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RESEARCH ARTICLE

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The impact of Medicare shared savings program participation on hospital financial performance: An event-study analysis

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Abstract

Objective: To evaluate the impact of hospitals' participation in the Medicare Shared Savings Program (MSSP) on their financial performance.

Data Sources: Centers for Medicare & Medicaid Services Hospital Cost Reports and MSSP Accountable Care Organizations (ACO) Provider-Level Research Identifiable File from 2011 to 2018.

Study Design: We used an event-study design to estimate the temporal effects of MSSP participation on hospital financial outcomes and compared within-hospital changes over time between MSSP and non-MSSP hospitals while controlling for hospital and year fixed effects and organizational and service-area characteristics. The following financial outcomes were evaluated: outpatient revenue, inpatient revenue, net patient revenue, Medicare revenue, operating margin, inpatient revenue share, Medicare revenue share, and allowance and discount rate.

Data Collection/Extraction Methods: Secondary data linked at the hospital level.

Principal Findings: Controlling for trends in non-MSSP hospitals, MSSP participation was associated with differential increases in net patient revenue by \$3.28 million ($p < 0.001$), \$3.20 million ($p < 0.01$), and \$4.20 million ($p < 0.01$) in the second, third, and fourth year and beyond after joining MSSP, respectively. Medicare revenue differentially increased by \$1.50 million ($p < 0.05$), \$2.24 million ($p < 0.05$), and \$4.47 million ($p < 0.05$) in the first, second, and fourth year and beyond. Inpatient revenue share differentially increased by 0.29% ($p < 0.05$) in the second year and 0.44% ($p < 0.05$) in the fourth year and beyond. Medicare revenue share differentially increased by 0.17% ($p < 0.01$), 0.25% ($p < 0.01$), 0.32% ($p < 0.01$), and 0.41% ($p < 0.01$) in consecutive years following MSSP participation. MSSP participation was associated with 0.33% ($p < 0.05$) and 0.39% ($p < 0.05$) differential reduction in allowance and discount rate in the second and third years.

Conclusions: MSSP participation was associated with differential increases in net patient revenue, Medicare revenue, inpatient revenue share, and Medicare revenue share, and a differential reduction in allowance and discount rate.

KEYWORDS
accountable care organizations, financial performance, hospital, Medicare, Medicare Shared Savings Program

What is known on this topic

- Prior research suggests that the Medicare Shared Savings Program (MSSP) was associated with modest reductions in Medicare spending, reduced inpatient utilization, reduced readmissions, improved preventive care, and improved patient experience.
- An increasing number of hospitals are participating in MSSP Accountable Care Organizations (ACOs).
- Few studies have examined the relationship between MSSP participation and hospital financial performance.

What this study adds

- This study leverages a national sample and a quasi-experimental design to estimate the effects of MSSP participation on hospital financial outcome measures.
- MSSP participation was associated with differential increases in net patient revenue, Medicare revenue, inpatient revenue share, and Medicare revenue share, and a differential reduction in allowance and discount rate.
- The evidence of no decline in operating margins after MSSP participation alleviates the policy concern that the MSSP may threaten hospitals' financial viability.

1 | INTRODUCTION

As a value-based payment model, the Accountable Care Organization (ACO) model is expected to curb spending growth and improve care quality by incorporating organizational accountability and pay-for-performance arrangements in health care delivery and payment.[1] The Medicare Shared Savings Program (MSSP), through which the Centers for Medicare & Medicaid Services (CMS) contracts with ACOs to provide care to assigned Medicare patient populations, is one of the most widespread value-based programs. Prior research suggested that MSSP ACOs were associated with modest reductions in Medicare spending,[2–4] decreased service utilization (inpatient and emergency department use in particular),[2,5,6] reduced readmissions,[7–9] improved preventive care,[10–12] and improvement in patient experience.[13] However, most of these effects observed from the early years of program implementation were small and inconclusive. Policy scholars further raised concerns about selective participation and its impact on program outcomes.[14–17]

Despite the ongoing policy debate,[18,19] a growing number of hospitals have participated in MSSP ACOs. In 2021, 1349 hospitals and 405 critical access hospitals (CAHs) participated in 477 MSSP ACOs.[20] However, there is a lack of systemic evidence on how MSSP participation affects hospitals' financial performance. This question is critical for hospital managers and policymakers as they strive to transform the health care delivery and payment system. From a managerial perspective, a healthy financial position enables hospitals to invest in infrastructure, adopt advanced health care technologies, and allocate ample personnel in health care delivery processes, which strongly predicts high service quality and better patient experience.[21,22] However, MSSP contracts create mixed incentives for hospital participants. While ACOs have incentives to reduce utilization and lower spending per Medicare patient, hospitals may lose revenue if the reduction comes mainly from inpatient and emergency department use and if they cannot recoup the loss from other sources (e.g., by expanding outpatient services or serving more non-Medicare patients).

From CMS's perspective, the impact of MSSP participation on hospitals' financial status will affect the program's sustainability. If MSSP participation would cause financial distress and revenue loss, hospitals may choose to discontinue their MSSP contracts. Understanding the impact of MSSP participation on hospital financial performance has become more pertinent as CMS aggressively pushes ACOs to assume downside financial risk.[23] The liability to repay CMS for expenditure overruns combined with potential financial loss may deter hospitals from engaging in ACO contracts. This deterring effect may be more salient for rural hospitals with fewer resources, higher operating expenses, and lower operating margins.[24] Thus, empirical research on the financial impact of MSSP participation on hospitals is needed.

