Peer Review File

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Reviewer A

This paper examined the association between hospital market concentration and financial margin, using New Jersey hospital data during 2010 - 2020. I have the following comments:

Comment A.1: Prior research on hospital market found increased hospital bargaining power and negotiated price as a result of hospital market consolidation. This paper further tests if there is empirical evidence on increased financial margin. While I understand this rationale, given that profit margin is driven by both revenue and cost, authors should test the relationship between hospital HHI and patient revenue, and the relationship between hospital HHI and operating cost, in two separate models. This would enable us to further understand if the increased margin is more driven by increased revenue, or reduced cost. At least, authors should review relevant literature in hospital pricing and financial/operational behaviors. For example, Wang & Anderson (2022) found that hospitals receiving increased commercial insurance payment rates were associated with higher increase in surplus, administrative expense, but smaller increase in patient-care related expense.

Reference: Wang Y, Anderson G. Hospital Resource Allocation Decisions When Market Prices Exceed Medicare Prices. Health Services Research. 2022;57(2):237-47. doi:10.1111/1475-6773.13914

Response A.1:

Thank you for the important observation and suggestion on separating revenue from cost when considering margin. In the revision, we followed your suggestion and conducted separate analyses using (a) operating margin, (b) inpatient revenue per patient day, and (c) inpatient revenue per discharge as the dependent variables, respectively. We could not test for associations with cost because as we do not have a credible measure of cost in our data. Moreover, our data sources did not include information that would allow us to create a measure of volume combining both inpatient and outpatient units. Thus, we examined models limited to inpatient revenue per discharge and inpatient revenue per patient day. While consistent in the direction of coefficients with models using operating margins, inpatient revenue models did not yield statistically significant results. We have no way to determine whether the absence of significance in these models was the result of missing data on ambulatory revenue or whether they indicated weak or absent price effects, thus we did not include them in the manuscript.

Changes in text: Sections 2.2 Primary Measures and Sections 2.3Analytic Strategy for methodological updates (lines 199 – 249). Section 3.2 Regression Results for updated results (lines 296 – 326).

We also expanded our literature review and added additional studies on hospital pricing and financial/operational behaviors, including Wang & Anderson (2023).

Changes in text: Section 1.1 Background for the reference added (lines 103 – 106).

Comment A.2: Authors used HMA fixed effects. I suggest using hospital fixed effects, which is more granular and would control for time-invariant factors across different hospitals within a HMA (i.e. different ownership type, bed size, etc).

Response A.2: We followed your suggestion and added hospital fixed effects in one of the robustness test specifications (see model (3) in Table 3). The results remain highly robust, suggesting the results are not driven by unobserved hospital heterogeneity.

Changes in text: Sections 2.3 Analytic Strategy for methodological updates (lines 222 – 249).

Comment A.3: Authors could further stratify their models by hospital characteristics, such as ownership, bed size, rural/urban status. This would enable us to investigate the dynamic impact across different hospitals, beyond the average estimated association.

Response A.3: We followed your suggestion and stratified the model by hospital bed size (i.e., above vs. below the median). As shown in the following table, the results remain highly robust for both the above and below-median bed size hospitals – there is no significant differences between the two groups. Since there is little variation in rural/urban status and ownership status of NJ hospitals— 94% of hospital-years in New Jersey were in urban areas (RUCA=1) and 83% were private non-profit hospitals, we were not able to stratify based on rural/urban status and ownership status.

Table A6: Regression Results for Herfindahl-Hirschman Index (HHI) on Operating Margins, 2010-2020 (Partitioned Results by Median Bed Size of 232)

	Dependent variable – Operating Margin	
	Below 232 Beds	Above 232 Beds
HHI	-1.8619**	-1.2131***
	(0.7162)	(0.4148)
HHI^2	2.1831***	2.1727***
	0.7739	(0.4730)
Constant	0.2873***	-0.2240***
	(0.1209)	(0.0705)
HMA Fixed Effect	Yes	Yes
Hospital Fixed Effect	No	No
Observations	394	395
R^2	0.0851	0.1689

Note: *p<0.1; **p<0.05; ***p<0.01

Year fixed effect included in all models. The two models are partitioned by the median bed size of 232 from our data. Standard errors in parentheses. Standard errors are level.

