 ^b	64.9 ^b	63.6 ^c	62.9 ^c	59.9 ^c	57.9 ^c	42.6 ^d	38.9 ^d	
MDs only	10.9 ^b	14.3 ^a	14.1 ^a	16.7	15.2 ^d	15.9 ^d	18.6 ^c	18.5	22.5 ^c	
MDs and DOs	13.7 ^b	18.8 ^a	19.6 ^a	16.8 ^c	17.8	18.2	19.3 ^d	25.4 ^d	27.8 ^d	
NPs/PAs and physicians	3.8 ^b	6.1 ^a	7.5 ^a	9.3 ^d	10.3 ^d	13.2 ^c	12.7	24.1 ^c	24.9 ^c	
NPs/PAs only	81.9 ^b	83.7 ^a	86.5 ^a	88.6 ^d	87.9 ^d	92.5 ^c	92.7 ^c	94.5 ^c	96.9 ^c	
Accepts Medicare (%)	62.2 ^b	68.6 ^a	74.7 ^a	80.7 ^d	81.2 ^d	87.3 ^c	89.2 ^c	93.6 ^c	94.4 ^c	
Accepts Medicaid (%)	13.1 ^b	16.1 ^a	14.3 ^a	10.5 ^d	10.01 ^d	12.1 ^c	11.3	11.5	13.4 ^c	
Affiliated with health system (%)	12.7 ^b	15.9 ^a	17.3 ^a	20.4 ^d	20.5 ^d	25.8 ^c	26.0 ^c	31.9 ^c	33.1 ^c	
Owned by hospital (%)										
EMR adoption (%)										
EMR installed	470 ^b	51.0 ^a	54.5 ^a	54.8 ^d	54.6	56.5	55.5	59.3 ^c	60.5 ^c	
EMR with e-RX capability	35.0 ^b	39.0 ^a	41.6 ^a	42.8	41.3 ^d	43.6	42.2	46.3 ^c	48.7 ^c	
EMR used to view lab results	34.7 ^b	38.9 ^a	41.6 ^a	41.7	41.4	43.0	42.1	46.1 ^c	48.7 ^c	
Number of observations	162,448	55,321	23,631	10,202	4,375	8,473	5,875	855	1,171	

Notes. ^{a(b)}indicates statistically significant higher (lower) means from the metro average at the $p = .05$ level.
^{c(d)}indicates statistically significant higher (lower) means from the nonmetro average at the $p = .05$ level.

Figure 1: EMR Adoption Rates by Rural–Urban Continuum Code (2012)

Note: 95% confidence intervals shown.

Source: SK&A Office-Based Providers Database (2012).

Even so, the focus of this paper is on adoption differences across individual RUC categories. As the 95 percent confidence intervals in Figure 1 suggest, each of the three metro (1–3) RUC codes are statistically different from each other. Additionally, there are measurable differences among the EMR adoption rates across nonmetro RUC codes. These include RUC = 4 versus 6 (55 percent vs. 57 percent, $p < .01$), 4 versus 8 (55 percent vs. 59 percent, $p < .01$), 4 versus 9 (55 percent vs. 60 percent, $p < .01$), 5 versus 6 (55 percent vs. 57 percent, $p = .02$), 5 versus 8 (55 percent vs. 59 percent, $p < .01$), 5 versus 9 (55 percent vs. 60 percent, $p < .01$), 6 versus 9 (57 percent vs. 60 percent, $p < .01$), 7 versus 8 (55 percent vs. 59 percent, $p = .02$), and 7 versus 9 (55 percent vs. 60 percent, $p < .01$).

