

Medicare Advantage in Rural Areas: Implications for Hospital Sustainability

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Rural hospitals are an important source of care for millions of Americans. They provide inpatient services and emergency care to treat patients with time-sensitive conditions. Compared with urban hospitals, rural hospitals have a lower and less consistent volume of patients; they also have limited access to staffing and often are in financial distress, placing them at risk of closure.¹ More than 100 rural hospitals have closed in the past decade.²

Many rural hospitals depend on Medicare as their main source of reimbursement because they serve populations older than the national averages.¹ Most Medicare beneficiaries are enrolled in traditional Medicare (TM).³ However, Medicare beneficiaries are increasingly enrolled in private plans through Medicare Advantage (MA) that can offer expanded benefits and reduced risk of out-of-pocket expenses. Nationwide, MA penetration increased from 15% in 2001 to 42% in 2021.³ Unlike TM, which reimburses hospitals based on an amount set by CMS, MA plans have an opportunity to negotiate with hospitals to include them in the plan's network. Negotiation includes establishing reimbursement rates, which may or may not replicate TM reimbursement structures, and potentially additional reporting requirements. Findings from studies examining whether MA plans pay more than, less than, or the same as TM for inpatient services have been mixed.⁴⁻⁷

Before the enactment of the Balanced Budget Act of 1997, only health maintenance organization (HMO) plans could offer private Medicare coverage. The private HMO Medicare plans were generally available only to beneficiaries in urban areas, where plans could form sizable networks. Under the Balanced Budget Act, health plans could offer preferred provider organization plans, which are easier to establish in areas with fewer providers, such as rural areas. MA enrollment in rural areas, particularly in preferred provider organization plans, has more than doubled in the past 10 years.⁸ If MA plans negotiate reimbursements with hospitals that are lower than TM rates, increasing MA penetration may be devastating to rural hospitals that are already operating with slim margins. Conversely, if MA plans are more generous with reimbursement in rural areas or steer enrollees to local sources of care, movement toward MA may support rural hospital stability.

ABSTRACT

OBJECTIVES: A growing number of Medicare beneficiaries in rural areas are enrolled in Medicare Advantage plans, which negotiate hospital reimbursement. This study examined the association between Medicare Advantage penetration levels in rural areas and hospital financial distress and closure.

STUDY DESIGN: This retrospective cohort study followed rural general acute care hospitals open in 2008 through 2019 or until closure using Healthcare Cost and Utilization Project State Inpatient Databases for 14 states.

METHODS: The primary independent variables were the percentage of Medicare Advantage stays out of total Medicare stays at the hospital and the percentage of Medicare Advantage beneficiaries out of total beneficiaries in the hospital's county. Financial distress was defined using the Altman Z score, where values less than or equal to 1.1 indicate financial distress and values greater than 2.8 indicate stability. The Z score was examined as a continuous outcome in hospital and county fixed-effects models. Risk of closure was examined using Cox proportional hazard models adjusted for hospital and market factors.

RESULTS: Rural hospital Medicare Advantage penetration grew from 6.5% in 2008 to 20.6% in 2019. A 1-percentage point increase in hospital penetration was associated with an increase in financial stability of 0.04 units on the Altman Z score [95% CI, 0.00-0.08; $P = .03$] and a 4% reduction in risk of closure [HR, 0.96; 95% CI, 0.92-1.00; $P = .04$]. Results were consistent when measuring Medicare Advantage penetration at the county level.

CONCLUSIONS: Our findings counter the notion that Medicare Advantage plans financially hurt rural hospitals because they pay less generously than traditional Medicare.

Am J Manag Care. 2023;29(11):594-600. doi:10.37765/ajmc.2023.89455

In this study, we examined the growth of MA and its relationship to rural hospital financial distress and closures. We quantified MA penetration from 2008 to 2019 using 2 measures as follows: (1) MA penetration among Medicare beneficiaries residing in the county of the hospital and (2) the percentage of Medicare stays at the hospital with MA. Next we measured differences in rural hospitals with high and low MA penetration. Then we estimated the association of MA penetration with hospital financial distress and risk of closure.

TAKEAWAY POINTS

This study of rural hospitals in 14 US states adds to the scant literature on Medicare Advantage in rural areas.

- ▶ Medicare Advantage penetration of beneficiaries in rural hospitals' counties (14.3% to 28.4%) and of Medicare inpatient stays (6.5% to 20.6%) both increased by 14 percentage points from 2008 through 2019.
- ▶ Still, one-fifth of rural hospitals included in this study served no Medicare Advantage inpatients in 2019.
- ▶ Medicare Advantage penetration was associated with increased financial stability and reduced risk of closure, countering the notion that these plans hurt rural hospitals through less generous payments than traditional Medicare or additional administrative requirements.

METHODS

Data Source and Study Population

This retrospective cohort study included acute care hospitals in rural areas open in 2008 and followed them through 2019 using Healthcare Cost and Utilization Project (HCUP) State Inpatient Databases⁹ for 14 states (see [eAppendix A](#) [eAppendices available at [ajmc.com](#)]). These states represented 45% of the overall US population and 32% of the rural population in 2020. They were selected because (1) they had payer codes distinguishing MA plan from TM payment in all study years,¹⁰ (2) the percentage of Medicare stays with MA in HCUP is reasonably consistent with CMS enrollment data,¹¹⁻¹³ and (3) they contained at least 1 rural hospital. Rural hospitals were defined based on zip codes eligible to receive funding from the Federal Office of Rural Health Policy,¹⁴ a broad definition that includes some metropolitan hospitals designated by other measures (eg, Rural-Urban Continuum Codes¹⁵).

Other data sources included CMS MA enrollment data, hospital closures identified from the University of North Carolina Cecil G. Sheps Center for Health Services Research, mergers and acquisitions identified from Irving Levin Associates,¹⁶ hospital characteristics from the American Hospital Association (AHA) Annual Survey, financial distress calculated from the CMS Cost Reports,¹⁷ hospital market characteristics from the American Community Survey,¹⁸ and state Medicaid expansion status from KFF.¹⁹

Primary Dependent Variables

We examined 2 outcomes: financial distress and closure. We used the Altman Z score, which has been used recently to monitor financial performance.²⁰ The Altman Z score has been used over the past 4 decades in multiple industries, including the health care sector.²¹ The score has been updated as it applies to entities of different ownership (ie, private for profit and nonprofit).²² We applied the version used by McCay et al²¹ (ie, Z double prime) because it was developed for industries including nonprofit entities. We calculated the composite score by adding 4 components—liquidity, profitability, efficiency, and productivity. In regression models, we treated the Altman Z score as a continuous variable. Lower values reflect more financial distress and higher values reflect more stability.

We provide descriptive information on a categorical variable of financially distressed (≤ 1.1), concerned (> 1.1 to ≤ 2.8), and stable (> 2.8) in [eAppendix B](#).²¹

Primary Independent Variables

The primary independent variables were (1) MA penetration of Medicare beneficiaries in the county of the hospital (ie, county penetration) and (2) the percentage of Medicare stays at the hospital with MA as the primary expected payer (ie, hospital penetration). The county penetration measure is used to provide insight on MA penetration as a market characteristic, whereas the hospital penetration measure provides insight on hospital exposure to MA as a payer. Both variables were included in the models as continuous variables that varied over time.

