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Hospital Closure and Hospital Choice: How Hospital Quality and Availability will Affect Rural Residents

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Deepak Premkumar[1], Dave Jones[2], Peter F. Orazem[3]

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This study estimates a model of rural patient hospital choice between the nearest rural hospital, the nearest urban hospital, or the nearest research hospital. We present separate estimates for inpatient and outpatient visits, for different diagnoses, and for emergency and nonemergency admissions. The analyses illustrate the tradeoffs between hospital quality and distance in deciding whether to choose the nearest hospital or to travel farther for an alternative. The model parameters are used to simulate two hospital closing scenarios for both outpatient and inpatient data: 1) closing 25% of lowest quality rural hospitals and 2) closing 15% of the least used rural hospitals. Closing 25% of the lowest quality rural hospitals results in a 20.7% increase in expected distance and a 7.7% increase in expected hospital quality for those with inpatient ailments. Closing the least used hospitals modestly increases average distance but lowers average quality. We conclude that closing the lowest quality rural hospitals is a better policy prescription than closing the least used hospitals since closing low quality hospitals results in a substantial increase in average quality of hospital with only a slight increase in distance traveled for chosen hospitals.

JEL Classifications: I11, H51, O18

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I. Introduction

The population shift from rural to urban regions has decreased the population density around hospitals in small towns and rural areas. At the same time, the availability of improved road systems that lower travel times, improved ability to deliver health services via the Internet, and larger urban-rural gaps in access to the latest medical technologies may make urban hospitals more attractive for rural patients. The combination of thinning populations and greater competition from urban hospitals make it more difficult for rural hospitals to maintain a large enough patient base to cover their costs on more specialized areas of health care delivery and threaten their ability to provide even the most common procedures. These financial exigencies threaten the future economic viability of rural hospitals (American Hospital Association, 2011).

As shown in Figure 1, the number of rural hospitals has declined more sharply than urban hospitals. Since 1990, the number of rural hospitals decreased 20% while the number of urban hospitals only decreased 3.5%. The steady decrease in rural hospitals over the last two decades continues a pattern of decline that began in the 1970s (Capalbo and Heggem, 1999). An issue we address in this study is the extent to which the declining rural health care options leaves rural residents without hospital care options or whether urban hospital services are replacing the exiting rural hospitals.

Iowa is a state with a large number of rural hospitals. Rural hospitals are particularly dependent on publicly subsidized healthcare provision with almost 60% of their revenues coming from Medicare and Medicaid. Medicare's Critical Access Hospital program started in the 1990s. It was devised to prop up hospitals in isolated areas where residents had few other healthcare options. Under its original rules, these hospitals had to be located at least 35 miles away from any other hospital to qualify. However, the law was amended to allow the states to designate “necessary provider” hospitals. Currently, Iowa has 82 hospitals receiving funds from the program, second only to Kansas with 83. Only about a third of the nation’s 1,300 Critical Access Hospitals would have qualified under the original rules. Federal budgetary constraints have led to renewed interest in imposing the more stringent rules, which would lead to further closure of rural hospitals in Iowa and elsewhere. A second issue addressed in the paper is how rural residents respond to the loss of a local hospital.

We base our analysis on an empirical model that estimates the sensitivity of rural choice of local, urban, or specialized research hospitals on distance to and quality of each of the three hospital options. We derive estimates of hospital choice for inpatient visits, for outpatient visits, separately for the most commonly diagnosed illnesses, and for emergency or nonemergency admissions. We use these estimates to simulate how potential hospital closings will alter hospital choices made by rural Iowa patients. We illustrate how two hospital closing scenarios, 1) closing 25% of lowest quality rural hospitals and 2) closing 15% of the least used rural hospitals in Iowa, affect the average distance to and quality of the chosen hospital.

We find that distance from home significantly lowers the probability of a patient choosing a particular hospital, while hospital quality marginally raises the probability of choosing the hospital. Closing 15% of the least used rural Iowa hospitals results in a marginal increase in expected distance of 1.8 miles and a small decrease in expected quality. Closing 25% of the lowest quality rural hospitals results in a larger increase in expected distance of 2.8 miles with a significant increase in expected quality. These outcomes suggest that closing the lowest quality hospitals is a better policy prescription than closing the least used, providing a substantial increase in quality with only a marginally higher increase in distance.

II. Literature Review

The impact of rural hospital closure depends on the extent to which rural residents bypass their existing rural options. Liu et al. (2007) reported that 20-50% of rural patients bypass their nearest rural hospital. The bypass decision varies by patient age and gender, by severity of the illness or type of diagnosis, and by method of payment (Basu, 2005; Basu and Cooper, 2000; Bronstein and Morrisey, 1991).

Radcliff et al. (2003) concluded that patients find rural hospitals a viable option for minor ailments while strongly preferring to bypass rural for urban hospitals for more serious health issues. Chandra et al. (2016) discovered that patients with more agency in hospital choice, such as transfer patients compared to emergency admissions, pick higher quality hospitals. Lin, Allan and Pennington (2002) found that patients seeking general medical or obstetrical care have lower bypass rates that those receiving complex medical, general surgery, or specialty surgery services. Hogan (1988) found that the elderly are less likely to bypass their nearest hospital option relative to their younger counterparts regardless of illness.

Radcliff et al. (2003) found that Medicare and uninsured patients have lower bypass rates while patients in managed care or commercial insurance have higher bypass rates. Ho and Pakes (2014) furthered this line of analysis by investigating the relationship between hospital choice, hospital prices, and financial incentives. Using hospital discharge data for patients in obstetric care in California, they showed the price paid by the insurer affects the patient allocation among hospitals within a given network, particularly for patients whose plans pay higher capitation fees for physician groups. They also illustrated that there may be a direct tradeoff between price and patient convenience: distance as a hospital choice factor may be eclipsed by price when it comes to hospital referrals, as patients are often sent to cheaper hospitals farther away. In many studies, rural residential choice of hospital is very sensitive to distance (Rieber et al., 1996). Studies consistently found a decrease in the likelihood of bypassing local hospitals with increases to distance of alternative hospitals (Bronstein and Morrisey, 1991; Buczko, 1994; Radcliff, et al., 2003).

Residents of communities with greater per capita incomes or wealth are more likely to bypass the nearest hospital (Basu and Cooper, 2000; Dranove et al., 1993; Goldsteen et al., 1994). Finkelstein et al. (2016) corroborated this community aspect by disentangling the demand-and supply-side factors that determine variation of hospital utilization of Medicare beneficiaries across the US. They found that 50-60% of variation is attributable to place-specific factors such as the number of for-profit hospitals, the intensity of doctors' care practices, and the human/physical capital of a community.

Few studies have evaluated the role of hospital quality in patient choices. This is likely to be a key factor explaining the incentives to bypass rural hospitals. Liu et al. (2007) conducted a preliminary examination of the role of hospital quality in hospital choice. Their study surveyed 647 hospital inpatients for their assessments as to why patients would bypass a local hospital. Following the lack of local specialists, the second most common reason cited for bypassing a local hospital was poor reputation or quality of local care. Chandra et al. (2016) used three different measures of quality: clinical outcomes (survival and readmission), how performed care measured against established guidelines, and patient satisfaction after hospital experience to examine how quality influenced market share. To our knowledge, no previous studies of rural or urban hospitals have explicitly examined the tradeoff between distance and quality in the bypass decision.