MSSP participation may impact hospital financial performance in several ways. First, MSSP participation may incentivize ACOs to reduce the utilization of costly inpatient services and shift care to outpatient services and preventive care. Care coordination and case management are used to reduce redundant and unnecessary services, especially among high-risk patients. Prior research suggests that these strategies increase outpatient service utilization and reduce readmission, preventable hospitalization, and inpatient spending.[2,3,15,25–28] At the hospital level, these strategies may decrease inpatient revenue, but increase outpatient revenue from Medicare if the hospital has a robust outpatient business model. Second, the MSSP may result in growth in both inpatient and outpatient revenue because some MSSP ACOs are built on preferred provider

networks that enable them to steer more patients to in-network hospitals.[29,30] Third, pre-existing trends of healthcare system integration and consolidation that have facilitated ACO formation may also strengthen the market power of ACO-participating hospitals,[31] which may lead to higher negotiation power, higher service price, and increased patient revenue.[18,32–34] Fourth, for rural hospitals, participation in MSSP ACOs provides them access to Medicare claims information about their attributed patients to improve care coordination and keep patients' care local, which would result in increased patient volume to spread fixed costs and make non-Medicare contracts more profitable.[35,36] Few studies have examined the relationship between MSSP participation and hospital financial performance. One exception is Comfort et al., who utilized the propensity score matching approach to assess the MSSP's effect on rural hospital service utilization and financial outcomes.[37] They reported no significant changes in outpatient visits, inpatient utilization, or operating margin after rural hospitals' entrance into the MSSP. It remains unclear how MSSP participation affects hospitals financially, given the numerous contingencies.

In this study, we empirically evaluated the extent to which MSSP participation affected hospital financial outcomes, including patient revenue, operating margin, different revenue source shares, and allowance and discount rate. Using data on a national hospital panel across 2011 to 2018, we employed an event-study design with year and hospital fixed effects to estimate the financial impact of MSSP participation on hospitals.

2 | METHODS

2.1 | Data and sample

We developed a panel data set including information on hospital financial outcomes, organizational characteristics, and MSSP participation from 2011 to 2018. Hospital financial outcome data were obtained from annual CMS Hospital Cost Reports.[38] Organizational characteristics were obtained from the American Hospital Association (AHA) Annual Survey.[39] MSSP participation status was identified from the annual MSSP ACO Provider-level Research Identifiable File (RIF).[40] We also extracted hospital service area characteristics at the Hospital Referral Region (HRR) level from the CMS Medicare Geographic Variation Public Use File.[41] Data were linked at the hospital level using the Medicare provider number and HRR code.

Our sample included all non-federal general medical and surgical hospitals operating in the 50 U.S. states and the District of Columbia. The study period was 2011– 2018. To ensure data consistency, we excluded the years prior to 2011 because CMS adopted a new cost report form in May 2010.[42] We deleted cases with any missing values (4.4% of the total sample, mostly missing financial outcomes). Our final sample included 4635 hospitals with 33,507 hospital-year observations. It included 1753 hospitals that had ever participated in MSSP with 13,432 hospital-year observations (MSSP hospitals) and 2882 hospitals that had never participated in MSSP with 20,075 hospital-year observations (non-MSSP hospitals).

2.2 | Variables

2.2.1 | Outcome variables

We measured hospital financial performance using eight outcome variables. Patient service revenue is a critical index to evaluate a hospital's financial performance. Thus, we used outpatient revenue, inpatient revenue, net patient revenue (i.e., total patient revenue minus contractual allowance and discount), and Medicare revenue. Operating margin is commonly used to measure the profitability of hospitals in delivering health care services.[21,43–46] We measured operating margin as the ratio of operating income (i.e., net patient revenue minus total operating expenses) to net patient revenue. Considering that MSSP participation may alter hospitals' reliance on different revenue sources, we used two variables to measure hospital revenue source shares: (1) inpatient revenue share is the percentage of inpatient revenue in total patient revenue (i.e., the sum of inpatient and outpatient revenue); and (2) Medicare revenue share is the percentage of Medicare revenue in total patient revenue. To evaluate the impact of MSSP participation on hospital negotiation power, we measured allowance and discount rates as the ratio of contractual allowance and discount to total patient revenue. The contractual allowance and discount include the amount of adjustment, discount, and other deductions from standard charges that the hospital does not receive for services. All revenue measures were scaled in million dollars.

2.2.2 | MSSP participation

Our exposure variable of interest was hospital participation in MSSP. We measured this time-varying dichotomous variable as 1 if a hospital was listed in the MSSP ACO Provider-level RIF as a MSSP participant in a given year and as 0 otherwise. Because CMS designated 2013 as the first performance year for MSSP participants starting in April 2012, July 2012, and January 2013, we coded 2013 as the first year of participation for participants in these cohorts.

2.2.3 | Covariates

Organizational and HRR characteristics (e.g., hospital size and patient mix) influence both hospital financial performance[47,48] and MSSP participation.[24,49,50] Accordingly, we included several hospital-level and HRR-level time-varying covariates in the regression to mitigate endogeneity issues. Organizational covariates included bed size, number of full-time equivalent (FTE) physicians, and system affiliation.[51] HRR characteristics included Medicare Advantage (MA) penetration rate (measured as the percentage of Medicare beneficiaries enrolled in MA

plans), Medicare beneficiary average age, Medicare beneficiary average risk score, Medicare beneficiary race/ethnicity composition (measured as the percentages of Medicare beneficiaries who were Non-Hispanic White, African American, Hispanic, and Other/Unknown), Medicare female beneficiary percentage, and Medicare-Medicaid dual eligibility rate. For Medicare beneficiary race/ethnical composition, we used the pre-specified race/ethnicity categories in the Medicare Geographic Variation dataset. We also included a time-varying indicator of whether a state expanded its Medicaid program under the Patient Protection and Affordable Care Act to control for the effect of Medicaid expansion on hospital financial outcomes.[52]