Other Covariates

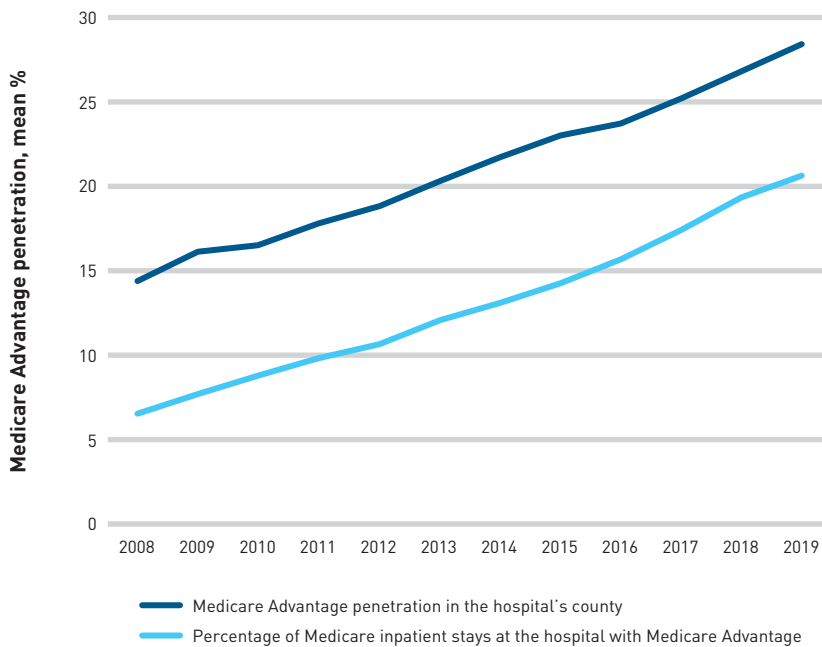
We identified hospital affiliation status using mergers and acquisition data from Irving Levin Associates, augmented with self-reported affiliation from the AHA. We also included a number of hospital organizational, utilization, and market characteristics ([eAppendix C](#)).

Analysis

In descriptive analyses, we examined county and hospital MA penetration from 2008 through 2019. Second, we examined characteristics of hospitals with high ($\geq 20\%$) and low ($< 20\%$) MA penetration. This cut point is consistent with existing literature.^{23,24}

We used fixed-effects models to examine the association of MA penetration with hospital financial distress. The data set included a record for each hospital in each year it was open. The models examining county MA penetration included fixed effects for the hospital's county. The models examining hospital MA penetration included hospital fixed effects. The county/hospital fixed effects limit the effect of MA penetration to variation within counties/hospitals across study years and control for confounders that do not vary over time. The effect of interest can be interpreted as the change in the Altman Z score associated with a 1–percentage point increase in MA penetration. SEs are robust, accounting for the clustering of observations within counties/hospitals over time.

FIGURE. Trends in Medicare Advantage Penetration Within Rural Hospitals' Counties and Among Medicare Inpatient Stays at the Hospital, 2008-2019



Source: Authors' analysis of Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, State Inpatient Databases and CMS Medicare Advantage data, 2008-2019.

Finally, we estimated survival models to quantify the association between MA penetration and hospital closure. We examined time to closure for hospitals open in 2008. Hospitals stopped contributing time in the year they closed. Thus, MA penetration corresponds to 1 year before each event. MA penetration was treated as a time-dependent covariate, where values could change over time. Proportional HRs are presented.

The survival models controlled for hospital organizational, utilization, and market characteristics measured at baseline in 2008. The hospital fixed effects controlled for all these factors at baseline in the financial distress models. We did not include additional time-varying covariates in the models because many of the variables may be on the causal pathway (eg, MA penetration may affect total discharge volume, which may affect financial distress) or may be a cause of financial distress (eg, financial distress may increase elimination of service lines).

The models are further stratified by financial distress and public vs private ownership, both measured in 2008. We estimated separate models for county MA penetration and hospital MA penetration.

Role of the Funding Organization

The funding organization (the Agency for Healthcare Research and Quality) had a role in data collection, data analysis and interpretation, and the right to approve or disapprove publication of the finished manuscript.

RESULTS

The final study sample included 556 rural hospitals, accounting for 25% of all rural community general acute care hospitals in 2008. Of these study hospitals, Medicare Advantage penetration of beneficiaries increased by 14 percentage points from 2008 through 2019 among rural hospitals' counties (14.3% to 28.4%) and among Medicare inpatient stays (6.5% to 20.6%) (Figure). Mean hospital MA penetration was lower but followed nearly a parallel trend to the county measure. Because hospital-level penetration started at a lower baseline (ie, 6.5% at baseline), the percentage increase in penetration was much higher at the hospital level than at the county level (217% vs 99%). In 2008, 70.7% of hospitals had a low county penetration rate of less than 20%, and 90.3% had a low hospital penetration rate. By 2019, these rates had decreased to 31.5% and 51.7%, respectively (Table 1). However, one-fifth of all rural hospitals included in this study still served no MA inpatients in 2019. One-third of these hospitals were in counties with high MA penetration.

With respect to county MA penetration, hospitals with high vs low penetration were more likely to be affiliated with another hospital or health system (31.7% vs 19.8% in 2019) but less likely to be public hospitals (24.4% vs 50.0%) or critical access hospitals (CAHs) (41.4% vs 68.5%) (Table 1). These hospitals also had larger bed sizes and higher annual discharge volumes and were more likely to be in metropolitan areas. For hospitals with high vs low county penetration rates, Medicare stays constituted a smaller percentage of all discharges (58.1% vs 62.9% in 2019), but Medicaid stays accounted for a greater share of all stays (17.2% vs 13.7% in 2019). They also had a lower market share of inpatient stays (22.0% vs 29.7% in 2019). However, hospitals with high vs low county penetration had a greater percentage of surgical stays (9.5% vs 5.3% in 2019). Of hospitals with high and low county penetration in 2019, 9.6% and 40.7%, respectively, had no MA inpatient stays during the year, which equals a total of 100 hospitals, or approximately one-fifth of the 515 rural hospitals still operating in 2019. Many differences noted above were similar when we compared high and low hospital MA penetration, as opposed to county penetration (Table 1). Additional characteristics are provided in eAppendix B.

With respect to financial distress, where higher values on the Altman Z score correspond to more stability, a 1-percentage point increase in hospital MA penetration was associated with an increase of 0.04 in the Altman Z score ($P = .03$) (Table 2). Thus, the mean increase in MA penetration (for counties and hospitals) of approximately 14 percentage points from 2008 through 2019 would be associated with an increase in the Altman Z score of 0.56. The

TABLE 1. Characteristics of Rural Hospitals by Medicare Advantage Penetration, 2008 and 2019