The data also provide additional detail into EMR adoption rates by specific types of practices. Generally, some types of practices have remarkably high EMR adoption rates (multispecialty, radiology, more than four doctors, and those affiliated with health systems). The general trend of higher adoption rates as increasing levels of rurality holds in almost all cases. Several additional statistics (not shown) are worthy of specific mention. EMR adoption rates in primary care practices, notably family practitioners, are measurably higher in the most rural RUC codes. This also holds for solo practitioners and those with low patient volume. EMR adoption rates are highest in cases where NPs and PAs work alongside physicians (compared to those with MDs only or DOs only), and are also higher when practices accept Medicare or Medicaid, or when associated with a health system/owned by a hospital. The association with Medicare/Medicaid could be indicative of a practice's participation in

the related federal incentive programs that provide payments for installing and meaningfully using EMRs (Centers for Medicare and Medicaid Services [CMS] 2010); this measure may serve as a proxy for such participation. However, the data only focus on whether or not the practice accepts Medicare/Medicaid and as such is an imperfect substitute for incentive program participation.

The basic logistic regression results are reported in Table 3. The associated odds ratios are generally as expected, given the trends discussed above. In terms of the type of the ambulatory practice, some specialties show higher odds of EMR adoption (family practice, internal medicine, pediatrician, multispecialty, podiatry, cardiology, and radiology), while others show lower odds (obstetrics/gynecology, psychiatry, ophthalmology, and orthopedic surgery) in comparison to the base category of “other specialty.” Larger practices, both in terms of number of doctors and number of patients, positively influence the likelihood of EMR adoption. Interestingly, the inclusion of DOs, NPs, and PAs at a practice all positively influences EMR adoption. Being affiliated with a health system, being owned by a hospital, and accepting Medicare (perhaps reflecting participation in the Medicare incentive program) all have a positive impact on the likelihood of EMR adoption.

After controlling for these characteristics, the impact of changing RUC categories is still highly significant. Each of the eight remaining RUC codes has significantly higher odds of EMR adoption when compared to the base category of RUC = 1.

Table 4 displays the marginal effects associated with RUC codes two through nine for the whole sample of over 270,000 practices. Each number represents changes to the likelihood of EMR adoption given a move from the reference category of RUC = 1 (the most urban) to the relevant RUC code. All other variables are evaluated at their means. The increased probability of EMR adoption ranges from 5.8 to 6.9 percentage points across the non-metropolitan codes of 4–9, and all are highly statistically significant. However, the variance among these nonmetro marginal effects is not large.

Pairwise comparison of these marginal effects indicates that *none* of the marginal effects across the *nonmetro* RUC codes shown in Table 4 are statistically different from one another ($p > .05$). Furthermore, five of the six nonmetro codes are not even statistically different from the metro category RUC = 3 ($p > .05$). Thus, even though the aggregate EMR adoption rates were significantly different across certain nonmetro RUC codes (Figure 1), the impact of changing RUC codes does not vary among the nonmetro

Table 3: Logistic Regression of Practice-Level EMR Adoption (2012)

<i>Type of Practice</i>	<i>Odds Ratio</i>	<i>95% Confidence Interval</i>	<i>p-values</i>
Primary care			
Family practitioner	1.327***	1.29–1.36	<.001
Internal medicine	1.205***	1.17–1.24	<.001
OB/GYN	0.889***	0.85–0.92	<.001
Pediatrician	1.173***	1.13–1.22	<.001
Specialist			
Multispecialty	1.035**	1.00–1.06	.044
Psychiatry	0.518***	0.49–0.53	<.001
Ophthalmology	0.789***	0.76–0.82	<.001
Podiatry	1.675***	1.60–1.75	<.001
Orthopedic surgery	0.910***	0.87–0.95	<.001
Cardiology	1.257***	1.20–1.32	<.001
General surgery	0.964	0.92–1.01	.142
Radiology	1.466***	1.39–1.54	<.001
Other specialty	Reference		
Practice size			
1 doctor	Reference		
2–3 doctors	1.455***	1.42–1.49	<.001
4+ doctors	1.972***	1.92–2.03	<.001
Daily patient volume			
0–50	Reference		
51–100	1.260***	1.23–1.29	<.001
100+	1.439***	1.38–1.50	<.001
Providers			
MDs only	Reference		
MDs and DOs	1.091***	1.06–1.12	<.001
NPs/PAs and physicians	1.417***	1.38–1.45	<.001
NPs/PAs only	1.597***	1.54–1.65	<.001
Accepts Medicare	1.312***	1.28–1.35	<.001
Accepts Medicaid	1.002	0.98–1.02	.687
Affiliated with health system	1.397***	1.36–1.43	<.001
Owned by hospital	1.187***	1.16–1.22	<.001
Rural–urban continuum code			
1	Reference		
2	1.085***	1.06–1.11	<.001
3	1.257***	1.22–1.29	<.001
4	1.312***	1.26–1.37	<.001
5	1.297***	1.22–1.38	<.001
6	1.340***	1.28–1.40	<.001
7	1.285***	1.22–1.36	<.001
8	1.328***	1.15–1.53	<.001
9	1.346***	1.19–1.52	<.001