2.3 | Statistical analysis

As a baseline model, we used a difference-in-difference (DD) model with two-way fixed effects to estimate the average treatment effect of MSSP participation on hospital financial performance.[53] The following equation was estimated:

$$\text{Outcome}_{it} = \alpha + \beta \text{Participation}_{it} + X_{it}\Phi + Z_{ist}\Psi + \text{Year}_t + \delta_i + \varepsilon$$

where Outcome_{it} was an outcome measure for hospital i in year t, $\text{Participation}_{it}$ was an MSSP participation indicator for hospital i in year t, X_{it} was a vector of the time-varying hospital-level covariates, Z_{ist} was a vector of the time-varying HRR-level covariates, Year_t was year fixed effects, δ_i was hospital fixed effects, and ε was the error term.

In our main model, we utilized an event-study design to estimate the temporal effects of MSSP participation on hospital financial outcomes. An event study is a quasi-experimental design similar to the DD model and is more suitable when the treatment is gradually assigned to the treatment group at various times.[54,55] This method has been widely applied to explore the effects of various health policies or programs.[56–62] Event study has two main advantages over the classic DD model.[54] First, the pre-treatment period estimation allows researchers to inspect the parallel trend assumption, which requires the treatment and control groups to follow a similar pattern in the pre-treatment period. Second, it enables researchers to capture the temporal effects instead of the single-coefficient average treatment effect in the DD model. Formally, we estimated the following equation:

$$\text{Outcome}_{it} = \alpha + \sum_{\substack{v=-4 \\ v \neq 0}}^{4} \beta_v \text{Relative time}_v + X_{it}\Phi + Z_{ist}\Psi + Year_t + \delta_i + \varepsilon$$

where Outcome_{it}, X_{it}, Z_{ist}, Year_t, δ_i and ε were defined in the same way as above. The indicator variables Relative time_v were the full set of binary variables indicating the relative year of an observation to the treatment—the number of years relative to the first year of MSSP participation for a hospital. We chose the year before MSSP participation, Relative time_0, as the reference year. Because of the small numbers of observations in the two tails, we used Relative time_4 to indicate observations in the fourth year or beyond after MSSP participation, and $\text{Relative time}_{-4}$ to indicate five or more years before MSSP participation. We coded all indicator variables as zero for hospitals that had never participated in the MSSP. Our parameters of interest are β_v, which capture the temporal effects of MSSP participation by comparing the difference in outcomes between MSSP and non-MSSP hospitals in relative time v to such a difference in the reference year. The robust standard errors were clustered by hospital. Given that the revenue variables are skewed and the ordinary least squares (OLS) estimates are biased by extreme outliers, we followed prior studies[63] and estimated the generalized linear model (GLM) with log link and gamma distribution for the four revenue variables. All analyses were conducted using STATA Version 17.[64]

3 | RESULTS

Table 1 presents the characteristics of the study sample and compares MSSP hospitals and non-MSSP hospitals in the baseline year (2011). Consistent with existing research,[21,50,65] MSSP hospitals were more likely to be larger (average bed size: 146.6% vs. 113.8%; average number of FTE physicians: 30.4% vs. 17.1%), system affiliated (66.9% vs. 51.2%), located in metropolitan areas (61.5% vs. 56.2%), and embedded in local markets with lower MA penetration rates (23.6% vs. 25.7%). MSSP hospitals also had better financial performance in the baseline year compared to non-MSSP hospitals. Specifically, MSSP hospitals had significantly higher average outpatient revenue ($271.1 vs. $187.3 million), inpatient revenue ($329.7 vs. $256.3 million), and operating margin (−1.2 vs. −3.9). The majority of characteristic differences between MSSP and non-MSSP hospitals are statistically significant.

Figure 1 depicts the unadjusted trends of outcome variables in the form of relative time. Following a similar approach in the existing literature,[58,66] we assigned a random participation year to the control group such that the distribution of MSSP participation year in the control group was at parity with the distribution in the treatment group. Figure 1 shows the resemblance of the trends between the treatment and control groups in the pre-MSSP period, especially in the 3 years leading up to program participation, and offers initial evidence for the parallel trend assumption needed for the DD and event-study estimation. The post-MSSP trends in the treatment group diverted from those in the control group for several outcomes, suggesting that MSSP participation may have triggered changes in financial outcomes. To test the robustness of this analysis, we plotted the trends for the control group using different random numbers and the results were similar (See Figure S1).

Table 2 reports the DD estimates in Panel A and the event-study estimates in Panel B. To facilitate interpretation, we present the incremental effects (i.e., average marginal effects for the binary independent variables) and 95% confidence intervals in the table (the original coefficients are presented in Table S1). The DD estimates support the positive average treatment effects of MSSP participation on

TABLE 1 Hospital characteristics in the baseline year (2011)