Characteristic	All hospitals		Medicare Advantage penetration in the hospital's county				Medicare inpatient stays at the hospital with Medicare Advantage, %			
	2008	2019	2008		2019		2008		2019	
			High: ≥ 20%	Low: < 20%	High: ≥ 20%	Low: < 20%	High: ≥ 20%	Low: < 20%	High: ≥ 20%	Low: < 20%
Total, n	556	515	163	393	353	162	54	502	249	266
Total, %	100.0	100.0	29.3	70.7	68.5	31.5	9.7	90.3	48.3	51.7
Closed between 2009 and 2019, %	7.4	— ^a	5.5	8.1	— ^a	— ^a	0.0	8.2	— ^a	— ^a
Altman Z score, mean	4.5	4.8	4.2	4.6	4.5	5.3	4.4	3.8	4.5	5.1
Affiliated, %	28.4	28.0	33.1	26.5	31.7 ^b	19.8 ^b	29.6	28.3	32.9 ^b	23.3 ^b
Ownership, %										
Public	31.5	32.4	17.8 ^b	37.2 ^b	24.4 ^b	50.0 ^b	14.8 ^b	33.3 ^b	24.5 ^b	39.8 ^b
Private nonprofit	58.1	59.2	76.1 ^b	50.6 ^b	65.7 ^b	45.1 ^b	83.3 ^b	55.4 ^b	64.3 ^b	54.5 ^b
Private for profit	10.3	8.3	6.1 ^b	12.0 ^b	9.9	4.9	1.9 ^b	11.2 ^b	11.2 ^b	5.6 ^b
Critical access hospital, %	48.0	49.9	46.0	48.9	41.4 ^b	68.5 ^b	48.1	48.0	35.3 ^b	63.5 ^b
Bed size, mean number of beds	57.4	55.4	62.3	55.4	63.2 ^b	38.3 ^b	60.8	57.0	70.7 ^b	41.0 ^b
Hospital location, %										
Metropolitan	18.3	19.6	34.4 ^b	11.7 ^b	23.5 ^b	11.1 ^b	38.9 ^b	16.1 ^b	21.7	17.7
Rural, metropolitan adjacent	48.9	47.8	46.6	49.9	54.1 ^b	34.0 ^b	48.1	49.0	59.0 ^b	37.2 ^b
Rural remote	32.7	32.6	19.0	38.4	22.4	54.9	13.0 ^b	34.9 ^b	19.3 ^b	45.1 ^b
Total discharge volume, mean	2298	1774	2546	2195	2054 ^b	1162 ^b	3039	2218	2339 ^b	1244 ^b
Payer mix, mean %										
Medicare	53.5	59.6	49.2 ^b	55.3 ^b	58.1 ^b	62.9 ^b	51.7	53.7	58.5	60.7
Medicaid	15.1	16.1	16.1	14.7	17.2 ^b	13.7 ^b	16.1	15.0	18.1 ^b	14.2 ^b
Private insurance	22.7	17.7	25.4 ^b	21.6 ^b	18.0	17.0	24.7	22.5	17.0	18.3
Self-pay/no charge	5.2	3.6	5.0	5.3	3.8	3.4	4.5	5.3	3.9	3.5
Hospital had no Medicare Advantage, %	45.5	19.4	28.2 ^b	52.7 ^b	9.6 ^b	40.7 ^b	0.0	50.4	0.0	37.6
General medical service line, mean %	68.5	70.2	62.9 ^b	70.8 ^b	68.4 ^b	74.2 ^b	62.3 ^b	69.2 ^b	68.3 ^b	72.1 ^b
Surgical service line, mean %	8.7	8.2	10.7 ^b	7.8 ^b	9.5 ^b	5.3 ^b	12.1 ^b	8.3 ^b	9.6 ^b	6.9 ^b
Market share of inpatient stays, mean %	33.8	24.4	31.1 ^b	34.9 ^b	22.0 ^b	29.7 ^b	32.9	33.8	22.6 ^b	26.0 ^b

^a2019 statistics include only those hospitals that were open in 2019.

^bP < .05 testing difference between mean or distribution between ≥20% and <20% Medicare Advantage penetration.

Source: Authors' analysis of Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, State Inpatient Databases for 14 states; American Hospital Association Annual Survey; CMS, Cost Reports and Medicare Advantage data; Irving Levin Associates, Inc, Mergers and Acquisitions Database; University of North Carolina Cecil G. Sheps Center for Health Services Research, 2008-2019.

cut points denoting financial stability and distress are 2.8 and 1.1, respectively, a 1.7-unit difference. Note that the mean increase in the Altman Z score across all hospitals from 2008 through 2019 was 0.3.

A similar association ($\beta = 0.08$) was observed for county MA penetration but was not significant at the conventional level ($P = .07$). However, these associations persisted only among hospitals that were already distressed in 2008 (county penetration: $\beta = 0.12$; $P = .02$; hospital penetration: $\beta = 0.05$; $P = .02$) and among those that were privately owned (county penetration: $\beta = 0.13$; $P = .02$; hospital penetration: $\beta = 0.07$; $P = .01$).

The association between the Altman Z score and county MA penetration appeared to be larger than the association with hospital MA penetration ($\beta = 0.08$ vs 0.04), but the difference was not significant. Further, the coefficients were estimated from 2 models that may not be directly comparable.

With respect to risk of closure, a 1–percentage point increase in county MA penetration was associated with a 5% reduction in risk of closure (HR, 0.95; $P = .01$) (Table 3). Similarly, a 1–percentage point increase in hospital MA penetration was associated with a 4% reduction in risk of closure (HR, 0.96; $P = .04$). The relationship between county MA penetration and lower risk of closure generally persisted among hospitals that were financially distressed (HR, 0.95; $P = .07$), financially stable (HR, 0.86; $P = .01$), and privately owned (HR, 0.95; $P = .04$).

DISCUSSION

This study of rural hospitals in 14 states found that MA penetration is associated with increased financial stability and reduced likelihood of rural hospital closure, suggesting that the growth of

TABLE 2. The Association of Medicare Advantage Penetration in Rural Hospitals' Counties and Among Medicare Inpatient Stays With the Altman Z Score Measuring Hospital Financial Distress^a

Study population	Primary independent variable associated with the Altman Z score							
	County fixed-effects model 1: Medicare Advantage penetration in the hospital's county				Hospital fixed-effects model 2: percentage of Medicare inpatient stays with Medicare Advantage			
	Hospital- years, n	β	95% CI	P	Hospital- years, n	β	95% CI	P
All hospitals	5959	0.08	-0.01 to 0.16	.07	6111	0.04	0.00-0.08	.03
Financially distressed in 2008	2153	0.12	0.02-0.22	.02	2157	0.05	0.01-0.09	.02
Financially stable in 2008	3806	0.05	-0.07 to 0.18	.41	3954	0.04	-0.02 to 0.09	.22
Public ownership in 2008	1795	-0.05	-0.16 to 0.07	.44	1939	-0.04	-0.10 to 0.02	.16
Private ownership in 2008	4164	0.13	0.02-0.24	.02	4172	0.07	0.02-0.11	.01

^aThe effect estimates can be interpreted as the change in level of financial distress associated with a 1-percentage point increase in Medicare Advantage penetration within the hospital or county. Models include hospital or county fixed effects; they are adjusted for no other variables.

Source: Authors' analysis of Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, State Inpatient Databases for 14 states; American Community Survey; American Hospital Association Annual Survey; CMS, Cost Reports and Medicare Advantage data; Irving Levin Associates, Inc, Mergers and Acquisitions Database; KFF; University of North Carolina Cecil G. Sheps Center for Health Services Research, 2008-2019.

TABLE 3. The Association of Medicare Advantage Penetration in Rural Hospitals' Counties and Among Medicare Inpatient Stays With Risk of Hospital Closure^a

Study population	Primary independent variable associated with risk of closure							
	Survival model 1: Medicare Advantage penetration in the hospital's county				Survival model 2: percentage of Medicare inpatient stays with Medicare Advantage			
	Hospitals, n	HR	95% CI	P	Hospitals, n	HR	95% CI	P
All hospitals	533	0.95	0.91-0.99	0.01	533	0.96	0.92-1.00	0.04
Financially distressed in 2008	184	0.95	0.89-1.01	0.07	184	0.94	0.89-0.99	0.03
Financially stable in 2008	349	0.86	0.77-0.96	0.01	349	0.96	0.90-1.02	0.22
Public ownership in 2008	164	— ^b	— ^b	— ^b	164	— ^b	— ^b	— ^b
Private ownership in 2008	369	0.95	0.90-1.00	0.04	369	0.97	0.92-1.02	0.19

^aThe effect estimates can be interpreted as the risk of closure associated with a 1-percentage point increase in Medicare Advantage penetration. Models are adjusted for the following variables measured in 2008: financial distress and ownership (unless stratified by it), affiliation, ownership, metropolitan location, hospital region, whether the hospital was located in a Medicaid expansion state, total discharges, occupancy rate, mean distance traveled to the hospital, payer mix, service line mix, mean household income in the market, percentage of residents with health insurance in the market, market unemployment rate, median age of residents in the market, percentage of White residents in the market, and market share of inpatient stays. The results of the full models can be found in **eAppendices D through G**.