Changes in text: Mentioned in Section 2.3 Analytic Strategy (lines 216-218) and Section 3.2 Regression Results (lines 283-284). Results added as Appendix Table A6.

Comment A.4: In the first paragraph of section 4.1 (key findings), authors mentioned reduced hospital margin in 2020, likely due to COVID-19 pandemic. Authors should reference the following studies as empirical evidence:

Wang Y, Bai G, Anderson G. COVID-19 and Hospital Financial Viability in the US. JAMA Health Forum. 2022;3(5):e221018. doi:10.1001/jamahealthforum.2022.1018

Rhodes JH, Santos T, Young G. The Early Impact of the COVID-19 Pandemic on Hospital Finances. Journal of Healthcare Management. 2023 Jan 1;68(1):38-55.

Response A.4: We addressed this issue by adding a sensitivity analysis excluding the year 2020 as suggested by reviewer C (Comment C.1) in which we exclude 2020 from our analysis (Appendix Table A5).

Changes in text: Added in Section 3.2 Regression Results (lines 281-283).

Reviewer B

This is an interesting paper on a topic of growing importance that makes contributions to the available literature by evaluating how hospital market concentration correlates with margins and profitability in 8 hospital market areas

(HMA) in New Jersey. The writing is very clear and the implications for policy are important. The authors find an intriguing non-linearity in the relationship between market concentration and operating margins and make a thoughtful hypothesis to explain these results - those M&A transactions may increase due to low margins in highly competitive markets and that above a threshold level of market consolidation, the profitability of hospitals increases substantially. The non-linearity may be increased as rival hospitals increase prices in response to a merger. To my knowledge, this paper is the first to find such a non-linearity and both suggests additional study may be needed in other areas and supports the authors' call for increased market oversight in New Jersey. Furthermore, given the proposed mergers that the authors cite in the manuscript, this paper is a timely contribution to the literature.

A few questions:
Comment B.1: Do the authors have evidence that the changes in HHI are essentially due to M&A rather than growth? Does this vary across HMAs?

Response B.1: Thank you for stressing this point. We added evidence that changes in HHI are associated with multiple M&A events over time. Appendix Table A1 listed the observed M&A events in NJ in each year of our study period. They vary across HMAs. Figure 1 also shows that number of independent hospitals has declined and the number of hospitals in systems has increased, indicating systems are acquiring independent hospitals.

Changes in text: Added more details in Section 3.1 Descriptive Results (lines 248 – 249) and added Appendix Table A1.

Comment B.2: Similarly, what is the variability in profitability or operating margins within each of the HMAs? Do the more dominant systems in each HMA have higher profitability?

Response B.2: There is sizeable variation in operating margins within each HMA. We compute the mean and standard deviation in operating margin for each HMA and show in the table below.

Hospital Market Area	Operation Margin (Mean)	Operation Margin (S.D.)
Atlantic City	0.0473	0.1244
Camden	-0.0034	0.2343
Hackensack, Ridgewood and Paterson	0.0516	0.0889
Morristown	0.0852	0.0917
New Brunswick	0.0093	0.0923
Newark/Jersey City	-0.1046	0.2666

Toms River	0.0436	0.0234
Trenton	-0.0174	0.0403

We also tested for the correlation between market share and profitability, and do not find strong evidence that dominant systems (with larger market share) have higher profit margins. For example, the correlation is only 0.182 in 2019.

Changes in text: none.

Overall, this paper is well-written and makes a significant and timely contribution to a large body of literature correlating hospital prices and profitability to consolidation.

Reviewer C

This is a well-written piece that clearly shows New Jersey's hospital market concentration is increasing while the impact this has had on operating margins is less clear. I have a number of comments/suggestions.

Comment C.1: Why not cut this study off at 2019? You mention almost all areas had relatively lower operating margins in 2020 and speculate that part of this is due to Covid. It seems worth excluding 2020 and re-estimating your main model.

Response C.1: We followed this suggestion and excluded year 2020 in one of the robustness tests. As shown in Appendix Table A5, the results remain highly robust to this change.