III. Methodology

In order to assess how possible hospital closures affect rural hospital choice, we need to establish how rural patients weight hospital quality and distance. While a hospital closure may lower utility because of increased distance to the nearest hospital, the decrease in utility may be offset if other hospital options are of higher quality. Consistent with that reasoning, we assume that rural residents choose hospitals to maximize expected utility from hospital services for a particular medical condition. Utility is assumed to take the form

(1) $V_{ij}^{k} = V\left(D_j^k, Q_j^k, I_{ij}, M_{ij}, Z_{ij}\right);\ k = S, U, R$

V_{ij}^{k} is the indirect utility that individual *i* from residence *j* gets from receiving health service from hospital of type *k*. The three hospital types are Rural (*R*), Urban (*U*), and Specialized Research (*S*) hospitals. We assume that patients will evaluate these three options based on their closest alternative of each hospital type. As a result, the distance to (D_j^k) and quality of (Q_j^k) the *kth* hospital option will vary across rural areas, and so individual choice will depend in part on the convenience and quality of the available choices in the individual's location. We expect that distance to hospital *k* lowers utility from that hospital, and so $V'_{D^k} < 0$. Utility increases in hospital quality, and so $V'_{Q^k} > 0$. Hospital choice will also depend on whether the patient is insured and the type of insurance (I_{ij}), both of which affect the patient out-of-pocket cost of each hospital option. The anticipated cost and quality will also depend on the particular medical issue (M_{ij}). Finally, individual attributes (Z_{ij}) including age, gender, education, tastes, and value of time will affect relative utility from the three hospital types.

Individual *i* in location *j* will choose hospital option *k* if

(2) $$H_{ij}^{k} = \begin{cases} 1 \ \ iff \ \ V\left(D_j^k, Q_j^k, I_{ij}, M_{ij}, Z_{ij}\right) \geq V\left(D_j^l, Q_j^l, I_{ij}, M_{ij}, Z_{ij}\right) \forall\, k \neq l \\ 0 \ \ otherwise \end{cases}$$

Inspection of (2) shows that only distance and quality will affect the choice of hospital type, *k*. Factors that only vary across individuals but not across hospital choices such as tastes, education, wages, medical problems, and insurance status will not affect choice of hospital type directly as they raise or lower utility equally across all hospital types. However, they can affect hospital choices indirectly to the extent that these factors are not separable from distance and quality. For example, if insurance status affects the marginal disutility of distance, then it can affect hospital choice through its interaction with distance.

To make (2) operational, we need to approximate the form of the indirect utility functions, $V(\cdot)$. To simplify notation, define the vector X_{ij} as X_{ij} = (I_{ij}, M_{ij}, Z_{ij}). Then

(3) $V_{ij}^{k} = \alpha_D D_j^k + \alpha_Q Q_j^k + \alpha_{DQ} D_j^k \cdot Q_j^k + \beta_{DX} D_j^k \cdot X_{ij} + \beta_{QX} Q_j^k \cdot X_{ij} + \gamma_X X_{ij} + \gamma_{XX} X_{ij}' X_{ij} + \varepsilon_{ij}^k$

The probability of choosing hospital type *k* over alternative *l* will be

(4) $Pr_{ij}^k = \Pr\left(H_{ij}^k = 1\right) = \Pr\big(\{\alpha_D [D_j^k - D_j^l] + \alpha_Q [Q_j^k - Q_j^l] + \alpha_{DQ} [D_j^k \cdot Q_j^k - D_j^l \cdot Q_j^l] +$

$\beta_{DX} [D_j^k - D_j^l] \cdot X_{ij} + \beta_{QX} [Q_j^k - Q_j^l] \cdot X_{ij}\} > \{\varepsilon_{ij}^l - \varepsilon_{ij}^k\}\big)$

If the error terms are independent draws from an extreme value distribution, the parameters can be estimated using a conditional logit specification. Because the distance and quality vary with each hospital type *k*, the parameters will reflect how quality and distance interact to make any given choice with a common set of coefficients $\alpha_D, \alpha_Q, \alpha_{DQ}, \beta_{DX},$ and β_{QX}. These coefficients represent the utility weights attached to each factor affecting hospital choice. Note that in comparing (4) with (3), it is only the interacted terms with X_{ij}, distance, and quality that will influence the hospital choice. All individual attributes and their higher moments affect utility of each hospital type the same; thus, they have no effect on hospital choice.

In the specification in (4), medical conditions only affect hospital choice through the channel of altering the marginal disutility of hospital distance or the marginal utility of hospital quality. Initially, we assume that the decision is unaffected by medical condition except for the broad distinction of whether the condition can be handled on an outpatient basis or requires inpatient services. We accommodate that difference by estimating the conditional logit specification separately for inpatient and outpatient choices. We then relax this restriction by estimating separate hospital choice equations for specific inpatient and outpatient conditions—as well as admission types—that occur with sufficient frequency in the data to allow us to estimate the full set of utility weights. For each set of results, it is important to interpret the coefficients within the context of the medical condition stipulated in the sample. For example, we will have one set of results that averages the hospital choice effects of factors across all inpatient conditions, then another set of results for each of several specific diagnoses, and finally a set of results for each of the hospital admission codes, which separate the patients by urgency.

Because patient attributes are constant across the three hospital types, they are controlled as a fixed effect. However, some of these attributes may alter the marginal effects of distance and quality. Hence, we include them interacted with the hospital attributes. We control for age and gender. Insurance is an indicator of whether the individual is covered by a private or employer-provided insurance plan. Self-pay is whether the visit is not covered by an insurance plan. Medicare, Medicaid, or some other type of public insurance covers the rest of the visits.

The coefficients are difficult to interpret directly, and so we transform the results for ease of interpretation. First, we estimate the marginal effect of each factor alone and/or in interactions on the probability of choosing a hospital, evaluated at sample means. We then use these marginal effects to compute the elasticities for each of the effects at the sample means. We computed the elasticities with respect to distance in two ways, one where we included all of the own and cross terms, and a simpler version where we only included the uninteracted measures of distance and quality in the conditional logit model and allowed the resulting coefficient to include any potential correlation with missing interacted variables. Results were usually similar but the elasticities with the full complement of interaction terms sometimes generated some implausibly large elasticities, particularly when we used some of the smaller subsamples. Absent any theoretical preference for one estimate versus the other, we opted for the simpler elasticity estimates.

IV. Data

We require a data set that allows sufficient variation in hospital quality and distance to allow us to estimate the tradeoffs between the two factors in hospital choice. As urban and metropolitan areas have easily accessible hospital choices, a cross-section of rural patients is more likely to provide the needed variation in distance and quality.

The Iowa Hospital Association records include every inpatient admission and outpatient visit to Iowa hospitals (Iowa Hospital Association, 2004). We have access to the recorded visits occurring between January 1, 2002 and December 31, 2002. The inpatient database includes 209,687 patients that were treated and discharged from an Iowa hospital during this period. Patients who were admitted prior to this period, but discharged during this period are not in the database. Similarly, patients who had not yet been discharged at the end of this period are not in the database. Non-Iowa residents in Iowa hospitals are not included, neither are Iowa residents who received their care out of state. The database also includes records on 138,685 outpatient records. Inclusion in the outpatient database does not require admission or release from the hospital, but only that the patient received treatment at an Iowa hospital.

We divide hospitals into three groups: rural, urban, and research. Rural hospitals are designated by the population density of the hospital county. Urban hospitals reside in counties containing a metropolitan statistical area. The final group includes the research hospitals in Des Moines and Iowa City.

Our focus is on the determinants of hospital choice for rural residents. Rural patients are defined as patients whose residence is in a zip code region listed as rural by the U.S. Census in 2000. To calculate distance, this study measures the straight line distance from the latitude and longitude of the patient's home zip code to the latitude and longitude of the nearest rural, the nearest urban, and the nearest research hospital even if none of those hospitals were chosen. Had we used distance to the chosen hospital, distance would be endogenous. In other words, the choice set is the nearest rural, urban, and research hospital.