^bCould not be estimated because of small cell sizes.

Source: Authors' analysis of Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, State Inpatient Databases for 14 states; American Community Survey; American Hospital Association Annual Survey; CMS, Cost Reports and Medicare Advantage data; Irving Levin Associates, Inc, Mergers and Acquisitions Database; KFF; University of North Carolina Cecil G. Sheps Center for Health Services Research, 2008-2019.

MA in rural areas has not contributed to rural hospital closures. We measured MA penetration at both the hospital and the county levels. Hospital-level penetration offers insight into the relationship between the share of MA patients and hospital operation. County-level penetration reflects the market condition, which can have significant influence on hospital finance. Our county fixed-effects models showed a positive association of county MA penetration with reduced risk of hospital closure, which suggests that improvement in hospital financial performance was not just an issue of the hospital's own operation but also related to those market conditions favorable to MA penetration.

Our findings counter the notion that MA plans hurt rural hospitals by not paying them as generously as TM. Although this study does not identify the mechanism underlying these findings, it could be that MA prices relative to TM fee-for-service rates are more generous

in rural areas or that MA plans steer patients to local sources of care. Previous research is inconclusive on whether MA plans negotiate rates that are less than TM. Based on interviews with hospital and health plan executives in 2014, Berenson et al⁵ concluded that MA plans pay hospitals TM prices. In contrast, using data from Medicare and commercial insurers in 2009 and 2012, Baker et al⁴ found MA plans paid 5.6% less for hospital services than TM did after adjusting for differences in hospital networks, geographic areas, and case mix. Relevant to rural hospitals, a survey of 60 CAH administrators regarding MA reimbursement found that 29% of CAHs were reimbursed under the same terms as TM: 101% of reasonable and allowable costs.⁷ Some CAHs were reimbursed based on cost only and others were reimbursed on a per diem basis. This study was conducted using data from 2007, and since then, MA plans may have opted to increase reimbursement to CAHs and rural hospitals

beyond TM rates because these hospitals must survive to provide MA enrollees with access to care.

Investigators have found concerning trends related to MA in rural areas that should be considered along with our results. For example, a recent study found that beneficiaries in rural areas enrolled in MA are more likely than their urban counterparts to switch back to TM.²⁵ Future research should monitor how MA affects patient experiences and health outcomes in rural areas.

We also found that some rural hospitals located in high MA penetrating counties served no MA patients. It could be that these hospitals opt not to participate in an MA network because of undesirable terms. Alternatively, MA plans may have excluded these hospitals from their network and/or steered enrollees to other hospitals. A recent study found MA enrollees were more likely to go to average-quality hospitals than TM enrollees, suggesting that MA plans may intentionally exclude or steer enrollees to certain hospitals.²⁶

This study fills several gaps in the literature. We found that MA penetration grew substantially from 2008 to 2019 (from 14.3% to 28.4%) in rural hospital counties. The percentage of Medicare inpatient stays that were MA at rural hospitals was lower but grew in parallel and at an even higher rate (from 6.5% to 20.6%). Our finding of lower MA penetration at the hospital vs the county level is not surprising, because MA enrollees tend to be healthier than TM beneficiaries and less likely to be hospitalized.²⁷ The difference could also be driven by steering of MA enrollees to other hospitals or sources of care. Nonetheless, the gap between the hospital- and the county-level penetration rates declined over time. There may be less selection bias and less restriction on hospital use with these plans today than 10 years ago.

Finally, we found that hospitals in areas with higher county or hospital MA penetration differed from hospitals in areas with lower MA penetration. Specifically, hospitals in lower MA penetration areas were more likely to be public and independent and have fewer beds. This is consistent with previous research that found hospitals used by TM patients were more likely to be public and independent.¹³ We controlled for these differences in modeling and conducted stratified analyses excluding public hospitals, but unmeasured factors related to expansion of MA and hospital survival, including changes to the share of Medicare inpatients,²⁸ might have confounded results. The consistency of our findings across county- and hospital-level growth in MA penetration lends robustness to our results. Finally, our study did not examine how MA penetration affects rural hospital volume. Increases in MA penetration might hasten rural hospital bypass in areas where no hospitals are in network.

Our findings of positive associations between MA penetration and rural hospital financial stability and sustainability differ from those of the limited previous work examining MA and hospital financial outcomes. Ramamonjariavelo et al²⁹ found MA penetration was negatively associated with total margin among public hospitals using a national sample of hospitals from 1997 to 2013. An analysis

conducted by Large et al³⁰ using 1992-1997 data found that Medicare HMO penetration was associated with a decline in profitability of hospitals in Florida. However, these earlier studies were focused on a specific type of hospital or health plan (public hospitals²⁹ and HMO penetration in Florida³⁰), were not limited to rural hospitals, and used older data. MA reimbursement for inpatient services may be more generous than Medicare reimbursement at rural but not urban hospitals. Thus, the effects of MA penetration on hospital performance were possibly lost in previous analyses, which looked at rural and nonrural hospitals, especially if nonrural hospitals have lower Medicare payer mixes and different associations between MA penetration and hospital finances.

Limitations

This observational study was not designed to establish causation. Although we employed a survival model adjusting for baseline factors to examine hospital closures and a fixed-effects model to examine financial distress, there may be unmeasured time-varying factors associated with both MA penetration and hospital outcomes that confound results. For example, if total hospitalization volume increased in tandem with MA shares, such volume increases could contribute to hospital financial outcomes. Further, our analysis is limited to 14 states for which we could consistently distinguish between TM and MA admissions in HCUP data and is not necessarily generalizable to all states. Finally, although we assessed the overall financial condition of the hospitals, we were unable to compare actual payments between MA plans and TM.

CONCLUSIONS

The results of this study have important policy implications related to the sustainability of rural hospitals. Specifically, our study's findings suggest that the growth of MA in rural areas over the past decade has not been associated with increasing rural hospital closures or financial distress. On the contrary, MA penetration may have improved the sustainability of rural hospitals. An important concern is the effect of MA on CAHs because they are paid cost-based rates by TM. Based on our analysis, most rural CAHs are located in low MA penetration markets. Thus, if MA penetration grows in these areas, these relationships should be monitored to uncover effects on these vulnerable hospitals. ■

Acknowledgments

The authors gratefully acknowledge staff formerly with IBM Watson Health, including Minya Sheng, MS; Jillian McCarty, MPH; and Olivia Reding, MPH, PMP, for assistance with data management, programming, and statistical support; and Mary Beth Schaefer, MS, for providing editorial review of the manuscript.

The authors also wish to acknowledge the HCUP Partner organizations that contributed to the data used in this study: California Office of Statewide Health Planning and Development, Connecticut Hospital Association, Florida Agency for Health Care Administration, Georgia Hospital Association, Kansas Hospital Association, Maryland Health Services Cost Review Commission, Massachusetts Center for Health Information and Analysis, Michigan Health & Hospital Association, Nevada Department of Health and Human Services, New Jersey Department of Health, New York State Department of Health, Tennessee Hospital Association, West Virginia Department of Health and Human Resources, West Virginia Health Care Authority, and Wisconsin Department of Health Services.