	Total sample $N = 4317$ Mean/Percent	Non-MSSP hospitals $N = 2650$ Mean/Percent	MSSP hospitals $N = 1667$ Mean/Percent	MSSP versus non-MSSP T-test Significance Level
Organizational characteristics				
Bed size	126.5	113.8	146.6	***
Full-time equivalent physicians	22.2	17.1	30.4	***
System affiliation (%)	57.2	51.2	66.9	***
CAH status (%)	28.4	29.3	26.9	
Metropolitan status (%)	58.2	56.2	61.5	***
HRR characteristics				
MA penetration rate (%)	24.9	25.7	23.6	***
Average age	71.3	71.3	71.4	
Female (%)	55.3	55.2	55.5	***
Race/ethnicity composition (%)				
Non-Hispanic White	82.7	81.3	85.0	***
African American	8.8	9.0	8.3	**
Hispanic	5.1	5.7	4.0	***
Other/Unknown	3.5	4.0	2.8	***
Dual eligibility (%)	22.4	22.9	21.7	***
Average HCC scores	1.0	1.0	1.0	
Financial outcomes				
Outpatient revenue	219.6	187.3	271.1	***
Inpatient revenue	284.6	256.3	329.7	***
Net patient revenue	159.4	134.1	199.7	***
Medicare revenue	151.5	132.1	182.3	***
Operating margin	−2.9	−3.9	−1.2	***
Inpatient revenue share (%)	42.8	43.1	42.3	
Medicare revenue share (%)	30.8	30.5	31.2	**
Allowance & discount rate (%)	57.1	56.7	57.6	

Note: Revenue is measured in million dollars. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
Abbreviations: CAH, critical access hospital; Dual eligibility: percent of Medicare fee-for-service beneficiaries who are eligible for Medicaid for at least 1 month in the year; FTE, full-time equivalent; HCC, hierarchical condition category; MA penetration rate: percent of Medicare Part A and Part B beneficiaries who are in enrolled in a MA program; MA, Medicare advantage; MSSP, Medicare Shared Savings Program.

several hospital financial outcomes. MSSP participation on average differentially increased net patient revenue by $2.19 million ($p < 0.01$), Medicare revenue by $3.82 million ($p < 0.001$), and Medicare revenue share by 0.26% ($p < 0.001$). MSSP participation had no significant average treatment effect on other financial indicators.

Event-study estimates decompose the DD effects and reveal the temporal effects of MSSP participation over time (estimates are presented in Table 2 Panel B and visualized in Figure S2). Most coefficients for the pre-MSSP years are statistically insignificant, which partly supports the parallel trend assumption. A few significant coefficients exist in the pre-period for inpatient revenue, net patient revenue, Medicare revenue, and allowance and discount rate, which call for caution when interpreting the results (additional checks for parallel trend assumptions are presented in Table S2). Significant coefficients for the post-MSSP years suggest that, controlling for trends in non-MSSP hospitals, MSSP participation differentially increased net patient revenue, Medicare revenue, inpatient revenue share, and Medicare revenue share in MSSP hospitals with more prominent effects in the later relative years. Compared with the reference year, net patient revenue differentially increased by $3.28 million ($p < 0.001$), $3.20 million ($p < 0.01$), and $4.20 million ($p < 0.01$) in the second, third, and fourth year and beyond after joining MSSP, respectively. Medicare revenue differentially increased by $1.50 million ($p < 0.05$), $2.24 million ($p < 0.05$), and $4.47 million ($p < 0.05$) in the first, second, and fourth year and beyond. Inpatient revenue share differentially increased by 0.29% ($p < 0.05$) in the second year and 0.44% ($p < 0.05$) in the fourth year and beyond. Medicare revenue share differentially increased by 0.17% ($p < 0.01$), 0.25% ($p < 0.01$), 0.32% ($p < 0.01$), and 0.41% ($p < 0.01$) in consecutive years following MSSP participation. We found significant negative effects on allowance and discount rate: MSSP participation was associated with 0.33% ($p < 0.05$) and 0.39% ($p < 0.05$) differential reduction in