As shown in Table 1, hospital choices do not differ much between inpatient and outpatient treatments. Almost 70% of rural residents choose a rural hospital for inpatient and outpatient service. Urban hospitals serve 12% of rural residents and 18% are served by research hospitals. The average rural patient lives about five miles from a rural hospital, but lives 51 miles from the nearest urban hospital and 71 miles from the nearest research hospital.

Health Grades, Inc. compiled the data on hospital quality. There are significant quality differences between hospitals exemplified by the company's simple one-to-five-star rating system. To avoid missing data, we used the two most common ailments, heart failure and pneumonia, to measure hospital quality.[1] Deaths from heart failure are recorded during the length of the patients' admissions at a hospital, and again on whether additional patients die at least six months after discharge. Deaths from pneumonia are also recorded during the stay and within six months of discharge, and a third measure is recorded for deaths within one month of discharge. Rather than using a single measure, we use the average of the reported measures across the five

[1] We were able to get information on hospital quality based on heart and pneumonia deaths for 117 of the 119 hospitals in Iowa. Quality measures based on other criteria were missing for at least 31% of the hospitals.

options. When a hospital is evaluated only on a subset of the measures, we take the average of the reported measures. This strategy is consistent with the presumption that the most common reason for partial reporting would be the lack of sufficient cases to generate a reliable measure. Thus, the best option is to use information on the measures for which there is sufficient data to generate a reliable estimate. Presuming random measurement error, an average of several indexes will have a lower measurement error variance than would any of the individual indexes. Table 1 illustrates a pronounced rise in quality when comparing rural hospitals to urban or research hospitals, with urban hospitals actually marginally outperforming research hospitals.[2]

V. Conditional Logit Results

The results of our model of inpatient and outpatient hospital choice are presented in Table 2. The key variables of interest are distance to and quality of the nearest hospital of each type. Distance is the single largest driving factor in the choice of hospital. At sample means, a 10% increase in distance lowers the probability of choosing that hospital type for inpatient services by 12.9%. Hospital choice is less sensitive to quality, although a trade-off between distance and quality is apparent. A 10% improvement in quality increases likelihood of choosing that hospital by 2.3% for an inpatient procedure. Hospital demand for outpatient services is also sensitive to distance, but not quality. The outpatient elasticity with respect to quality is negative but very small. The interaction terms suggest that women, older patients, and patients who do not pay through insurance are more distance sensitive. These effects are similar for inpatient and outpatient care. Quality is more important for men and for patients with private insurance or those who pay for procedures out-of-pocket. Seen from the quality-distance cross term, as distance increases, quality becomes less important to hospital choice.

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[2] This is consistent with reported hospital infection rates for the University of Iowa Hospitals which were higher than for urban hospitals, possibly because the research hospitals treat more complicated cases.

We expect that those patients with more severe or time sensitive needs might be more sensitive to distance and less sensitive to quality. For inpatient hospitalizations, the three admission codes—ordered from most to least critical—are emergency, urgent, and elective. Consistent with our expectations, emergency and urgent admissions are much more sensitive to distance than elective ones (Table 3). A 10% increase in distance leads to a 17.5% and 16.1% reduction in the probability of choosing a hospital for emergency and urgent patients respectively, while it only leads to a 8.3% drop for elective procedures. Choice of where to receive emergency and urgent care is also sensitive to quality, while choice of hospital for elective procedures is virtually unaffected by quality. There are apparent tradeoffs between distance and quality even for the most time-sensitive admissions. For patients with insurance, quality is more important for both emergency and elective procedures.

Under all admission types, the interaction between distance and quality is negative and statistically significant. This result suggests that when a patient is surrounded by higher quality hospitals distance is a larger disincentive for a hospital than if the patient is surrounded by average quality hospitals. Naturally, the interaction seems intuitive since regardless of whether you have an emergency, urgent, or elective condition, a patient would feel less of an urge to travel farther if the closer hospitals are higher quality than average.

The relative importance of distance and quality varies by the nature of the treatment required. Each inpatient visit is labeled by one of 25 possible Major Diagnostic Categories (MDC). We list the MDCs in Appendix 1. We analyze the seven most common diagnoses representing 73% of all inpatient admissions to examine if patient hospital choice differs by type of ailment. Table 4 summarizes the key elasticities derived from conditional logit estimates for each diagnostic group. The distance elasticities are consistently negative and the quality elasticities are consistently positive. Rural hospitals are more likely to be selected for the diagnoses with the smallest quality elasticities (digestive and respiratory problems). The distance and quality elasticities are quite large in general, showing substantial tradeoffs between distance and quality for a wide variety of common health problems. Thus, there is a mechanism to reduce the lost utility from the closure of nearby rural hospitals if the remaining hospital choices are of higher quality.

We also report elasticities for the most common outpatient procedures. Other than nervous system procedures, outpatient admissions tend to be less sensitive to distance than inpatient hospital choice, consistent with the presumption that outpatient visits are not immediately life-threatening and a consequence of longer term planning. These finding suggest that outpatient services could be delivered by more distant but higher quality hospitals without greatly compromising the utility of rural patients.

VI.A. Simulation Model of Hospital Closings

The conditional logit specification performs well in modeling the rural patient decisions to select or bypass the nearest rural hospital, highlighting the importance of quality as well as distance in these choices. The model parameters also allow us to simulate how hospital closings will alter hospital choice. The rural hospital closings are illustrated by two different scenarios: 1) closing 25% of the lowest quality rural hospitals and 2) closing 15% of the least used rural hospitals.

If individual *i* has nearest their rural hospital (R) closed, the new indirect utility is computed using R', the next nearest open rural hospital with its associated quality and distance:

(5) $V_{ij}^{k'} = V\left(D_j^{k'}, Q_j^{k'}, I_{ij}, M_{ij}, Z_{ij}\right);\ k' = S, U, R'$

The difference between (5) and (1) is the utility (or disutility) to individual *i* associated with the closing of their nearest rural hospital option. This change in utility only applies for individuals who lost their nearest rural hospital (R). We shall reference (1) as the 'baseline' model and (5) as the 'post-closing' model.

Given (5), the implied hospital choice post-closing model is derived in the same manner as in (2) except with new distance and quality for hospital R':

(6) $H_{ij}^{k'} = 1 \;\; iff \;\; V\left(D_j^{k'}, Q_j^{k'}, I_{ij}, M_{ij}, Z_{ij}\right) \geq V\left(D_j^{l}, Q_j^{l}, I_{ij}, M_{ij}, Z_{ij}\right) \; \forall \; k' \neq l$

$= 0 \; otherwise$

Similarly, we can use the same probability model (4) using (6) to determine the probability $Pr_{ij}^{k'}$ that individual *i* will choose hospital k' given that we replaced R for R'. Rural hospital closings affect hospital choice through changes in expected distance and quality of selected hospitals. The predicted probability of choosing each hospital type for both the baseline model and the post-closing model allows for the computation of expected quality *(EQ)* and expected distance *(ED)*:

(7) Baseline: $EQ_{ij} = \sum_k Q_j^k * Pr_{ij}^k \, ; \; k = S, U, R; \quad ED_{ij} = \sum_k D_j^k * Pr_{ij}^k \, ; \; k = S, U, R$

(8) Post-closing: $EQ'_{ij} = \sum_k Q_j^{k'} * Pr_{ij}^{k'} \, ; \; k' = S, U, R'; \quad ED'_{ij} = \sum_k D_j^{k'} * Pr_{ij}^{k'} \, ; \; k' = S, U, R'$

Again, we generate two simulations of possible rural hospital closings to examine the impacts on rural patients: 1) closing 15% of the least used rural hospitals, and 2) closing 25% of the lowest quality rural hospitals.[3] We estimate the expectations in (7) and (8) for both hospital closing scenarios, separating the analysis by diagnosis groups, inpatient admission type, and whether the procedure was inpatient or outpatient.