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Source of Funding: HHS, Agency for Healthcare Research and Quality (AHRQ), Healthcare Cost and Utilization Project contract number HHS-290-2018-00001-C.

Author Disclosures: Dr Henke and Dr Fingar were employed by IBM, which received funding from AHRQ for this research. The remaining authors report no relationship or financial interest with any entity that would pose a conflict of interest with the subject matter of this article.

Authorship Information: Concept and design (RMH, KRF, LL, HJJ); acquisition of data (LL, HJJ); analysis and interpretation of data (RMH, KRF, LL, HJJ); drafting of the manuscript (RMH, KRF, LL, HJJ); critical revision of the manuscript for important intellectual content (RMH, KRF, LL, HJJ); statistical analysis (RMH, KRF, LL, HJJ); obtaining funding (RMH, LL, HJJ); administrative, technical, or logistic support (KRF); and supervision (RMH, HJJ).

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eAppendix A. Healthcare Cost and Utilization Project State Inpatient Databases

We selected 14 states based on the ability to reliably distinguish between Medicare Advantage and Traditional Medicare in their State Inpatient Database:

- California
- Connecticut
- Florida
- Georgia
- Kansas
- Maryland
- Massachusetts
- Michigan
- Nevada
- New Jersey
- New York
- Tennessee
- West Virginia
- Wisconsin

eAppendix B. Characteristics of Rural Hospitals by Medicare Advantage Penetration in the Hospital’s County and Among Medicare Inpatient Stays, 2008 and 2019

Characteristic	All hospitals		Medicare Advantage penetration in the hospital’s county				Percentage of Medicare inpatient stays at the hospital with Medicare Advantage			
	2008	2019	2008		2019		2008		2019	
			High: ≥20%	Low: <20%	High: ≥20%	Low: <20%	High: ≥20%	Low: <20%	High: ≥20%	Low: <20%
Total, N	556	515	163	393	353	162	54	502	249	266
Total, %	100.0	100.0	29.3	70.7	68.5	31.5	9.7	90.3	48.3	51.7
Hospital characteristics										
Closed between 2009 and 2019, %	7.4	— ^a	5.5	8.1	— ^a	— ^a	0.0	8.2	— ^a	— ^a
Altman Z-score, mean	4.5	4.8	4.2	4.6	4.5	5.3	4.4	3.8	4.5	5.1
Financial distress, %										
Distressed (Altman Z-score ≤1.1)	19.2	20.8	17.8	19.8	21.0	20.4	16.7	19.5	20.5	21.1
Concerned (>1.1 to ≤2.8)	14.4	14.0	17.2	13.2	14.7	12.3	16.7	14.1	16.9	11.3
Stable (>2.8)	62.8	61.6	63.8	62.3	60.6	63.6	66.7	62.4	59.0	63.9
Affiliated, %	28.4	28.0	33.1	26.5	31.7 ^b	19.8 ^b	29.6	28.3	32.9 ^b	23.3 ^b
Ownership, %										
Public	31.5	32.4	17.8 ^b	37.2 ^b	24.4 ^b	50.0 ^b	14.8 ^b	33.3 ^b	24.5 ^b	39.8 ^b
Private nonprofit	58.1	59.2	76.1 ^b	50.6 ^b	65.7 ^b	45.1 ^b	83.3 ^b	55.4 ^b	64.3 ^b	54.5 ^b
Private for profit	10.3	8.3	6.1 ^b	12.0 ^b	9.9	4.9	1.9 ^b	11.2 ^b	11.2 ^b	5.6 ^b
Critical access hospital, %	48.0	49.9	46.0	48.9	41.4 ^b	68.5 ^b	48.1	48.0	35.3 ^b	63.5 ^b
Bed size, mean number of beds	57.4	55.4	62.3	55.4	63.2 ^b	38.3 ^b	60.8	57.0	70.7 ^b	41.0 ^b
Hospital location, %										
Metropolitan	18.3	19.6	34.4 ^b	11.7 ^b	23.5 ^b	11.1 ^b	38.9 ^b	16.1 ^b	21.7	17.7
Rural, metropolitan adjacent	48.9	47.8	46.6	49.9	54.1 ^b	34.0 ^b	48.1	49.0	59.0 ^b	37.2 ^b
Rural remote	32.7	32.6	19.0	38.4	22.4	54.9	13.0 ^b	34.9 ^b	19.3 ^b	45.1 ^b
Region, %										
Northeast	11.3	11.3	12.9	10.7	14.7 ^b	3.7 ^b	18.5	10.6	18.9 ^b	4.1 ^b
Midwest	43.9	46.0	54.6 ^b	39.4 ^b	38.5 ^b	62.3 ^b	55.6	42.6	35.7 ^b	55.6 ^b
South	32.2	30.5	19.0 ^b	37.7 ^b	41.4 ^b	6.8 ^b	16.7 ^b	33.9 ^b	42.6 ^b	19.2 ^b
West	12.4	12.2	13.5	12.0	5.4 ^b	27.2 ^b	9.3	12.7	2.8 ^b	21.1 ^b
Medicaid expanded, %	0.0	41.2	0.0	0.0	43.9	35.2	0.0	0.0	45.4	37.2

Characteristic	All hospitals		Medicare Advantage penetration in the hospital's county				Percentage of Medicare inpatient stays at the hospital with Medicare Advantage			
	2008	2019	2008		2019		2008		2019	
			High: ≥20%	Low: <20%	High: ≥20%	Low: <20%	High: ≥20%	Low: <20%	High: ≥20%	Low: <20%
Utilization characteristics										
Total discharge volume, mean	2,298	1,774	2,546	2,195	2,054 ^b	1,162 ^b	3,039	2,218	2,339 ^b	1,244 ^b
Occupancy rate, mean %	52.8	46.1	56.7 ^b	51.2 ^b	46.9	44.2	58.0	52.3	47.3	45.0
Distance to hospital, mean miles	16.6	19.3	17.1	16.4	17.9	22.4	15.8	16.7	19.3	19.3
Payer mix, mean %										
Medicare	53.5	59.6	49.2 ^b	55.3 ^b	58.1 ^b	62.9 ^b	51.7	53.7	58.5	60.7
Medicaid	15.1	16.1	16.1	14.7	17.2 ^b	13.7 ^b	16.1	15.0	18.1 ^b	14.2 ^b
Private insurance	22.7	17.7	25.4 ^b	21.6 ^b	18.0	17.0	24.7	22.5	17.0	18.3
Self-pay/no charge	5.2	3.6	5.0	5.3	3.8	3.4	4.5	5.3	3.9	3.5
Service line mix, mean %										
Maternal/neonatal	14.7	13.7	17.1 ^b	13.7 ^b	14.1	12.8	16.8	14.5	13.9	13.5
MSUD	3.8	4.2	4.6	3.5	4.5	3.5	4.1	3.8	4.7	3.8
Injury	4.3	3.7	4.7 ^b	4.1 ^b	3.5 ^b	4.1 ^b	4.6	4.3	3.6	3.8
Surgical	8.7	8.2	10.7 ^b	7.8 ^b	9.5 ^b	5.3 ^b	12.1 ^b	8.3 ^b	9.6 ^b	6.9 ^b
General medical	68.5	70.2	62.9 ^b	70.8 ^b	68.4 ^b	74.2 ^b	62.3 ^b	69.2 ^b	68.3 ^b	72.1 ^b
Medicare stays with Medicare Advantage, mean %	6.5	20.7	13.9 ^b	3.4 ^b	27.8 ^b	5.3 ^b	31.7 ^b	3.8 ^b	37.5 ^b	5.0 ^b
Hospital had no Medicare Advantage stays, %	45.5	19.4	28.2 ^b	52.7 ^b	9.6 ^b	40.7 ^b	0.0	50.4	0.0	37.6
Market characteristics, mean										
Medicare Advantage penetration, %	15.1	28.4	29.2 ^b	8.8 ^b	38.1 ^b	6.4 ^b	32.2 ^b	13.2 ^b	39.2 ^b	18.1 ^b
Market share of inpatient stays, %	33.8	24.4	31.1 ^b	34.9 ^b	22.0 ^b	29.7 ^b	32.9	33.8	22.6 ^b	26.0 ^b
Mean household income, \$, thousands	55.1	66.2	55.9	54.8	64.5 ^b	70.0 ^b	54.9	55.1	63.6 ^b	68.7 ^b
Percentage with health insurance	85.7	91.4	87.1 ^b	85.0 ^b	91.4	91.5	87.4 ^b	85.5 ^b	91.1	91.7
Percentage unemployed	8.8	5.4	9.0	8.7	5.8 ^b	4.5 ^b	8.5	8.8	6.0 ^b	4.9 ^b
Median age, years	41.1	42.7	41.0	41.1	42.8	42.3	41.0	41.1	42.5	42.8
Percentage White residents	82.7	81.1	86.8 ^b	81.0 ^b	82.0	79.1	86.6	82.3	81.5	80.7