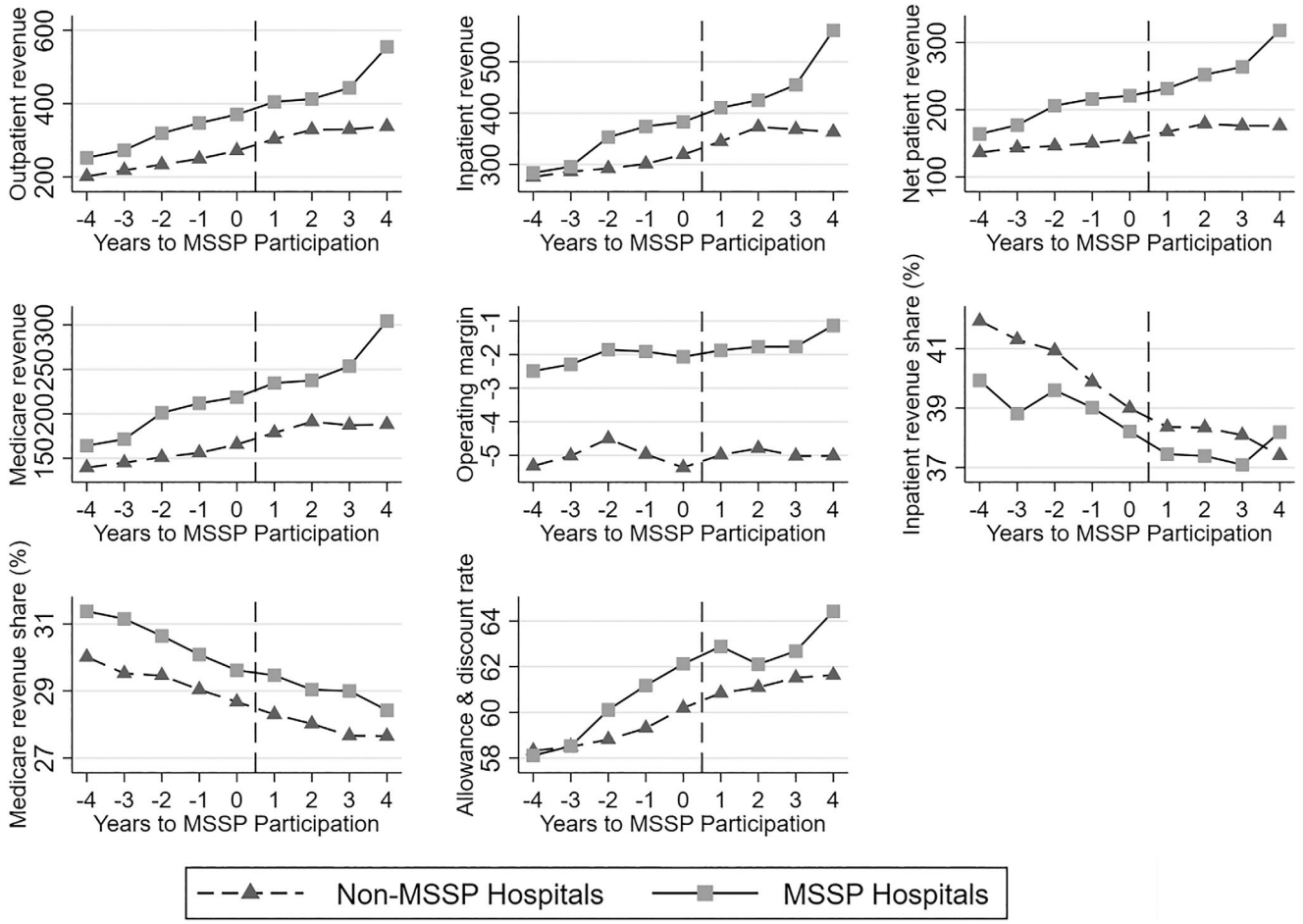

FIGURE 1 Unadjusted trends of financial outcomes in MSSP and non-MSSP hospitals. The figure presents the unadjusted means of financial outcomes in MSSP and non-MSSP hospitals in relative years. The x-axis shows the relative year compared to the first year of MSSP participation, where negative values and zero indicate the pre-MSSP period, positive values indicate the post-MSSP period. The vertical reference line separates the pre-MSSP period (relative year ≤ 0) and the post-MSSP period (relative year > 0). The reference period is the year prior to the first year of MSSP participation (relative year = 0). For each non-MSSP hospital, we assigned a randomly selected participation year generated from the observed distribution of MSSP participation years. Revenue was measured in million dollars. MSSP, Medicare Shared Savings Program.

allowance and discount rate in the second and third years. The effects on inpatient revenue, outpatient revenue, and operating margin were insignificant in all years. We present the adjusted trends of the eight financial outcomes in Figure 2. After adjusting the covariates and fixed effects, MSSP hospitals exhibit slightly faster increases in net patient revenue and Medicare revenue, slightly slower decreases in inpatient revenue share and Medicare revenue share, and slightly slower increases in allowance and discount rate, compared to non-MSSP hospitals.

3.1 | Heterogeneity in MSSP effects

Policymakers are concerned with the financial viability of non-metropolitan hospitals and CAHs during the transition to value-based payment models. We conducted subgroup analyses based on metropolitan (See Table S3A) and CAH status (See Table S3B). We separately re-estimated the event-study model for each subgroup. Chow test results suggest that the MSSP effects on outpatient revenue are different between metropolitan and non-metropolitan hospitals ($p < 0.05$). MSSP participation differentially reduced outpatient revenue among metropolitan hospitals but had no significant effect among non-metropolitan hospitals. There are no significant differences between metropolitan and non-metropolitan hospitals regarding the MSSP effects on other financial outcomes. Chow test results suggest significant differences between CAHs and non-CAHs in the MSSP effects on net patient revenue ($p < 0.05$) and inpatient revenue share ($p < 0.01$). MSSP participation generally has significant and positive effects on these outcomes in non-CAHs, but has no such effects in CAHs. The lack of effect on net patient revenue among CAHs may be partly due to their cost-based reimbursement and smaller patient population/volume, which may cause patient revenue to be less sensitive to MSSP participation. The Chow test also suggests a difference in the MSSP effects on inpatient revenue, which is likely driven by pre-treatment differences.

TABLE 2 Incremental effects of MSSP participation on hospital financial performance

	Outpatient revenue		Inpatient revenue		Net patient revenue		Medicare revenue	
	Effect	95% CI	Effect	95% CI	Effect	95% CI	Effect	95% CI
Panel A: Classic DD								
MSSP participation	1.00	(−2.05; 4.04)	1.53	(−2.73; 5.78)	2.19**	(0.62; 3.77)	3.82***	(1.87; 5.76)
Panel B: Event study								
−4: 5 or more years before MSSP	−5.11	(−10.88; 0.66)	−3.13	(−10.86; 4.60)	3.65*	(0.31; 6.99)	−4.90*	(−8.71; −1.09)
−3: 4 years before MSSP	−1.32	(−5.54; 2.90)	−1.62	(−7.38; 4.14)	1.62	(−0.86; 4.09)	−2.55	(−5.22; 0.12)
−2: 3 years before MSSP	−0.78	(−3.75; 2.19)	−1.39	(−5.56; 2.78)	0.23	(−1.57; 2.03)	−1.76	(−3.65; 0.14)
−1: 2 years before MSSP	−1.86	(−4.00; 0.29)	−4.06**	(−6.96; −1.16)	−1.61*	(−2.95; −0.28)	−2.27**	(−3.58; −0.97)
0: 1 year before MSSP (Omitted)								
1: 1st year of joining MSSP	−0.13	(−2.19; 1.94)	0.67	(−2.56; 3.91)	0.69	(−0.62; 2.00)	1.50*	(0.13; 2.87)
2: 2nd year after joining MSSP	−2.30	(−5.48; 0.84)	0.68	(−4.09; 5.48)	3.28***	(1.53; 5.03)	2.24*	(0.16; 4.32)
3: 3rd year after joining MSSP	−3.29	(−7.53; 0.95)	−2.34	(−8.56; 3.88)	3.20**	(0.90; 5.50)	2.07	(−0.71; 4.85)
4: 4th year and beyond after joining MSSP	−0.80	(−6.88; 5.29)	5.72	(−3.30; 14.73)	4.20**	(1.05; 7.36)	4.47*	(0.60; 8.34)