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[3] The least used hospitals differ slightly between inpatient and outpatient hospitalizations, leading to slight differences in the hospitals dropped in the simulations depending on diagnosis.

As discussed earlier, the phenomenon of rural bypass has substantially weakened rural hospitals. Rural hospitals also face a potential rule change in Medicare's Critical Access Hospital program, possibly siphoning away millions of dollars from 82 rural Iowa hospitals. Declining demand and potential loss of subsidy would leave many rural hospitals in Iowa fiscally insolvent. In our simulation where we close the least used hospitals, we opt for a utilization threshold of 50%. Therefore, we shutter all of the hospitals that were chosen less than 50% of the time. These hospitals would be the most threatened if the Medicare Critical Access Hospital standards become more stringent. Rural patients living nearest to the closed hospitals under this simulation selected them between 11% and 41% of the time for inpatient hospitalizations, and between 6% and 41% of the time for outpatient services.

Our second simulation assumes that the reduction in subsidy would be tied to hospital quality rather than current use. Our simulation results in closing 25% of the lowest quality rural hospitals. The 24 hospitals closing under this scenario had quality rankings ranging from 1 to 1.83, well below the average hospital quality of 3.3.

VI.B. Hospital Closings Results: 15% of the Least Used Rural Hospitals

Table 5 illustrates our main findings from the simulated closings for the 15% of the least used hospitals. Appendix 2 provides additional information concerning results by diagnosis. There is a slight difference in the dropped hospitals for inpatient and outpatient procedures, suggesting some difference may be a result of that discrepancy. To examine heterogeneity in existing tastes for hospitals, we present different estimates based on all rural patients ('Chose Any Hospital'), the subset of rural patients who originally chose a rural hospital ('Chose Rural Hospitals'), and the subset of rural patients who originally chose one of the hospitals closed in the simulation ('Chose Closed Hospitals'). The simulated effects of closing the least-used hospitals on expected distance traveled and on quality are surprisingly small. In the outpatient data, we see only a 2.2-mile increase (15.4%) in expected distance and a 0.044 increase in expected quality (1.6%). Though the percentage terms seem high, the magnitude of these changes are rather small. To put in perspective, the change in expected quality and distance for outpatient procedures has a baseline expected distance of 14.1 miles and a quality measure of 2.8.

The effects are larger when we confine the estimates to patients that chose rural hospitals or that chose one of the closed hospitals. Those patients who sought out outpatient procedures and selected closed hospitals have an expected distance increase of 7.1 miles (284%) and a decrease in expected quality of -0.34 (-26.9%). When compared to inpatients, rural outpatients are the more negatively affected by this hospital closure policy. Their expected travel distance to hospitals increase to 16 miles and the quality of hospital marginally rises to 2.8 on average.

In the inpatient data, there remains a consistent increase in distance and decrease of quality for those who chose rural hospitals and those who chose a closed hospital (the more adversely affected groups). Patients who chose closed hospitals experience an increase in expected distance of 6.1 miles and a decrease of -0.39 in expected quality. The inpatient data generally shares a more muted effect size when comparing to the outpatient data, but there is variation among the magnitude of effects by diagnosis (Appendix 2). The diagnosis groups that are the most harmed by the closings are patients seeking treatment for nervous system or respiratory system complications with expected distance increase of 6.5 miles and 7.1 miles and an expected quality decrease of -0.33 and -0.45 respectively. The least adversely affected diagnosis groups are those seeking musculoskeletal and newborn related procedures.

Examining subsets of the inpatient data by admission type, all types see a reduction in the probability of choosing their closest rural hospital (Table 5). Because it is the least used hospitals that are closed, the effect is quite small. The drop in probability of choosing the closest rural hospital is largely shifted to the urban hospital, with the smallest drop coming from the elective admission type. The elective admission types had the lowest baseline probability of choosing a rural hospital to begin with since these patients had less time-sensitive conditions and were most able to bypass the closest rural option. The hospital closings result in a small increase in expected distance ranging from 1.3 to 1.8 miles across admission types. With increases in expected quality being all below 1%, quality is not significantly affected when averaging across the entire admission type. The results do not noticeably change when looking at the sample of patients who chose a rural hospital.

However, focusing on patients who chose a closed hospital under the simulation, there are some larger negative consequences. Patients with elective admissions have a decrease in expected quality that is about a third of the effect size of emergency and urgent admissions, a drop of -11.0% versus -34.9% and -32.0% respectively. In terms of miles for those who chose a least-used hospital, expected distance does not substantially vary across admission type. Expected travel distance rises by 6.7 miles for patients undergoing elective procedures, while patients with emergency and urgent conditions are expected to travel 5.7 and 5.1 miles farther, respectively.

The general conclusion from Table 5 is that there are only modest increases in distance and nearly negligible decreases in quality from closing the least utilized rural hospitals. The magnitude of these changes vary by admission and MDC type, but even for the most concentrated negative impacts, we see at most a 7.2 mile increase in expected distance. These small changes may seem surprising except that optimizing patients are already adapting to the available choices of hospitals. As the population ages and anticipates increased likelihood of necessary emergency or critical hospital care, rural residents move closer to hospitals that they trust. As a result, many patients have already voted with their feet regarding their preferred hospital and so closing less-favored hospitals has a smaller impact than would be true if rural populations could not move.

VI.C. Hospital Closings Results: 25% of the Lowest Quality Rural Hospitals

The findings from the simulated closure of 25% of the lowest quality rural hospitals are presented in Table 6. Compared to eliminating the least-used hospitals, closing the lowest quality hospitals has a more significant effect on distance but with an improved quality of the remaining choices.[4] For outpatient data, there is an increase in expected distance of 2.9 miles (20.3%) and increase in expected quality of 0.22 (7.4%). Intuitively, the patients who chose rural hospitals and closed hospitals experience more pronounced effects in terms of distance and quality, aligning with similar trends in the previous scenario. Patients with outpatient procedures who chose a closed hospital saw an increase in 9.6 miles in expected distance but with an increase of 0.7 in expected quality.

Similar magnitudes changes take place in the inpatient data. The effects do not vary substantially by diagnosis (Appendix 3). Closing 25% of the lowest quality hospitals also produces similar effects across admission types as it did in the inpatient and outpatient data sets (Table 6). The probability of choosing a rural hospital falls by 1.2 to 8.8 percentage points depending on the sub-group. This drop is smaller than in the previous scenario because we are

[4] It is important to note that this simulation does close more hospitals, and some of the differences between the scenarios are mechanical. The inequality between the number of hospitals closed in the least used and lowest quality scenarios is for the aforementioned feasibility reasons. See the end of Section VI.A. for more information.

not closing any higher quality rural hospitals that might attract more distant rural patients when low quality competitors are removed.

Across all admission types, there is a reduction in the probability of closest rural hospital as well as an increase in expected distance and expected quality. Elective admission types experience similar effects to the inpatient and outpatient results. Those who chose rural hospitals and closed hospitals saw an increase up to 8.0% and 59.2% in expected quality respectively. For conditions that result in elective admissions, closing the lowest quality hospitals is a better policy prescription than closing the least used. Patients with emergency and urgent admissions face an increase in expected distance of 2.6 and 3.7 miles respectively—which is 1-2 miles higher than the expected distance from closing the least-used hospitals. However, expected hospital quality rises by more than 8% compared to declining quality for many of the sub-groups under the least-used hospital simulation. For patients who chose the lowest quality hospitals originally, the effects are accentuated with expected distance increases of 9.9 and 10.9 miles for the emergency and urgent types, almost double the rise in expected distance instigated from closing the least-used hospitals. However, in that same subset of those who chose lowest quality hospitals, emergency and urgent admission types see a considerable surge in expected quality of 76.5% and 50.2%.