Changes in text: Mentioned in Section 2.3 Analytic Strategy (lines 213-215) and Section 3.2 Regression Results (lines 281-283). Added Appendix Table A5.

2. Can you do more to answer the "Why New Jersey?" question that readers will certainly have? Is there something special about New Jersey's health care markets that you can communicate to the reader a little more. It seems this study could be done in most states given they've all experienced considerable consolidation lately.

Response C.2: We appreciate the reviewer's question and have added the following text: New Jersey offers a useful case example of the relationship between hospital consolidation and profitability. Hospitals in the state have undergone substantial consolidation over our study period and data available from state regulators allowed us to examine in detail the impact of such merger and acquisition activities on hospital profitability. In addition, our study contributes to the literature on the extent to which the link between consolidation and profitability holds even in markets dominated by not-for-profit hospitals, as over 80% of hospitals in New Jersey are not-for-profit.

Changes to Text: Added explanations in Section 1.2 Rationale and Knowledge Gap (lines 120 – 131)

Comment C.3: I'm having a hard time grasping why we'd expect only a positive association with operating margin above 0.336. I don't think there is a theoretical reason to expect this. What happens when you look at the HMAs that crossed over the 0.25 highly concentrated threshold during your study period? Do the hospitals in these HMAs, or the most dominant hospitals in these HMAs show an relative increase in operating margin? Using the 0.25 threshold is at least tied to the guidelines. 0.336 feels arbitrary.

Response C.3: Thank you for your observation, we have clarified our discussion of this issue, as the meaning of the 0.336 threshold was not clear in our original manuscript. To clarify, the 0.336 was the inflection point we empirically identified based on the results of our econometric estimation model; it was not how we define/categorize market concentration level. Specifically, we computed this number from the coefficients on HHI and HHI-squared terms in Table 2, Column 1 of the original manuscript (-1.2980 and 1.9326 respectively based on the results from the original manuscript) and computed the inflection point of the quadratic function which is 1.2980/(2*1.9326)=0.336.

In the revised manuscript, since we made several significant changes to the model in response to other reviewer comments (e.g., using hospital-year level observations instead of market-year level, including time-varying market-level control variables such as unemployment rate, including hospital characteristics such as ownership status, rural/urban status, and bed size as control variables, adding hospital fixed effects etc.), our point estimate slightly changed (but is still highly significant). The coefficients of the HHI and HHI-squared terms in Table 3 Column 1 become -1.5580 and 2.1600 respectively. The inflection point now becomes 1.5580/(2*2.1600)=0.361.

We believe that market conditions at different levels of HHI may explain the differences in the association between concentration and margin below and above this threshold (inflection point). Specifically, we believe that that the negative association of HHI and margins at lower levels of HHI (below the inflexion point) may be due to lower hospital margins and profitability (resulting from market demand and supply-related factors) incentivizing M&A activities. In turn, these changes increased market concentration reflected in higher HHI. As consolidation activities continued to increase and correspondingly the resultant HHI, hospital market power and profitability increased as well resulting in a positive relation between HHI and hospital profitability.

Comment C.4: How are you defining "systems"? Could an independent hospital count as one of the 29 systems you listed in 2010? The 29 systems in 2010 to 21 systems in 2020 is a significant drop over ten years.

Response C.4: We define systems as including two or more licensed hospitals. Individual hospitals are not considered systems. The number of systems declined as system size grew through consolidation among systems.

Comment C.5: Can you comment on how HMAs compare to either counties, MSAs, or hospital referral regions in terms of size? Readers will be more familiar with these geographic markets. You mention HMAs were defined by modifying the boundaries of the Dartmouth Atlas hospital referral regions, but it's unclear how this modification was done.

Response C.5: We believe that empirically derived hospital market areas (HMAs) are the most appropriate units for understanding variability in the impact of hospital consolidation on profitability. As such, we used HMAs derived from Dartmouth Atlas Hospital Referral Regions, modified to conform to state lines by a state study commission in 2008 (described in Appendices 1 and 2 in https://www.nj.gov/health/rhc/documents/entire_finalreport.pdf).