	Operating margin		Inpatient revenue share		Medicare revenue share		Allowance & discount rate	
	Effect	95% CI	Effect	95% CI	Effect	95% CI	Effect	95% CI
Panel A: Classic DD								
MSSP participation	0.23	(−0.22; 0.68)	0.07	(−0.15; 0.29)	0.26***	(0.11; 0.41)	−0.10	(−0.31; 0.11)
Panel B: Event study								
−4: 5 or more years before MSSP	−0.28	(−1.19; 0.62)	0.41	(−0.01; 0.82)	−0.21	(−0.51; 0.08)	−0.57**	(−0.97; −0.16)
−3: 4 years before MSSP	−0.11	(−0.86; 0.63)	0.002	(−0.31; 0.31)	−0.05	(−0.27; 0.17)	−0.36*	(−0.69; −0.04)
−2: 3 years before MSSP	−0.24	(−0.82; 0.34)	−0.05	(−0.28; 0.18)	−0.03	(−0.20; 0.14)	−0.08	(−0.34; 0.19)
−1: 2 years before MSSP	−0.20	(−0.66; 0.26)	−0.11	(−0.26; 0.05)	−0.07	(−0.18; 0.04)	−0.05	(−0.24; 0.14)
0: 1 year before MSSP (Omitted)								
1: 1st year of joining MSSP	0.02	(−0.43; 0.47)	0.04	(−0.12; 0.20)	0.17**	(0.06; 0.27)	−0.11	(−0.30; 0.08)
2: 2nd year after joining MSSP	0.30	(−0.35; 0.95)	0.29*	(0.03; 0.56)	0.25**	(0.09; 0.42)	−0.33*	(−0.59; −0.07)
3: 3rd year after joining MSSP	0.21	(−0.53; 0.95)	0.22	(−0.12; 0.55)	0.32**	(0.11; 0.53)	−0.39*	(−0.70; −0.07)
4: 4th year and beyond after joining MSSP	0.16	(−0.73; 1.05)	0.44*	(0.001; 0.88)	0.41**	(0.14; 0.68)	−0.29	(−0.71; 0.13)

Note: Estimated incremental effects based on Medicare Hospital Cost Report and MSSP Provider-level RIF data from 2011 to 2018. Sample size is 33,507 hospital-year observations. Standard errors are clustered at hospital level. All regression models controlled for hospital-level covariates, HRR-level covariates, whether a state adopted Medicaid expansion, and year and hospital fixed effects. *$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.
Abbreviations: CI, confidence interval; DD, difference-in-differences; HRR, hospital referral region; MSSP, Medicare Shared Savings Program; RIF, research identifiable file.

3.2 | Sensitivity analysis

We conducted several sensitivity analyses to test whether our estimates were sensitive to model and sample specifications. First, we compared the coefficients from the log-linear model (See Table S4A) and the GLM estimates for the revenue outcomes, and found no significant differences. Second, we changed the ACO participation start year to 2012 for those hospitals that joined the MSSP in April 2012 and July 2012 (See Table S4B), and only minimal differences in effect size were detected. Third, we tested the sensitivity of our estimates to attrition bias. About 19% of MSSP hospitals dropped out of the MSSP after joining the program, and the possible attrition bias may result in a misestimation of the effects of MSSP participation since the hospitals with adverse financial outcomes may be more likely to terminate their MSSP participation. We therefore estimated the models without the hospitals that dropped out of the MSSP (See Table S4C). Coefficients were larger than those in our main models, but the significance levels and coefficient signs were very similar to