These substantial increases in expected distance from either hospital closing scenario may be potentially too large for a time-sensitive condition, even if one closing scenario results in significant increases in expected quality. The differential effects for urgent/emergency admission types under the two closing scenarios suggest the preferential policy is to limit services in lowest quality hospitals to time-sensitive, urgent/emergency procedures. The specific set of procedures relay back to the effects varying by diagnosis. The general trends from dropping the lowest quality hospitals are an increase in expected distance—a larger effect than when dropping the least used hospitals—and a substantial increase in expected quality up to 77% of baseline levels for the most adversely affected groups. Given heterogeneous impacts by diagnosis and admission type, these results bolster the basis of reducing certain non-emergency services—particularly for diagnoses that are bypassed regardless—without tremendous ramifications for other diagnoses or patient utility.

VII. Discussion and Conclusion

The outmigration of rural residents to urban areas requires a re-evaluation of rural health care delivery. Federal budgetary constraints and waning rural hospital demand have questioned the sustainability of many rural hospitals. This paper highlights distance as the most significant factor in patient choice while illustrating the burden of plausible hospital closing scenarios on rural residents.

A notable finding of this paper is that the quality of a health institution is an important factor in hospital choice, and that patients assess tradeoffs in distance and quality when deciding where to get hospital services. The tradeoff is most salient for inpatient treatments and for emergency or urgent care. Proximity largely drives hospital choice for elective procedures and outpatient services. Our results are consistent with previous research that concludes patients with severe or complicated issues will seek out higher quality care, while people with time-sensitive conditions and the elderly are more distance sensitive. Our findings also illustrate that patients with insurance coverage are more sensitive to quality.

Our simulations show that closing 15% of the least used rural Iowa hospitals results in a marginal increase in distance (around 1.8 miles) and a small decrease in quality, while closing 25% of the lowest quality hospitals results in a marginal increase in distance (around 2.9 miles) and a significant increase in quality. To analyze differential impacts, we separate the analysis by inpatient-outpatient, admission type, and diagnosis. Closing the 15% least-used hospitals have more pronounced effects on expected quality and distance for outpatient admissions over inpatient, while closing the 25% lowest-quality hospitals have similar magnitudes for both.

When segregating by type of admission (emergency, urgent, or elective), we found that closing the 15% least-used hospitals increased expected distance the most for elective procedures. The reductions in quality were largest for the urgent and emergency patients who originally chose a closed hospital.

On the other hand, closing the 25% lowest-quality hospitals resulted in a substantial rise in expected quality coupled with only a slightly greater increase in expected distance. For the elective admission type, there is no significant change in expected distance with patients still benefiting from the higher quality. For emergency and urgent admission types, the increased distance is partially offset by large gains in expected quality. As a result, closing the lowest quality hospitals is a better policy prescription, providing a substantial increase in quality with only a marginally higher increase in distance.

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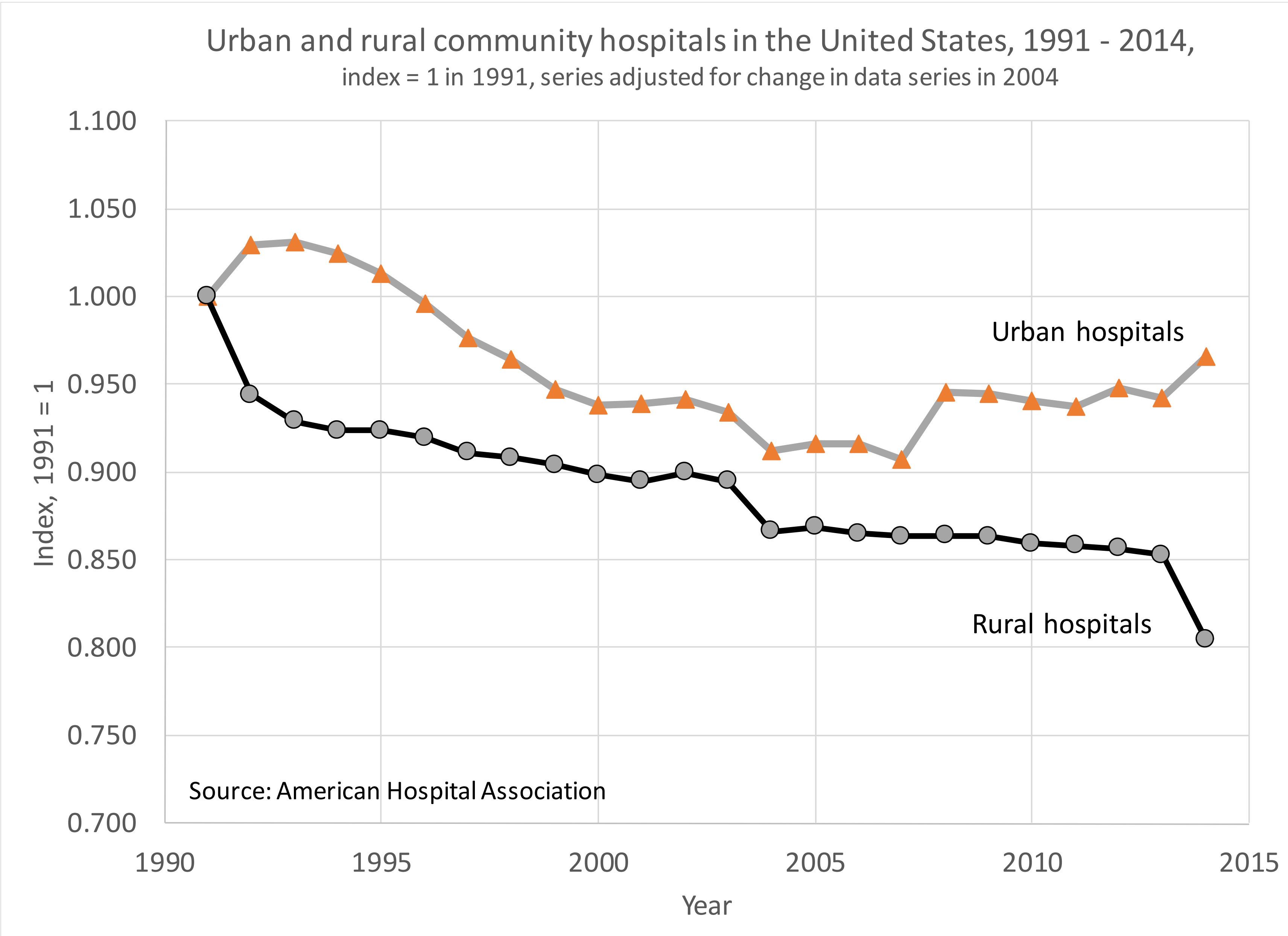
Urban and rural community hospitals in the United States, 1991 - 2014,
index = 1 in 1991, series adjusted for change in data series in 2004
1.100
1.050
1.000
0.950
0.900
0.850
0.800
0.750
0.700
Index, 1991 = 1
1990
1995
2000
2005
2010
2015
Year
Urban hospitals
Rural hospitals
Source: American Hospital Association

Table 1: Mean Values of Variables by Hospital Location and Inpatient/Outpatient Status

	Inpatient					**Outpatient**			
	Total	Rural	Urban	Research		Total	Rural	Urban	Research
Hospital Choice (Share)		0.69	0.12	0.19	Hospital Choice (Share)		0.70	0.12	0.18
Distance/100	0.43	0.05	0.51	0.71	Distance/100	0.42	0.05	0.51	0.70
Quality	3.32	2.45	3.84	3.66	Quality	3.28	2.46	3.79	3.60
Age/10	5.45				Age/10	5.57			
Male	0.41				Male	0.44			
Insurance	0.35				Insurance	0.45			
Self-pay	0.036				Self-pay	0.020			