New Jersey, though spanning 7 metropolitan statistical areas (MSAs), is a densely populated state that is in fact dominated by 2 large MSAs shared with close-by states. The other 5 MSAs only contain a single county each. Hence, MSAs are not useful units for studying state-level hospital market conditions. The 21 New Jersey counties vary widely in population size, characteristics, and market conditions, hence, are also not useful units to study hospital market dynamics. We added a footnote (#2) to explain this selection of modified HMAs.

Changes to text: More discussion added to Section 2.2 Primary Measures (lines 170-174) as well as a Footnote 2 (line 173).

Comment C.6: Can you provide a little more information about the ACH Cost Reports? Cost reports are sometimes tricky about how financial information gets presented at the hospital level or rolled up to the system level.

Response C.6: We used New Jersey Acute Care Hospital (ACH) annual cost reports to which all NJ licensed acute care hospitals are required to report to the New Jersey Department of Health. Cost data in the ACH reports are required by law to reflect results of audited hospital financial reports. We received these data under a request pursuant to New Jersey's Open Public Records Act. More details about the ACH reports can be found at: https://www.nj.gov/health/hcf/financial-reports/index.shtml. We added a footnote (#1) to clarify this issue.

Changes to text: Section 2.1 Data Sources (lines 153-157) as well as a Footnote 1 (line 153).

Comment C.7: Do you have a set of HMA level time-varying controls that you could include in the model? I appreciate the inclusion of HMA fixed effects, but I'm wondering about any changes in the economic conditions (e.g. unemployment rate) of local markets that could affect your results.

Response C.7: We followed your suggestion and added the time-varying county-level unemployment rate as a control variable for our primary specifications (in model 2) in the revised manuscript.

Changes to text: Section 2.1 Data Sources explains the source (lines 166-168); Section 2.3 Analytic Strategy reports the model (lines 199-209).

Comment C.8: Figure 3 is a bit muddled with lines and dots going every which way. There a better way to communicate its information?

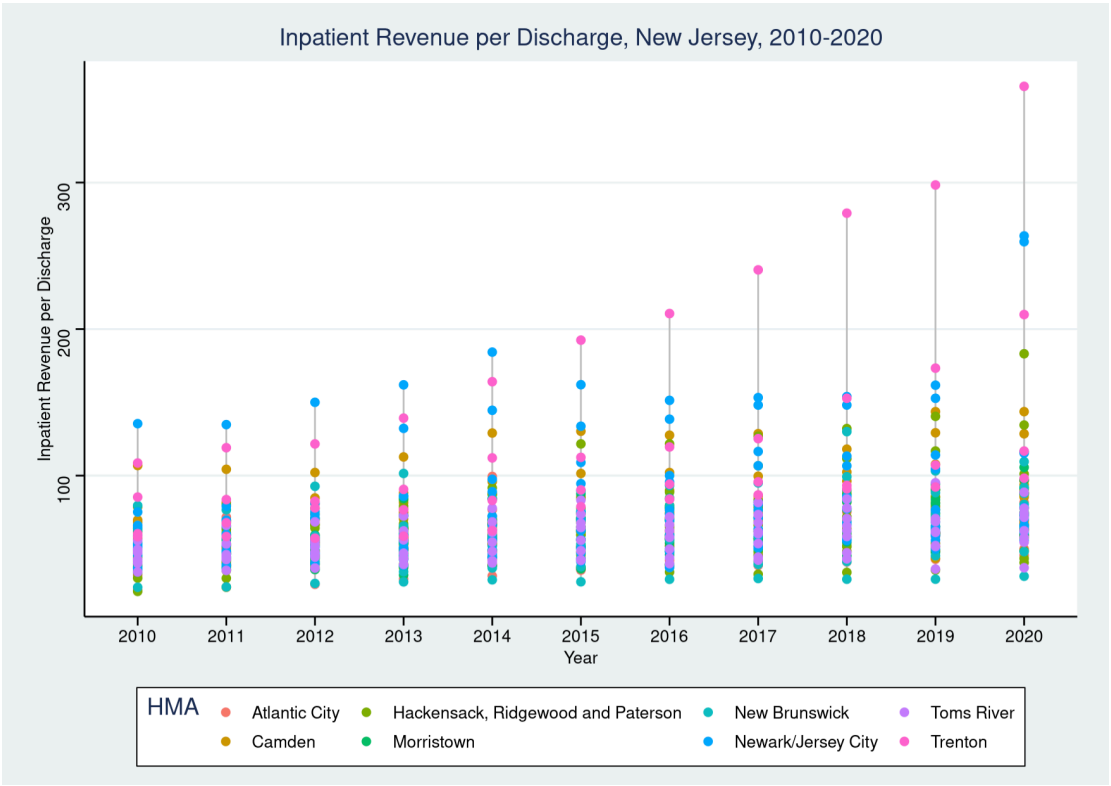
Response C.8: We agree that the original Figure 3 was not well-presented. We decided to drop this figure as well as Figure 2 and Appendix Figure A1 which are in the same format. Instead, we describe the increasing relevant trends in in the text alone.