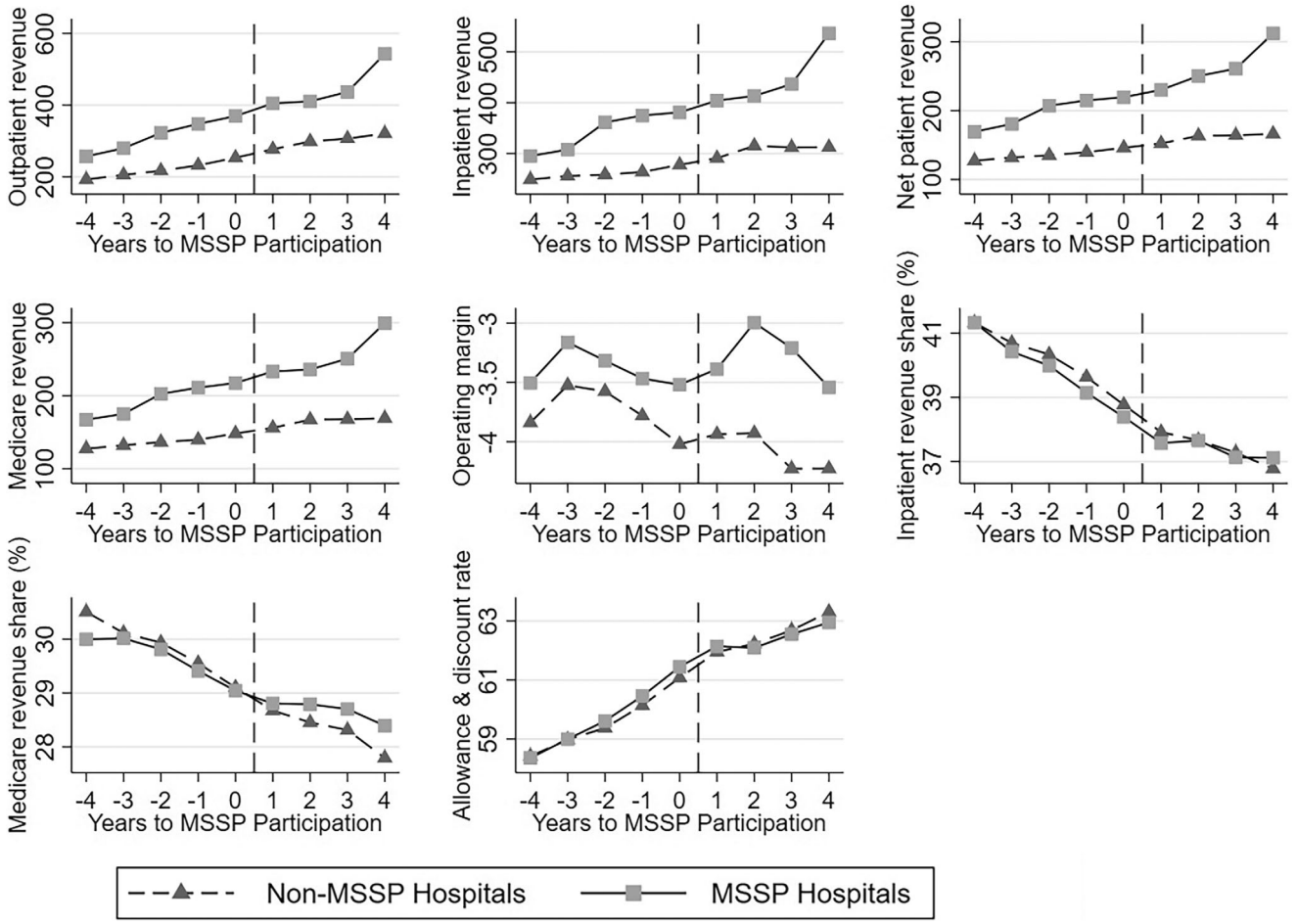

FIGURE 2 Adjusted trends of financial outcomes in MSSP and non-MSSP hospitals. This figure presents the adjusted means of financial outcomes in MSSP and non-MSSP hospitals in relative years. The x-axis shows the relative year compared to the first year of MSSP participation, where negative values and zero indicate the pre-MSSP period, positive values indicate the post-MSSP period. The vertical reference line separates the pre-MSSP period (relative year ≤ 0) and the post-MSSP period (relative year > 0). The reference period is the year prior to the first year of MSSP participation (relative year = 0). The y-axis shows adjusted means based on regression models estimated by OLS and GLM with standard errors clustered at the hospital level. All regression models controlled for hospital-level covariates, HRR-level covariates, whether a state adopted Medicaid expansion, year and hospital fixed effects. GLM, Generalized linear model; HRR, Hospital Referral Region; MSSP, Medicare Shared Savings Program; OLS, ordinary least squares

those in the main models. Fourth, early and late MSSP participants did not provide the full range of observations around the reference year for the event-study estimation. Thus, we conducted the analyses of a balanced sample of the 2015 and 2016 cohorts that had data for at least 3 years before and 3 years after MSSP participation (See Table S4D). Results indicated that MSSP participation differentially decreased inpatient revenue, increased net patient revenue, and decreased the allowance and discount rate in this subsample. This suggests that the observed MSSP effects on inpatient revenue, Medicare revenue, and revenue shares in the full sample may be driven by early cohorts of MSSP participants. Fifth, we estimated the models with the HRR linear trends, which isolated the potential influence of market volatility and policy changes shared by hospitals in the same service areas (See Table S4E). Results are similar to those in our main models. Finally, we separately added the HRR-level Herfindahl–Hirschman indexes (HHI) based on either outpatient visits or inpatient admissions into our models to estimate the impact of market consolidation on our estimates (See Tables S4F and S4G). After controlling for the market consolidation indexes, the estimates of MSSP effects on the financial outcomes remained similar to those in the main models. Overall, the sensitivity analyses suggest that our results are robust.

4 | DISCUSSION

Leveraging an event-study design and a national hospital sample, we found evidence that, controlling for temporal trends in non-MSSP hospitals, participation in the MSSP differentially increased hospital net patient revenue, Medicare revenue, inpatient revenue share, and Medicare revenue share. We also found that MSSP participation was associated with a differential reduction in allowance and discount rate.

Our finding that MSSP participation had no negative effect on inpatient revenue in the full sample may seem contradictory to the current literature. Prior studies have found a reduction in inpatient utilization—specifically, significant drops in hospitalization and readmission rates among Medicare beneficiaries as a result of the MSSP.[7,25,26] Several ACO activities and strategies were directly targeted at reducing avoidable inpatient utilization, including expanding access to primary care and preventive care, developing care coordination across various providers, and monitoring specific patient groups with different medical needs.[67–71] A key difference is that prior research almost exclusively analyzed inpatient service utilization at the patient level, while our analyses were conducted at the hospital level. At the hospital level, although MSSP participation may reduce per capita inpatient service utilization by existing Medicare beneficiaries, hospitals may adopt strategies to increase inpatient revenue from other sources[72]; however, this may not be a sustainable approach because of the overall decline in inpatient utilization in recent years.[73] Another explanation is cohort heterogeneity: our sensitivity analysis suggested that early MSSP participants might have been more successful in maintaining inpatient revenue than the 2015 and 2016 cohorts, for which MSSP participation was associated with decreases in inpatient revenue. Future research is needed to examine how hospital service utilization, revenue, and revenue sources change in the context of the value-based payment transition.