Table 2: Conditional Logit Estimation of Rural Resident Hospital Choice by Inpatient and Outpatient Status, Hospital Quality and Hospital Distance, 2002

	Inpatient (N=209,687)		**Outpatient (N=138,685)**	
	Coefficient	Marginal Effect	Coefficient	Marginal Effect
Distance	-2.7882	-0.5136	-0.3790	-0.0612
	(-45.38)	(-51.22)	(-4.86)	(-4.97)
Age x Distance	-0.0625	-0.0115	-0.3151	-0.0508
	(-11.06)	(-11.03)	(-42.28)	(-38.93)
Male x Distance	0.8086	0.1490	0.3088	0.0498
	(28.78)	(28.37)	(9.21)	(9.18)
Insurance x Distance	0.1031	0.0190	-1.1152	-0.1799
	(2.95)	(2.95)	(-28.44)	(-27.39)
Selfpay x Distance	-0.9014	-0.1661	-1.0127	-0.1634
	(-10.56)	(-10.54)	(-9.22)	(-9.19)
Quality x Distance	-0.3380	-0.0623	-0.4145	-0.0669
	(-24.04)	(-21.47)	(-23.16)	(-19.80)
Quality	0.1381	0.0254	-0.0170	-0.0027
	(11.95)	(11.53)	(-1.06)	(-1.06)
Age x Quality	0.0008	0.0002	0.0099	0.0016
	(.58)	(.58)	(4.90)	(4.89)
Male x Quality	0.0240	0.0044	0.0209	0.0034
	(3.65)	(3.65)	(2.56)	(2.56)
Insurance x Quality	0.0659	0.0121	0.1031	0.0166
	(7.85)	(7.86)	(10.51)	(10.51)
Selfpay x Quality	0.0995	0.0183	0.3127	0.0505
	(4.84)	(4.83)	(10.04)	(9.97)
Pseudo R2	.39		.40	
Log likelihood	-141234.9		-91638.0	
<u>Elasticities</u>				
Distance	-1.29		-1.30	
	(-245.1)		(-202.9)	
Quality	0.23		-0.06	
	(28.1)		(-5.38)	

Dependent Variable is Choice of Rural, Urban or Research Hospital.
t-statistics are in parentheses.

Table 3: Conditional Logit Estimation of Rural Inpatient Hospital Choice by Admission Type, Hospital Quality and Hospital Distance, 2002

	(1) Emergency **(N = 52,096)**	(2) Urgent **(N = 68,648)**	(3) Elective **(N = 71,012)**
Distance	-3.3225	-3.6244	0.0689
	(-20.26)	(-28.24)	(0.77)
Age x Distance	-0. 2022	-0.1605	-0.2084
	(-12.68)	(-12.79)	(-23.17)
Male x Distance	0. 6823	1.3675	1.0127
	(9.61)	(23.51)	(25.90)
Insurance x Distance	0.0067	-0.0288	-0.3434
	(0.07)	(-0.40)	(-7.24)
Selfpay x Distance	-0.0406	-1.6524	-0.7508
	(-0.24)	(-8.44)	(-6.12)
Quality x Distance	-0.2006	-0.2297	-0.5444
	(-5.90)	(-7.98)	(-28.26)
Quality	0.1794	0.2060	0.0265
	(5.87)	(8.56)	(1.33)
Age x Quality	0.0011	0.0019	0.0127
	(0.31)	(0.64)	(4.96)
Male x Quality	0.0297	-0.0313	0.0373
	(2.08)	(-2.39)	(3.62)
Insurance x Quality	0.0986	0.0154	0.1047
	(5.12)	(0.92)	(8.08)
Selfpay x Quality	0.0010	0.1152	0.0364
	(0.02)	(2.55)	(1.09)
Pseudo R2	0.49	0.48	0.26
Log Likelihood	-29241.0	-39575.4	-57785.5
Elasticities			
Distance	-1.75	-1.61	-0.83
	(-122.0)	(-144.6)	(-127.7)
Quality	0.47	0.38	-0.024
	(26.0)	(24.0)	(-1.87)

Dependent Variable is Choice of Rural, Urban or Research Hospital.
t-statistics are in parentheses.

Table 4: Cross Sample Comparisons

	Inpatient Elasticity			Inpatient Selection Rate		
	Distance	Quality	N	Rural	Urban	Research
All Inpatient	-1.29**	0.23**	209,976	0.69	0.12	0.19
Nervous (1)	-0.90**	-0.037	10,956	0.63	0.11	0.26
Respiratory (4)	-2.13**	0.080**	24,362	0.81	0.08	0.11
Circulatory (5)	-0.91**	0.33**	37,630	0.61	0.16	0.23
Digestive (6)	-1.72**	0.047	21,277	0.76	0.10	0.14
Muscular (8)	-0.87**	0.40**	20,745	0.58	0.19	0.23
Pregnancy (14)	-1.73**	0.56**	20,033	0.70	0.13	0.18
Newborn (15)	-1.65**	0.56**	19,238	0.69	0.13	0.18
Emergency	-1.75**	0.47**	52,219	0.74	0.08	0.18
Urgent	-1.61**	0.38**	68,648	0.74	0.14	0.12
Elective	-0.83**	-0.024*	71,097	0.60	0.14	0.26

	Outpatient Elasticity			Outpatient Selection Rate		
	Distance	Quality	N	Rural	Urban	Research
All Outpatient	-1.30**	-0.06**	138,685	0.70	0.12	0.18
Nervous (1)	-1.05**	-0.47	4,055	0.63	0.15	0.22
Respiratory (4)	-0.76**	0.026	2,527	0.61	0.11	0.28
Circulatory (5)	-0.74**	0.15**	13,118	0.60	0.11	0.29
Digestive (6)	-1.69**	0.11**	52,327	0.74	0.12	0.14

*Significant at the 10% level; ** Significant at the 5% level

Table 5: Simulated Impacts of Closing the 15% Least Used Rural Hospitals on the Distance to and Quality of Hospital

Estimates are in changes relative to the baseline hospital choice							
Data Set/Diagnostic Category	**Patients who:**	**Average**	**Probability**	**Expected Distance (miles)**	**Expected Quality**	**% Distance**	**% Quality**
Outpatient	**chose any hospital**	Rural Average	-0.036	1.169	-0.072	33.6%	-4.0%
		Urban Average	0.020	0.514	0.075	8.6%	12.7%
		Research Average	0.016	0.486	0.041	10.4%	11.0%
		All	0.000	2.170	0.044	15.4%	1.6%
	chose rural hospitals	Rural Average	-0.017	0.634	-0.031	19.1%	-1.5%
	chose closed hospitals	Closed Average	-0.188	7.119	-0.344	284.1%	-26.9%
Inpatient	**chose any hospital**	Rural Average	-0.024	0.866	-0.065	26.6%	-3.6%
		Urban Average	0.015	0.365	0.055	5.7%	8.4%
		Research Average	0.009	0.302	0.027	6.4%	6.7%
		All	0.000	1.533	0.017	10.7%	0.6%
	chose rural hospitals	Rural Average	-0.011	0.443	-0.029	14.2%	-1.4%
	chose closed hospitals	Closed Average	-0.146	6.146	-0.399	232.0%	-26.5%
Emergency	**chose any hospital**	Rural Average	-0.024	0.598	-0.065	16.1%	-3.4%
		Urban Average	0.015	0.379	0.056	7.5%	9.6%
		Research Average	0.009	0.277	0.029	7.9%	7.7%
		Total Average	0.000	1.253	0.021	10.2%	0.7%
	chose rural hospitals	Rural Average	-0.010	0.325	-0.035	8.9%	-1.7%
	chose closed hospitals	Closed Average	-0.178	5.710	-0.616	186.2%	-34.9%
Urgent	**chose any hospital**	Rural Average	-0.026	0.658	-0.083	21.1%	-4.3%
		Urban Average	0.020	0.409	0.065	8.0%	11.8%
		Research Average	0.007	0.247	0.021	7.1%	7.0%
		Total Average	0.000	1.315	0.003	11.2%	0.1%
	chose rural hospitals	Rural Average	-0.007	0.231	-0.026	7.9%	-1.2%
	chose closed hospitals	Closed Average	-0.165	5.089	-0.577	126.5%	-32.0%
Elective	**chose any hospital**	Rural Average	-0.018	1.191	-0.040	39.3%	-2.5%
		Urban Average	0.010	0.272	0.038	3.1%	4.8%
		Research Average	0.008	0.288	0.025	3.9%	4.5%
		Total Average	0.000	1.751	0.023	9.2%	0.8%
	chose rural hospitals	Rural Average	-0.011	0.792	-0.015	26.4%	-0.9%
	chose closed hospitals	Closed Average	-0.094	6.709	-0.131	352.8%	-11.0%