continued

Table 3. *Continued*

<i>Type of Practice</i>	<i>Odds Ratio</i>	<i>95% Confidence Interval</i>	<i>p-values</i>
Intercept	0.448***	0.44–0.46	<.001
Pseudo R^2	0.054		
Number of observations	272,351		

** and *** indicate statistical significance at the $p = .05$ and 0.01 levels, respectively.
DO, doctors of osteopathy; MD, medical doctors; NP, nurse practitioners; PA, physician assistants.

Table 4: Marginal Effects of Changing RUC Code on EMR Adoption (All Practices)

<i>RUC Code</i>	<i>Marginal Effect</i>	<i>SE</i>	
1	Reference		
2	0.019***	0.002	
3	0.053***	0.003	A
4	0.063***	0.005	AB
5	0.060***	0.007	AB
6	0.068***	0.005	B
7	0.058***	0.006	AB
8	0.066***	0.017	AB
9	0.069***	0.014	AB
No. of obs	272,351		
Pseudo R^2	0.054		

Notes. Margins sharing a letter (A, B) are not significantly different from each other at the $p < .05$ level. All other variables evaluated at their means.
***Indicates statistically significantly different from reference at the $p < .01$ level.

categories once other characteristics such as practice type, size, and hospital ownership are taken into account.

Additional analysis shows, however, that the marginal effects associated with changing RUC codes differ by specialty. Logistic regressions were run on specific subsets of the data (the four primary care categories and eight specialty types of practices shown in Table 2). As detailed in Appendix A (available online), the marginal effects of moving from the most urban county to other RUC codes varies from being not significant at all (radiology) to being highly significant and economically meaningful (psychiatry—where a move to RUC code 6, 7, or 8 is associated with a roughly 20 percentage point increase in the likelihood of EMR adoption).

Other specialties are generally consistent with the overall result demonstrated in Table 4. The four primary care categories have marginal effects ranging from 2 percent to 10 percent for a move from the most urban code to any nonmetro code; other specialties have marginal effects of over 12–15 percent for moves to nonmetro codes (multispecialty, orthopedic surgery).

DISCUSSION

This research is among the first to document EMR adoption rates for medical practices across the rural–urban continuum. At an aggregate level (and after controlling for practice specialty and other predictors of EMR adoption), the marginal impacts of moving away from the most urban counties are relatively similar for most types of nonmetropolitan counties (RUC codes 4 through 9). These impacts range from 5.8 percent to 6.9 percent, and none are statistically different from each other. However, additional results indicate that the marginal impacts of moving across RUC codes on EMR adoption do vary significantly by specialty. These differences suggest that, for at least some specialties, the designation of a practice's degree of rurality is important. For multispecialty practices, the marginal impact of moving to the most remote category of counties is 18 percentage points, which is statistically higher than the impact for all other RUC codes. Psychiatry also demonstrates high marginal impacts associated with rurality, ranging from 12 percentage points for a move to a relatively urban nonmetro county (RUC = 4) to 20 percentage points for a move to a more rural category (RUC = 6). Other specialties exhibit consistent marginal impacts in the 6–8 percentage point range across nonmetro RUC codes (general surgery), while others have no significant results at all (radiology).