We observed a slight increase in Medicare revenue share after MSSP participation, which suggests MSSP hospitals did not shift away from serving Medicare patients. This growth of Medicare revenue share is not substantial enough to affect MSSP hospitals' immediate financial status. But given that Medicare pays substantially less than private insurances and only compensates for approximately 90% of allowable costs for non-CAHs,[74,75] the less generous Medicare payment combined with a hypothetical and substantial increase in Medicare revenue share may affect hospital financial status in the long term.

Although we did not observe an increase in operating margins, the increased net patient revenue is important for hospitals, especially rural hospitals. In recent decades, hospitals serving non-metropolitan areas have been more likely to experience financial hardship compared to their metropolitan counterparts.[76] Researchers estimated that financial distress has caused 135 rural hospitals to close and 453 additional rural hospitals to be vulnerable to closure since 2010.[77] Additional net patient revenue could relieve hospitals' financial distress to some extent. If hospitals are able to increase operational efficiency and reduce operating expenses per visit (as a result of increased operation efficiency and spread-out fixed costs), they could improve operating margins and further strengthen their financial viability.[78] From the MSSP program's perspective, the growth of net patient revenue may be an important incentive to sustain rural hospitals' participation in the program.

Our findings have three policy implications. First, MSSP is a viable option for hospital participants as it has a positive impact on net patient revenue and Medicare revenue and no negative impact on other financial status indicators. Given the absence of significant differential changes in inpatient and outpatient revenue, the differential increase in net patient revenue is likely the result of increased negotiation power and decreased allowance and discount rates among MSSP hospitals (as supported by our results). Scholars have been concerned that ACOs may contribute to accelerating the trend of hospital-led delivery system consolidation (including hospitals and health systems acquiring physician practices), which would increase the market power of these consolidated systems and impose a substantial cost to private health plans.[18] Recent studies have found that the pre-existing trend of consolidation may help drive the formation of ACOs,[31] but there was little evidence that the ACO programs accelerated the consolidation trend or resulted in price increases.[32–34] Our findings offer evidence of MSSP hospitals gaining some negotiation power, but not substantial enough to reverse the trend of increasing allowances and discount rates. While CMS should continue engaging hospitals with ACO programs, the impact of consolidation on service price, health insurance premium, and the societal cost of care should be continuously monitored.

Second, our results suggest that MSSP participation does not necessarily reduce inpatient revenue. It may be surprising to some ACO analysts, because it is prevalently assumed that MSSP reduced Medicare inpatient utilization and further led to revenue loss.[27] Several researchers used such an argument to explain why hospitals had less motivation to lower inpatient spending and why hospital-led ACOs underperformed physician-led ACOs.[79,80] However, our findings suggest that the financial impact of value-based payment models is more complicated and reducing per capita inpatient utilization does not directly translate to hospital revenue loss. Researchers should conduct more hospital-level analyses to examine scenarios in which participation in MSSP affects hospital revenue, expenses, and financial performance, which will inform future policy development.

Third, our finding of no decline in operating margins due to MSSP participation is encouraging because it alleviates the policy concern that the MSSP may threaten hospitals' financial viability.[72,81] Further, participation in MSSP could bring non-financial benefits to hospitals. Researchers have identified positive effects of MSSP participation, including adoption of health information exchange, implementation of care coordination strategies, fostering population health management, and obtaining access to timely patient data.[24,82–85] These positive effects, combined with no decline in financial viability, should make the MSSP an attractive value-based payment model to hospitals.

Our study has several limitations. First, selection and attrition biases are inevitable in MSSP research[32,86,87] because hospital financial status may influence the decision to participate in or exit the MSSP. We drew on an event-study design with year and hospital fixed effects to mitigate the selection bias. We examined the parallel trend assumption in the pre-treatment period and controlled for pre-existing differences. We included hospital- and HRR-level covariates in the regression models to reduce omitted variable bias. Our sensitivity analysis suggested that program attrition might have led to slightly underestimated MSSP effects, but did not bias our conclusion. Second, we could not eliminate the possibility that other health policies may have exerted effects on MSSP and non-MSSP hospitals

in the post-treatment period. Although we have included a Medicaid expansion indicator in our models, we could not exhaust the influence of other health policies (e.g., the Medicare Hospital Readmissions Reduction Program). Third, wider confidence intervals on both tails of the pre- and post-MSSP periods suggest that our point estimates are less reliable when the relative times are 4 years or more before/after MSSP participation due to the limited sample size. Fourth, we were unable to control for hospital-level patient case mix in our estimates because data were unavailable, though we tried to alleviate this issue by including HRR-level patient population covariates. Future research may examine facility-level patient case mix as a confounder in the relationship between value-based payment models and hospital financial performance.

5 | CONCLUSION

Financial performance is a key measure of success for hospitals that are undergoing significant changes, and therefore, it is critical to examine the impact of MSSP participation on hospital financial outcomes. This study examined such an impact using a national sample of hospitals and a quasi-experimental design. Our results showed that participation in MSSP was associated with differential increases in net patient revenue, Medicare revenue, and Medicare revenue share, and a differential reduction in allowance and discount rate. We did not find significant changes in operating margin and other financial outcome measures after MSSP participation. Overall, the findings suggest that MSSP participation did not harm hospitals' financial bottom line. Given the many non-financial benefits, hospitals should consider MSSP ACOs as a viable option.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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