Table 6: Simulated Impacts of Closing the 25% Lowest Quality Rural Hospitals on the Distance to and Quality of Hospital

Estimates are in changes relative to the baseline hospital choice							
Data Set/Diagnostic Category	**Patients who:**	**Average**	**Probability**	**Expected Distance (miles)**	**Expected Quality**	**% Distance**	**% Quality**
Outpatient	**chose any hospital**	Rural Average	-0.020	2.031	0.148	58.4%	9.5%
		Urban Average	0.011	0.463	0.040	7.8%	3.3%
		Research Average	0.009	0.373	0.028	8.0%	3.4%
		All	0.000	2.867	0.216	20.3%	7.4%
	chose rural hospitals	Rural Average	-0.019	2.289	0.163	68.9%	8.2%
	chose closed hospitals	Closed Average	-0.081	9.601	0.686	296.8%	60.0%
Inpatient	**chose any hospital**	Rural Average	-0.017	2.200	0.158	67.6%	8.8%
		Urban Average	0.010	0.437	0.039	6.9%	5.9%
		Research Average	0.007	0.324	0.023	6.9%	5.6%
		All	0.000	2.962	0.220	20.7%	7.7%
	chose rural hospitals	Rural Average	-0.018	2.486	0.171	79.4%	8.6%
	chose closed hospitals	Closed Average	-0.071	9.823	0.675	317.2%	59.0%
Emergency	**chose any hospital**	Rural Average	-0.013	2.042	0.189	55.1%	10.0%
		Urban Average	0.008	0.335	0.029	6.6%	5.1%
		Research Average	0.005	0.231	0.018	6.5%	4.8%
		Total Average	0.000	2.607	0.236	21.2%	8.3%
	chose rural hospitals	Rural Average	-0.012	2.257	0.208	61.9%	9.9%
	chose closed hospitals	Closed Average	-0.051	9.885	0.909	266.4%	76.5%
Urgent	**chose any hospital**	Rural Average	-0.023	2.739	0.169	87.7%	8.7%
		Urban Average	0.013	0.557	0.045	10.9%	8.3%
		Research Average	0.010	0.450	0.030	12.9%	10.0%
		Total Average	0.000	3.746	0.245	31.9%	8.7%
	chose rural hospitals	Rural Average	-0.026	3.186	0.184	108.5%	8.8%
	chose closed hospitals	Closed Average	-0.088	10.886	0.630	371.5%	50.2%
Elective	**chose any hospital**	Rural Average	-0.012	1.968	0.138	64.9%	8.7%
		Urban Average	0.007	0.298	0.029	3.4%	3.6%
		Research Average	0.004	0.205	0.014	2.8%	2.6%
		Total Average	0.000	2.472	0.181	12.9%	6.2%
	chose rural hospitals	Rural Average	-0.012	2.152	0.141	71.8%	8.0%
	chose closed hospitals	Closed Average	-0.051	9.018	0.590	309.0%	59.2%

Appendix 1: List of Major Diagnostic Categories (MDC)

MDC	Description
0	Pre-MDC
1	Nervous System
2	Eye
3	Ear, Nose, Mouth And Throat
4	Respiratory System
5	Circulatory System
6	Digestive System
7	Hepatobiliary System And Pancreas
8	Musculoskeletal System And Connective Tissue
9	Skin, Subcutaneous Tissue And Breast
10	Endocrine, Nutritional And Metabolic System
11	Kidney And Urinary Tract
12	Male Reproductive System

13	Female Reproductive System
14	Pregnancy, Childbirth And Puerperium
15	Newborn And Other Neonates (Perinatal Period)
16	Blood and Blood Forming Organs and Immunological Disorders
17	Myeloproliferative DDs (Poorly Differentiated Neoplasms)
18	Infectious and Parasitic DDs
19	Mental Diseases and Disorders
20	Alcohol/Drug Use or Induced Mental Disorders
21	Injuries, Poison And Toxic Effect of Drugs
22	Burns
23	Factors Influencing Health Status
24	Multiple Significant Trauma
25	Human Immunodeficiency Virus Infection

Appendix 2.a: Simulated Impacts of Dropping the 15% Least Used Rural Hospitals on the Distance to and Quality of Hospital

Estimates are in changes relative to the baseline hospital choice							
Data Set/Diagnostic Category	**Patients who:**	**Average**	**Probability**	**Expected Distance (miles)**	**Expected Quality**	**% Distance**	**% Quality**
Nervous System (MDC 1)	**chose any hospital**	Rural Average	-0.018	0.985	-0.052	32.5%	-3.1%
		Urban Average	0.011	0.267	0.040	3.4%	5.4%
		Research Average	0.007	0.261	0.022	3.7%	4.4%
		Total Average	0.000	1.513	0.010	8.4%	0.3%
	chose rural hospitals	Rural Average	-0.009	0.503	-0.026	17.4%	-1.4%
	chose closed hospitals	Closed Average	-0.123	6.531	-0.332	291.1%	-23.0%
Respiratory System (MDC 4)	**chose any hospital**	Rural Average	-0.033	0.888	-0.079	24.6%	-3.9%
		Urban Average	0.021	0.517	0.079	14.1%	19.0%
		Research Average	0.012	0.389	0.039	16.0%	16.5%
		Total Average	0.000	1.793	0.038	18.5%	1.4%
	chose rural hospitals	Rural Average	-0.021	0.696	-0.044	20.4%	-2.0%
	chose closed hospitals	Closed Average	-0.216	7.133	-0.448	268.9%	-26.5%
Circulatory System (MDC 5)	**chose any hospital**	Rural Average	-0.020	0.835	-0.060	28.0%	-3.6%
		Urban Average	0.013	0.320	0.048	3.8%	6.0%
		Research Average	0.007	0.267	0.022	4.0%	4.2%
		Total Average	0.000	1.422	0.010	7.9%	0.4%
	chose rural hospitals	Rural Average	-0.010	0.431	-0.029	14.5%	-1.6%
	chose closed hospitals	Closed Average	-0.137	5.863	-0.393	245.9%	-27.5%
Digestive System (MDC 6)	**chose any hospital**	Rural Average	-0.027	0.796	-0.073	22.2%	-3.8%
		Urban Average	0.017	0.405	0.062	8.6%	12.3%
		Research Average	0.010	0.328	0.033	9.8%	10.8%
		Total Average	0.000	1.528	0.022	13.1%	0.8%
	chose rural hospitals	Rural Average	-0.013	0.468	-0.033	13.7%	-1.6%
	chose closed hospitals	Closed Average	-0.171	6.364	-0.450	203.6%	-27.9%