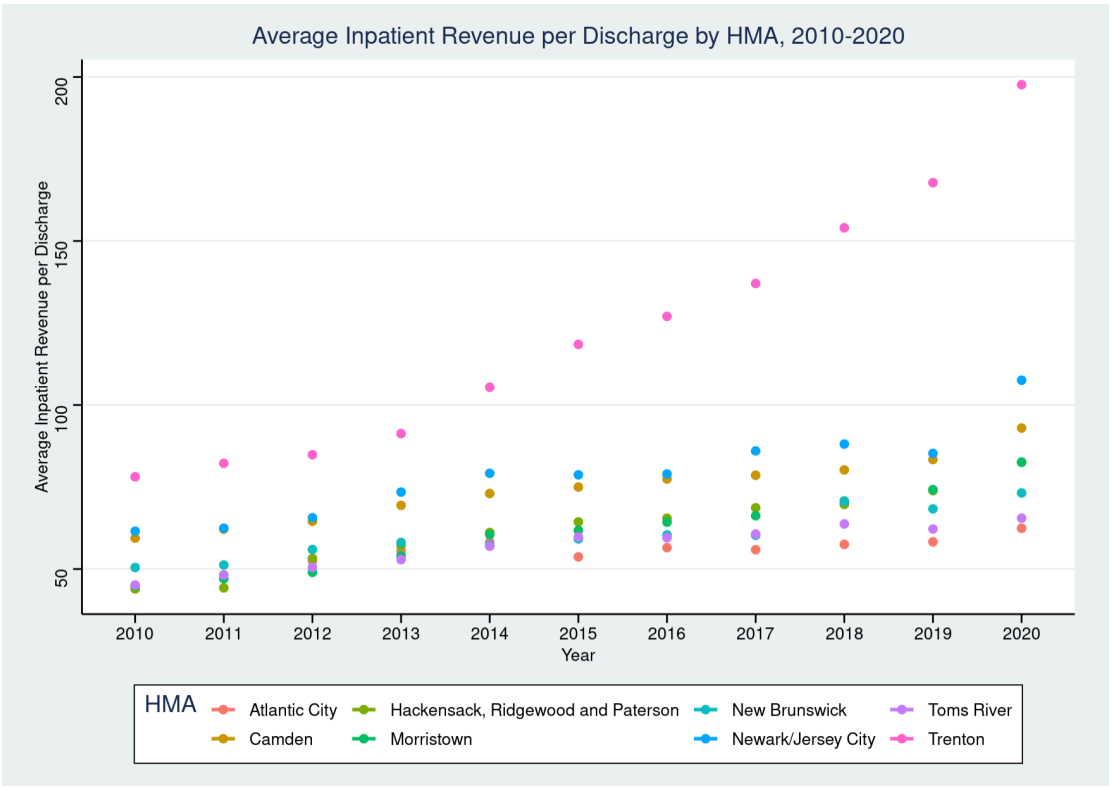
<u>Reviewer D</u>

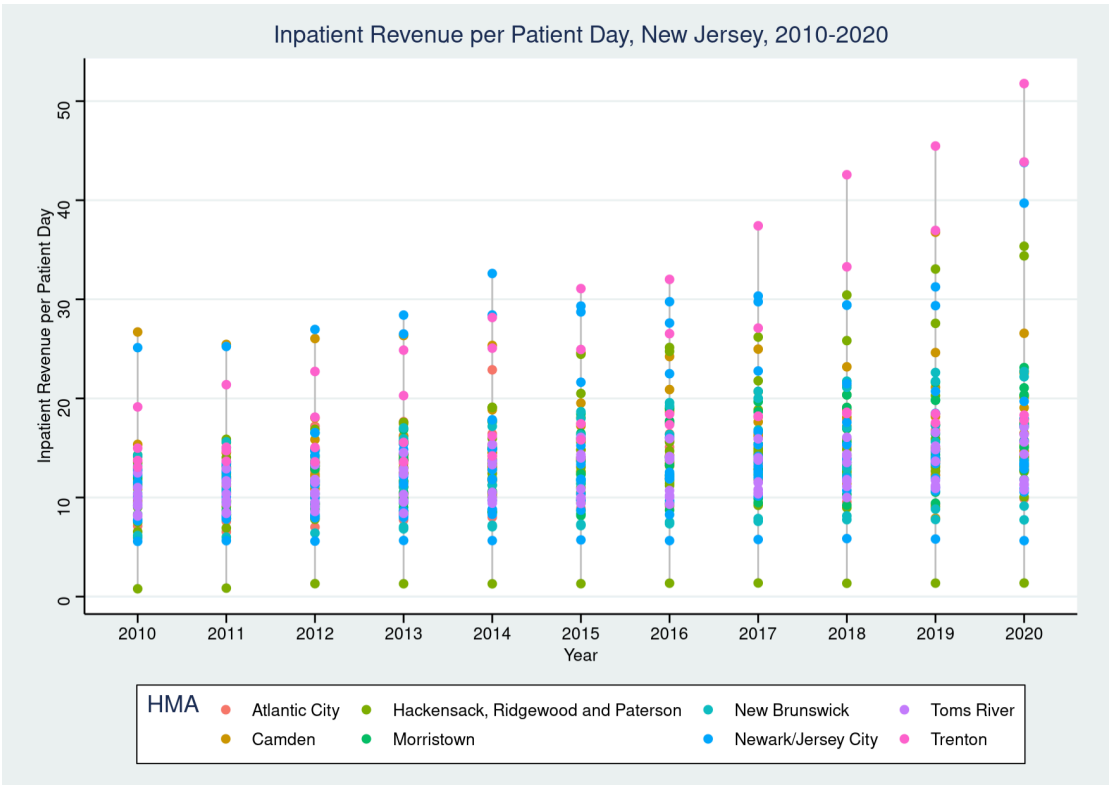
Comment D: The authors examine impacts of hospital mergers on consolidation. While limited to a single US state, the empirical approach is robust and the evidence is strong. I have few comments for the well-written paper.