MSUD, mental and/or substance use disorder.

^a 2019 statistics include only those hospitals that were open in 2019.

^b p value testing difference between mean or distribution between $\geq 20\%$ and $< 20\%$ Medicare Advantage penetration < 0.05 .

Source: Authors' analysis of Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, State Inpatient Databases for 14 states; American Community Survey; American Hospital Association Annual Survey; Centers for Medicare & Medicaid Services, Cost Reports and Medicare Advantage data; Irving Levin Associates, Inc., Mergers and Acquisitions Database; Kaiser Family Foundation; University of North Carolina Sheps Center, 2008-2019.

eAppendix C. Other Variables

Other variables included in the descriptive analyses were hospital characteristics, including affiliation with another hospital or health system, as well as ownership, critical access status, size (number of beds), occupancy rate, rural/urban location (Rural-Urban Continuum Codes), and region from the American Hospital Association (AHA); utilization characteristics, including total discharges, mean distance traveled to the hospital, payer mix, and service line mix derived from the State Inpatient Databases (SID); and market characteristics, including mean household income, percentage of residents with health insurance, unemployment rate, median age, and percentage of White residents from the American Community Survey (ACS), as well as market share of inpatient stays derived from the SID.

Affiliation is a broad group that includes mergers and acquisitions documented in Levin, as well as self-reported system membership according to the AHA, which may also include formal mergers and acquisitions as well as informal affiliations that do not involve change in governance.¹ Some hospitals report affiliation to the AHA but are not in Levin. We reviewed the pattern of affiliation reporting for these hospitals and additionally, through public information searches confirmed affiliations. These hospitals were coded as affiliated.

Markets were defined as the collection of ZIP Codes that accounted for 75% of a hospital's inpatient stays, consistent with previous rural hospital market definitions.² The variables from ACS were a weighted average based on the proportion of inpatient stays from the ZIP Code.

¹ American Hospital Association. Fast Facts on U.S. Hospitals, 2022. January 2022. Accessed May 1, 2022. <https://www.aha.org/statistics/fast-facts-us-hospitals>

² Goody B. Defining rural hospital markets. *Health services research*. 1993 Jun;28(2):183.

eAppendix D. The Association of Medicare Advantage Penetration in Rural Hospitals' Counties and Among Medicare Inpatient Stays With Risk of Hospital Closure, All Hospitals (N=533)

Time-variant primary independent variable and other time-fixed independent variables	Primary independent variable associated with risk of closure					
	Survival model 1: Medicare Advantage penetration in the hospital's county			Survival model 2: percentage of Medicare inpatient stays with Medicare Advantage		
	HR	SE	<i>p</i> value	HR	SE	<i>p</i> value
Primary independent variable						
Medicare Advantage penetration	0.9487	1.0218	0.0146	0.9567	1.0218	0.0401
Hospital characteristics, 2008						
Financially distressed	3.3596	1.5337	0.0046	3.0488	1.5478	0.0107
Affiliated	0.7137	1.5646	0.4512	0.9678	1.5214	0.9378
Ownership						
Public	0.3538	1.8062	0.0789	0.3797	1.7810	0.0934
Private nonprofit	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Private for profit	1.6091	1.6112	0.3187	1.7188	1.7125	0.3140
Critical access hospital	0.0690	2.0012	0.0001	0.0881	2.0044	0.0005
Bed size, N	1.0116	1.0041	0.0046	1.0113	1.0045	0.0112
Hospital location						
Metropolitan	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Rural, metropolitan adjacent	0.4041	1.7842	0.1176	0.4446	1.7903	0.1639
Rural remote	0.4439	1.9189	0.2127	0.5991	1.9513	0.4434
Region						
Northeast	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Midwest	0.8996	2.7772	0.9175	0.5793	2.7569	0.5903
South	0.8117	2.3365	0.8058	0.3801	2.6031	0.3120
West	2.7085	2.9983	0.3642	1.7392	3.1769	0.6321
State expanded Medicaid	0.8101	1.9344	0.7496	0.5747	1.9121	0.3928
Utilization characteristics, 2008						
Total discharge volume, N	0.9997	1.0002	0.0947	0.9998	1.0002	0.2757
Occupancy rate, %	0.2662	2.4247	0.1351	0.2244	2.6721	0.1284
Distance to hospital, miles	0.9878	1.0323	0.7004	0.9434	1.0646	0.3515
Payer mix, %						
Medicare	0.9770	1.0146	0.1102	0.9826	1.0149	0.2344
Private insurance	0.9910	1.0300	0.7599	0.9794	1.0300	0.4809
Self-pay/no charge	0.9887	1.0406	0.7756	0.9919	1.0454	0.8553
Other	0.9812	1.0364	0.5951	0.9903	1.0365	0.7864
Service line mix, %						
Maternal/neonatal	0.9540	1.0216	0.0279	0.9687	1.0212	0.1306
MSUD	0.9502	1.0316	0.0999	0.9524	1.0361	0.1694
Injury	0.9199	1.0961	0.3625	0.9139	1.1061	0.3719
Surgical	0.9433	1.0451	0.1860	0.9564	1.0491	0.3525

Time-variant primary independent variable and other time-fixed independent variables	Primary independent variable associated with risk of closure					
	Survival model 1: Medicare Advantage penetration in the hospital's county			Survival model 2: percentage of Medicare inpatient stays with Medicare Advantage		
	HR	SE	<i>p</i> value	HR	SE	<i>p</i> value
Market characteristics, 2008						
Market share of inpatient stays, %	0.9689	1.0177	0.0715	0.9643	1.0191	0.0544
Mean household income, \$	0.9999	1.0000	0.0146	0.9999	1.0000	0.0364
Percentage with health insurance	1.0848	1.0652	0.1978	1.0395	1.0648	0.5376
Percentage unemployed	0.9943	1.0983	0.9512	1.0077	1.1015	0.9368
Median age, years	1.0326	1.0625	0.5965	1.0713	1.0691	0.3022
Percentage White residents	0.9818	1.0184	0.3137	0.9828	1.0170	0.3033

HR, hazard ratio; MSUD, mental and/or substance use disorder; SE, standard error.