Appendix 2.b: Simulated Impacts of Dropping the 15% Least Used Rural Hospitals on the Distance to and Quality of Hospital

Estimates are in changes relative to the baseline hospital choice							
Data Set/Diagnostic Category	**Patients who:**	**Average**	**Probability**	**Expected Distance (miles)**	**Expected Quality**	**% Distance**	**% Quality**
Musculoskeletal System (MDC 8)	**chose any hospital**	Rural Average	-0.020	0.869	-0.056	29.0%	-3.5%
		Urban Average	0.013	0.316	0.046	3.5%	5.4%
		Research Average	0.007	0.252	0.020	3.6%	3.6%
		Total Average	0.000	1.437	0.010	7.6%	0.3%
	chose rural hospitals	Rural Average	-0.007	0.305	-0.021	10.1%	-1.2%
	chose closed hospitals	Closed Average	-0.126	5.507	-0.380	219.2%	-28.2%
Pregnancy (MDC 14)	**chose any hospital**	Rural Average	-0.031	0.826	-0.087	24.8%	-4.6%
		Urban Average	0.021	0.486	0.076	9.9%	12.4%
		Research Average	0.010	0.337	0.032	10.0%	8.4%
		Total Average	0.000	1.649	0.021	14.2%	0.7%
	chose rural hospitals	Rural Average	-0.009	0.313	-0.024	9.6%	-1.1%
	chose closed hospitals	Closed Average	-0.160	5.846	-0.452	167.1%	-25.9%
Newborn (MDC 15)	**chose any hospital**	Rural Average	-0.030	0.806	-0.085	24.5%	-4.6%
		Urban Average	0.020	0.464	0.072	9.0%	11.4%
		Research Average	0.010	0.327	0.031	9.2%	7.9%
		Total Average	0.000	1.598	0.018	13.3%	0.6%
	chose rural hospitals	Rural Average	-0.008	0.272	-0.024	8.4%	-1.1%
	chose closed hospitals	Closed Average	-0.152	5.504	-0.487	163.8%	-28.0%
Factors & Health Status (MDC 23)	**chose any hospital**	Rural Average	-0.029	0.757	-0.093	21.0%	-4.5%
		Urban Average	0.020	0.435	0.063	12.0%	16.1%
		Research Average	0.009	0.300	0.027	13.4%	13.6%
		Total Average	0.000	1.492	-0.003	15.8%	-0.1%
	chose rural hospitals	Rural Average	-0.019	0.536	-0.061	15.3%	-2.7%
	chose closed hospitals	Closed Average	-0.240	6.892	-0.782	229.7%	-40.7%

Appendix 3.a: Simulated Impacts of Dropping the 25% Lowest Quality Rural Hospitals on the Distance to and Quality of Hospital

Estimates are in changes relative to the baseline hospital choice							
Data Set/Diagnostic Category	**Patients who:**	**Average**	**Probability**	**Expected Distance (miles)**	**Expected Quality**	**% Distance**	**% Quality**
Nervous System (MDC 1)	**chose any hospital**	Rural Average	-0.013	2.116	0.154	69.7%	9.2%
		Urban Average	0.007	0.316	0.028	4.0%	3.8%
		Research Average	0.005	0.256	0.017	3.6%	3.4%
		Total Average	0.000	2.689	0.199	14.9%	6.8%
	chose rural hospitals	Rural Average	-0.015	2.406	0.164	83.1%	8.7%
	chose closed hospitals	Closed Average	-0.057	9.335	0.636	319.5%	59.5%
Respiratory System (MDC 4)	**chose any hospital**	Rural Average	-0.027	2.608	0.173	72.2%	8.4%
		Urban Average	0.016	0.618	0.063	16.8%	15.1%
		Research Average	0.010	0.430	0.035	17.7%	15.0%
		Total Average	0.000	3.656	0.271	37.6%	10.0%
	chose rural hospitals	Rural Average	-0.026	2.913	0.185	85.3%	8.5%
	chose closed hospitals	Closed Average	-0.101	11.076	0.705	323.1%	53.2%
Circulatory System (MDC 5)	**chose any hospital**	Rural Average	-0.010	2.078	0.151	69.8%	9.2%
		Urban Average	0.006	0.280	0.024	3.4%	3.0%
		Research Average	0.004	0.199	0.013	2.9%	2.4%
		Total Average	0.000	2.556	0.188	14.2%	6.3%
	chose rural hospitals	Rural Average	-0.013	2.409	0.164	81.2%	8.9%
	chose closed hospitals	Closed Average	-0.051	9.300	0.633	331.6%	60.1%
Digestive System (MDC 6)	**chose any hospital**	Rural Average	-0.025	2.394	0.166	66.8%	8.6%
		Urban Average	0.015	0.592	0.056	12.5%	11.0%
		Research Average	0.010	0.446	0.035	13.4%	11.5%
		Total Average	0.000	3.431	0.256	29.5%	9.3%
	chose rural hospitals	Rural Average	-0.026	2.711	0.180	79.5%	8.7%
	chose closed hospitals	Closed Average	-0.098	10.331	0.685	302.0%	55.4%

Appendix 3.b: Simulated Impacts of Dropping the 25% Lowest Quality Rural Hospitals on the Distance to and Quality of Hospital

Estimates are in changes relative to the baseline hospital choice							
Data Set/Diagnostic Category	**Patients who:**	**Average**	**Probability**	**Expected Distance (miles)**	**Expected Quality**	**% Distance**	**% Quality**
Musculoskeletal System (MDC 8)	**chose any hospital**	Rural Average	-0.003	2.082	0.162	69.4%	10.2%
		Urban Average	0.002	0.102	0.009	1.1%	1.0%
		Research Average	0.001	0.060	0.002	0.8%	0.4%
		Total Average	0.000	2.243	0.173	11.8%	5.8%
	chose rural hospitals	Rural Average	-0.006	2.447	0.180	80.7%	9.9%
	chose closed hospitals	Closed Average	-0.023	9.263	0.682	343.3%	68.0%
Pregnancy (MDC 14)	**chose any hospital**	Rural Average	-0.011	2.158	0.169	64.8%	9.0%
		Urban Average	0.006	0.228	0.022	4.6%	3.6%
		Research Average	0.004	0.160	0.012	4.7%	3.1%
		Total Average	0.000	2.545	0.203	21.9%	7.1%
	chose rural hospitals	Rural Average	-0.011	2.453	0.186	75.1%	8.6%
	chose closed hospitals	Closed Average	-0.046	10.563	0.799	332.3%	68.2%
Newborn (MDC 15)	**chose any hospital**	Rural Average	-0.010	2.106	0.167	64.0%	9.0%
		Urban Average	0.006	0.217	0.020	4.2%	3.2%
		Research Average	0.004	0.155	0.011	4.4%	2.8%
		Total Average	0.000	2.478	0.199	20.6%	6.9%
	chose rural hospitals	Rural Average	-0.010	2.395	0.184	74.1%	8.6%
	chose closed hospitals	Closed Average	-0.044	10.338	0.796	316.1%	68.5%
Factors & Health Status (MDC 23)	**chose any hospital**	Rural Average	-0.019	2.459	0.186	68.1%	8.9%
		Urban Average	0.014	0.508	0.052	14.0%	13.4%
		Research Average	0.005	0.217	0.017	9.7%	8.5%
		Total Average	0.000	3.184	0.255	33.6%	9.5%
	chose rural hospitals	Rural Average	-0.017	2.670	0.203	76.3%	9.1%
	chose closed hospitals	Closed Average	-0.072	11.350	0.861	303.0%	64.1%