The differences shown across specialties (and across degrees of rurality) may be indicative of the emphasis that specific RECs put on certain types of practices. Alternatively, it has been suggested that these fluctuations may arise from the differing levels of success that professional organizations have had in distributing EMR-related information to their members (Whitacre 2015). For example, the American Podiatric Medical Association has developed an EMR decision guide for their physicians, while the American College of Physicians (an association for Internal Medicine practitioners) provides a road map and tools for EMR adoption, and offers member discounts on EMR market share reports.

Limitations

The SK&A data are self-reported and may be subject to measurement error. Furthermore, this study utilized a definition of EMR adoption that was solely based on whether the technology had been installed, and it was not based on “meaningful use” criteria that are required for Medicare or Medicaid Incentive program reimbursement. It should be noted that while 80 percent of primary care providers enrolled with an REC had an EMR installed, only 50 percent had demonstrated meaningful use as of 2013 (Lynch et al. 2014). As financial penalties loom for practices that have not demonstrated meaningful use as of 2015, using a definition of EMR adoption more geared toward “use” would be an improvement to this analysis. In particular, it would be interesting to determine whether rural–urban discrepancies exist among the percentages of practices that have installed EMRs but have not met the official definition of meaningful use. Finally, the fit of the logistic models ranges from pseudo- R^2 values of 0.02 to 0.09, which are not exceedingly high in terms of explanatory power. However, the area under the curve for these models ranges from 0.65 to 0.74, which is around the threshold of 0.70 typically considered to be reasonable (Hosmer and Lemeshow 2000).

CONCLUSION

This study finds that, in general, rates of EMR adoption among physician offices tend to increase with the degree of rurality. The results of the logistic regressions and marginal effect analysis indicate that at the aggregate level, the impact of moving from the most urban classification of county to a non-metropolitan one is around a 6–7 percentage point increase in the likelihood of EMR adoption, and the effect does not vary much across nonmetropolitan designations. However, the “rural influence” on EMR adoption rates does vary substantially by specialty, with some types of practice displaying no significant marginal impacts while others demonstrated impacts that jumped from 10 to 20 percentage points across RUC codes.

The REC program has largely been seen as successful in its goal of supporting over 100,000 providers in small, rural, and underserved practices achieve meaningful use of an EMR system. While over 10,000 specialty practices worked with RECs, priority was given to those in primary care practices (Samuel et al. 2013; Lynch et al. 2014). The evidence here

suggests that more rural practices have fared very well in terms of EMR adoption; however, the data do not speak explicitly to the role of RECs as it does not contain information on which practices participated in the REC program. Recent evidence suggests that EMR nonadopters are much more likely than adopters to regard national health information technology policies (including financial penalties, incentive payments, and technical assistance) as major influences in their adoption decision (Jamoom et al. 2014). Furthermore, recent surveys among REC participants suggest that although the technical assistance they received was beneficial, they typically wanted additional education or support after the installation—sometimes months or years after (Boas et al. 2014). As some RECs move from government-provided funding into self-sufficiency, this desire for long-term follow-up should be included in their transition plan, as should methods for engaging nonadopters. The data show that certain specialties lag behind in terms of EMR adoption—and that the degree of rurality does matter in many cases. It also demonstrates that *urban* practices may in fact be the lowest hanging remaining fruit. When combined, these findings provide evidence that the remaining RECs can find a niche by catering to urban specialty practices that lag behind—notably, in psychiatry, orthopedic surgery, and multispecialty practices. A 2014 survey found that 85 percent of REC executives did not expect to close their doors after their government funds were exhausted (Healthcare Information and Management Systems Society [HIMSS] 2014). The RECs that remain should be aware of these trends, and would also benefit from a series of “lessons learned” from particularly successful RECs. Continuing to assess variation in EMR adoption across degrees of remoteness will be important for state and national policy makers, especially as penalties for not demonstrating meaningful use begin in 2015.

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SUPPORTING INFORMATION

Additional supporting information may be found in the online version of this article:

Appendix SA1: Marginal Effects of Changing RUC Code on EMR Adoption, by Specialty.