Notes: The effect estimates for the primary independent variable can be interpreted as the risk of closure associated with a 1 percentage point increase in Medicare Advantage penetration.

Models are adjusted for the following variables measured in 2008: financial distress and ownership (unless stratified by it), affiliation, ownership, metropolitan location, hospital region, whether the hospital was located in a Medicaid expansion state, total discharges, occupancy rate, mean distance traveled to the hospital, payer mix, service line mix, mean household income in the market, percentage of residents with health insurance in the market, market unemployment rate, median age of residents in the market, percentage of White residents in the market, and market share of inpatient stays.

Source: Authors' analysis of Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, State Inpatient Databases for 14 states; American Community Survey; American Hospital Association Annual Survey; Centers for Medicare & Medicaid Services, Cost Reports and Medicare Advantage data; Irving Levin Associates, Inc., Mergers and Acquisitions Database; Kaiser Family Foundation; University of North Carolina Sheps Center, 2008-2019.

eAppendix E. The Association of Medicare Advantage Penetration in Rural Hospitals' Counties and Among Medicare Inpatient Stays With Risk Of Hospital Closure, Hospitals That Were Financially Distressed in 2008 (N=184)

Time-variant primary independent variable and other time-fixed independent variables	Primary independent variable associated with risk of closure					
	Survival model 1: Medicare Advantage penetration in the hospital's county			Survival model 2: percentage of Medicare inpatient stays with Medicare Advantage		
	HR	SE	p value	HR	SE	p value
Primary independent variable						
Medicare Advantage penetration	0.9453	1.0320	0.0741	0.9405	1.0281	0.0270
Hospital characteristics, 2008						
Affiliated	0.2828	1.9971	0.0679	0.4278	1.8758	0.1771
Ownership						
Public	0.0774	2.3666	0.0030	0.0872	2.2099	0.0021
Private nonprofit	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Private for profit	1.0012	1.8258	0.9984	0.8289	2.0992	0.8002
Critical access hospital	0.0202	4.8293	0.0132	0.0402	4.0779	0.0222
Bed size, N	1.0080	1.0041	0.0532	1.0067	1.0052	0.1985
Hospital location						
Metropolitan	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Rural, metropolitan adjacent	0.3644	2.4145	0.2521	0.4119	2.3572	0.3010
Rural remote	0.5762	2.4429	0.5371	0.7742	2.4510	0.7753
Region						
Northeast	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Midwest	0.7185	3.0533	0.7671	0.2558	3.8768	0.3144
South	0.4306	2.8552	0.4219	0.1670	3.5331	0.1562
West	4.5096	3.5105	0.2304	1.9609	3.8873	0.6199
State expanded Medicaid	1.2489	2.3507	0.7948	0.6138	2.2205	0.5407
Utilization characteristics, 2008						
Total discharge volume, N	0.9997	1.0002	0.1028	0.9998	1.0002	0.3028
Occupancy rate, %	0.2782	2.3763	0.1394	0.3416	2.4753	0.2360
Distance to hospital, miles	0.9881	1.0321	0.7054	0.9390	1.1065	0.5341
Payer mix, %						
Medicare	1.0097	1.0141	0.4888	1.0186	1.0177	0.2945
Private insurance	0.9599	1.0327	0.2035	0.9474	1.0397	0.1648
Self-pay/no charge	1.0418	1.0655	0.5185	1.0077	1.0930	0.9313
Other	0.8800	1.0534	0.0140	0.8910	1.0540	0.0283
Service line mix, %						
Maternal/neonatal	0.9520	1.0231	0.0311	0.9757	1.0276	0.3664
MSUD	0.9980	1.0369	0.9558	1.0117	1.0573	0.8344
Injury	1.0024	1.0985	0.9795	0.9562	1.1590	0.7616
Surgical	0.9747	1.0485	0.5889	1.0082	1.0852	0.9204

Time-variant primary independent variable and other time-fixed independent variables	Primary independent variable associated with risk of closure					
	Survival model 1: Medicare Advantage penetration in the hospital's county			Survival model 2: percentage of Medicare inpatient stays with Medicare Advantage		
	HR	SE	<i>p</i> value	HR	SE	<i>p</i> value
Market characteristics, 2008						
Market share of inpatient stays, %	0.9598	1.0225	0.0651	0.9610	1.0248	0.1047
Mean household income, \$	0.9999	1.0001	0.0187	0.9999	1.0001	0.0372
Percentage with health insurance	1.0146	1.0845	0.8584	0.9601	1.0980	0.6635
Percentage unemployed	0.9758	1.1121	0.8179	0.9695	1.1279	0.7968
Median age, years	1.1079	1.1084	0.3193	1.1014	1.1030	0.3246
Percentage White residents	0.9612	1.0260	0.1235	0.9664	1.0239	0.1473

HR, hazard ratio; MSUD, mental and/or substance use disorder; SE, standard error.

Notes: The effect estimates for the primary independent variable can be interpreted as the risk of closure associated with a 1 percentage point increase in Medicare Advantage penetration.

Models are adjusted for the following variables measured in 2008: financial distress and ownership (unless stratified by it), affiliation, ownership, metropolitan location, hospital region, whether the hospital was located in a Medicaid expansion state, total discharges, occupancy rate, mean distance traveled to the hospital, payer mix, service line mix, mean household income in the market, percentage of residents with health insurance in the market, market unemployment rate, median age of residents in the market, percentage of White residents in the market, and market share of inpatient stays.

Source: Authors' analysis of Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, State Inpatient Databases for 14 states; American Community Survey; American Hospital Association Annual Survey; Centers for Medicare & Medicaid Services, Cost Reports and Medicare Advantage data; Irving Levin Associates, Inc., Mergers and Acquisitions Database; Kaiser Family Foundation; University of North Carolina Sheps Center, 2008-2019.

eAppendix F. The Association of Medicare Advantage Penetration in Rural Hospitals' Counties and Among Medicare Inpatient Stays With Risk of Hospital Closure, Hospitals That Were Financially Stable in 2008 (N=349)

Time-variant primary independent variable and other time-fixed independent variables	Primary independent variable associated with risk of closure					
	Survival model 1: Medicare Advantage penetration in the hospital's county			Survival model 2: percentage of Medicare inpatient stays with Medicare Advantage		
	HR	SE	p value	HR	SE	p value
Primary independent variable						
Medicare Advantage penetration	0.8568	1.0590	0.0070	0.9588	1.0345	0.2156
Hospital characteristics, 2008						
Affiliated	6.1114	2.9606	0.0954	6.8130	2.4841	0.0350
Ownership						
Public	1.1366	2.1468	0.8669	4.2792	2.8607	0.1666
Private nonprofit	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Private for profit	7.7727	4.2975	0.1596	20.5580	5.9869	0.0911
Critical access hospital	0.0089	10.2086	0.0423	0.0354	4.1354	0.0185
Bed size, N	1.0345	1.0176	0.0521	1.0196	1.0158	0.2160
Hospital location						
Metropolitan	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Rural, metropolitan adjacent	0.4322	3.6964	0.5211	0.7805	2.7310	0.8052
Rural remote	0.4982	6.9687	0.7197	0.8105	8.1580	0.9203
State expanded Medicaid	0.0380	8.4474	0.1253	0.0633	4.6519	0.0727
Utilization characteristics, 2008						
Total discharge volume, N	0.9993	1.0008	0.3684	0.9992	1.0010	0.3719
Distance to hospital, miles	0.8417	1.2186	0.3833	0.8606	1.1604	0.3129
Payer mix, %						
Medicare	0.9019	1.1421	0.4368	0.9160	1.1339	0.4851
Private insurance	0.9831	1.0614	0.7751	0.9742	1.0613	0.6608
Self-pay/no charge	0.8277	1.1103	0.0706	0.8635	1.1052	0.1425
Other	1.1448	1.0586	0.0175	1.1012	1.0528	0.0612
Service line mix, %						
Maternal/neonatal	0.9219	1.0691	0.2237	0.9382	1.0653	0.3128
MSUD	0.8035	1.5177	0.6000	0.8870	1.3210	0.6666
Injury	0.5313	1.4858	0.1102	0.5880	1.2919	0.0382
Surgical	0.8803	1.0568	0.0211	0.8585	1.0652	0.0156
Market characteristics, 2008						
Market share of inpatient stays, %	0.8759	1.0489	0.0055	0.9285	1.0464	0.1017
Mean household income, \$	0.9999	1.0001	0.3645	1.0000	1.0001	0.7468
Percentage with health insurance	0.8447	1.2790	0.4928	0.8893	1.2017	0.5230
Percentage unemployed	0.8521	1.2357	0.4494	0.8974	1.3468	0.7161
Median age, years	0.9483	1.1812	0.7500	0.9243	1.0995	0.4067
Percentage White residents	1.0640	1.0425	0.1356	1.0591	1.0446	0.1882

HR, hazard ratio; MSUD, mental and/or substance use disorder; SE, standard error.

Notes: The effect estimates for the primary independent variable can be interpreted as the risk of closure associated with a 1 percentage point increase in Medicare Advantage penetration. Models are adjusted for the following variables measured in 2008: financial distress and

ownership (unless stratified by it), affiliation, ownership, metropolitan location, whether the hospital was located in a Medicaid expansion state, total discharges, mean distance traveled to the hospital, payer mix, service line mix, mean household income in the market, percentage of residents with health insurance in the market, market unemployment rate, median age of residents in the market, percentage of White residents in the market, and market share of inpatient stays. Region and occupancy rate were not included in the model because the variables had unstable estimates.

Source: Authors' analysis of Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, State Inpatient Databases for 14 states; American Community Survey; American Hospital Association Annual Survey; Centers for Medicare & Medicaid Services, Cost Reports and Medicare Advantage data; Irving Levin Associates, Inc., Mergers and Acquisitions Database; Kaiser Family Foundation; University of North Carolina Sheps Center, 2008-2019.

eAppendix G. The Association of Medicare Advantage Penetration in Rural Hospitals' Counties and Among Medicare inpatient Stays With Risk of Hospital Closure, Hospitals That Were Privately Owned in 2008 (N=369)

Time-variant primary independent variable and other time-fixed independent variables	Primary independent variable associated with risk of closure					
	Survival model 1: Medicare Advantage penetration in the hospital's county			Survival model 2: percentage of Medicare inpatient stays with Medicare Advantage		
	HR	SE	p value	HR	SE	p value
Primary independent variable						
Medicare Advantage penetration	0.9491	1.0253	0.0367	0.9679	1.0250	0.1870
Hospital characteristics, 2008						
Financially distressed	6.8052	1.7588	0.0007	5.7548	1.7767	0.0023
Affiliated	0.5620	1.6503	0.2500	0.7217	1.5724	0.4711
Ownership						
Private nonprofit	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Private for profit	1.6261	1.6471	0.3300	1.6661	1.7589	0.3660
Critical access hospital	0.0668	2.5221	0.0034	0.1065	2.4977	0.0144
Bed size, N	1.0093	1.0053	0.0766	1.0081	1.0061	0.1827
Hospital location						
Metropolitan	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Rural, metropolitan adjacent	0.8181	2.0578	0.7809	0.8840	2.0416	0.8628
Rural remote	0.5378	2.3004	0.4566	0.8507	2.2775	0.8443
Region						
Northeast	[ref]	[ref]	[ref]	[ref]	[ref]	[ref]
Midwest	0.7472	2.9907	0.7902	0.5328	3.2807	0.5961
South	0.6255	2.6187	0.6260	0.3690	3.4069	0.4161
West	2.3051	3.6435	0.5183	1.5019	5.2609	0.8065
State expanded Medicaid	1.5100	2.2237	0.6061	1.0054	2.3291	0.9949
Utilization characteristics, 2008						
Total discharge volume, N	0.9996	1.0002	0.0314	0.9998	1.0002	0.2009
Occupancy rate, %	0.1561	3.0185	0.0927	0.1349	3.6362	0.1207
Distance to hospital, miles	1.0042	1.0168	0.8009	0.9553	1.0852	0.5761
Payer mix, %						
Medicare	0.9838	1.0186	0.3762	0.9936	1.0198	0.7434
Private insurance	0.9336	1.0392	0.0740	0.9282	1.0413	0.0656
Self-pay/no charge	1.0507	1.0502	0.3130	1.0573	1.0565	0.3108
Other	0.8790	1.0775	0.0841	0.8969	1.0739	0.1267
Service line mix, %						
Maternal/neonatal	0.9772	1.0229	0.3087	0.9969	1.0287	0.9116
MSUD	0.9944	1.0484	0.9053	1.0023	1.0572	0.9675
Injury	0.9665	1.1138	0.7517	0.9134	1.1409	0.4918
Surgical	1.0012	1.0465	0.9784	1.0223	1.0621	0.7139

Time-variant primary independent variable and other time-fixed independent variables	Primary independent variable associated with risk of closure					
	Survival model 1: Medicare Advantage penetration in the hospital's county			Survival model 2: percentage of Medicare inpatient stays with Medicare Advantage		
	HR	SE	<i>p</i> value	HR	SE	<i>p</i> value
Market characteristics, 2008						
Market share of inpatient stays, %	0.9798	1.0189	0.2748	0.9735	1.0226	0.2279
Mean household income, \$	0.9999	1.0001	0.0505	0.9999	1.0001	0.1230
Percentage with health insurance	1.0399	1.0808	0.6149	1.0111	1.0850	0.8928
Percentage unemployed	0.8969	1.1275	0.3648	0.9318	1.1461	0.6046
Median age, years	1.0164	1.0704	0.8106	1.0562	1.0895	0.5234
Percentage White residents	0.9992	1.0274	0.9776	0.9944	1.0272	0.8343

HR, hazard ratio; MSUD, mental and/or substance use disorder; SE, standard error.

Notes: The effect estimates for the primary independent variable can be interpreted as the risk of closure associated with a 1 percentage point increase in Medicare Advantage penetration.

Models are adjusted for the following variables measured in 2008: financial distress and ownership (unless stratified by it), affiliation, ownership, metropolitan location, hospital region, whether the hospital was located in a Medicaid expansion state, total discharges, occupancy rate, mean distance traveled to the hospital, payer mix, service line mix, mean household income in the market, percentage of residents with health insurance in the market, market unemployment rate, median age of residents in the market, percentage of White residents in the market, and market share of inpatient stays.

Source: Authors' analysis of Agency for Healthcare Research and Quality, Healthcare Cost and Utilization Project, State Inpatient Databases for 14 states; American Community Survey; American Hospital Association Annual Survey; Centers for Medicare & Medicaid Services, Cost Reports and Medicare Advantage data; Irving Levin Associates, Inc., Mergers and Acquisitions Database; Kaiser Family Foundation; University of North Carolina Sheps Center, 2008-2019.