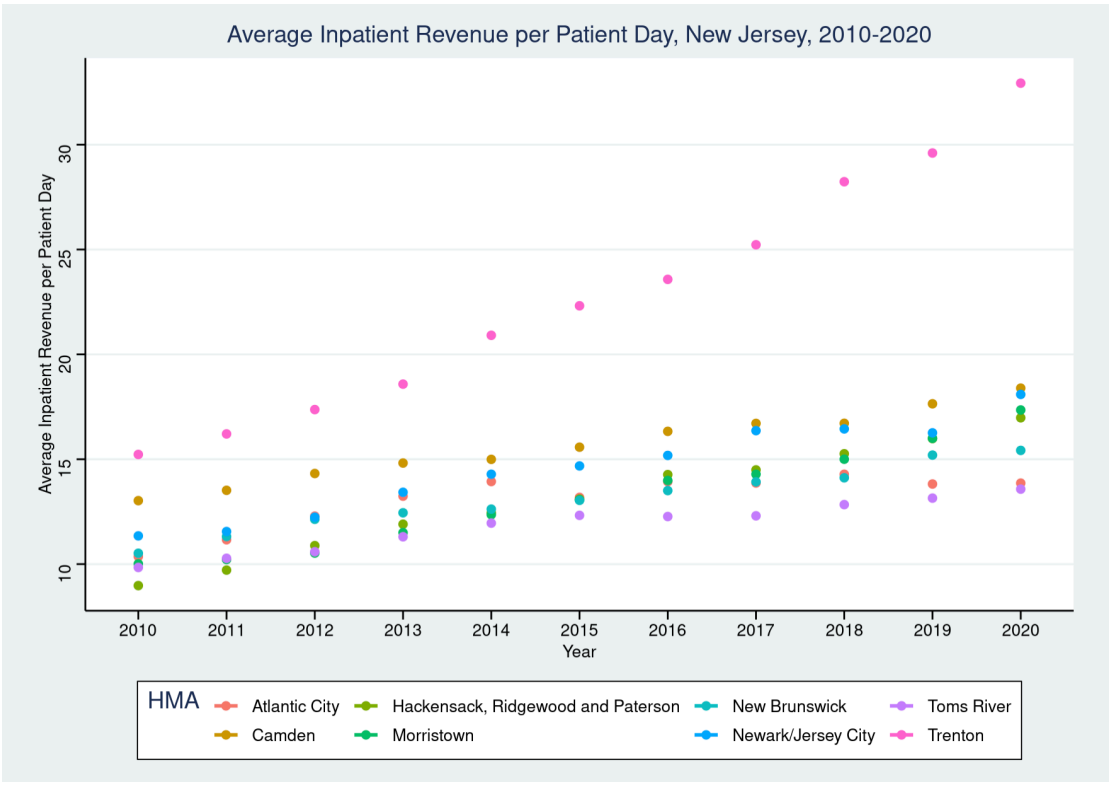
If possible, it would be helpful to examine changes in price, quality, or provision of care.

Response D: Thank you for your interest and support of the manuscript, and for the helpful comments. In the revised manuscript, we added two proxies for price, which is the inpatient revenue per discharge and inpatient revenue per patient day. We examined the trend in these two variables and found that their variances became larger over time, as presented in the four figures below. Data are not available in our dataset to evaluate quality or provision of care, and we believe examining these outcomes would be outside the scope of this manuscript.


Inpatient Revenue per Discharge, New Jersey, 2010-2020
Inpatient Revenue per Discharge
100
200
300
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Year
HMA
Atlantic City
Camden
Hackensack, Ridgewood and Paterson
Morristown
New Brunswick
Newark/Jersey City
Toms River
Trenton


Average Inpatient Revenue per Discharge by HMA, 2010-2020
Average Inpatient Revenue per Discharge
50
100
150
200
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Year
HMA
Atlantic City
Camden
Hackensack, Ridgewood and Paterson
Morristown
New Brunswick
Newark/Jersey City
Toms River
Trenton


Inpatient Revenue per Patient Day, New Jersey, 2010-2020
Inpatient Revenue per Patient Day
0
10
20
30
40
50
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Year
HMA
Atlantic City
Camden
Hackensack, Ridgewood and Paterson
Morristown
New Brunswick
Newark/Jersey City
Toms River
Trenton


Average Inpatient Revenue per Patient Day, New Jersey, 2010-2020
Average Inpatient Revenue per Patient Day
10
15
20
25
30
2010
2011
2012
2013
2014
2015
2016
2017
2018
2019
2020
Year
HMA
Atlantic City
Camden
Hackensack, Ridgewood and Paterson
Morristown
New Brunswick
Newark/Jersey City
Toms River
Trenton

Reviewer E

Comment E.1: Main Points:

Given that it did not examine the association with concentration and prices or price growth, the implication noted on page 2, which is, "continued monitoring is needed to prevent further decreases in competition in already concentrated markets with a deleterious impact on prices and quality," is hardly substantiated. It must have been based on the results.

Response E.1: We agree and have dropped this statement in the revised manuscript.

Comment E.2: You should have obtained the data on price itself rather than using the operating margin measure in order to contribute to the existing literature on the association between consolidation and prices (regarding the papers that you cited 14-18).

Margins = Revenues – Costs. That said, it is incorrect to say that this study examined the effect of consolidation on prices. Margins can increase because of either higher prices or lower costs. All of the papers that you cited (14-18) seem to examine the price itself, which is different from profit margin.

Response E.2: Thank you for pointing out this important distinction. We fully agree and in the revised manuscript, we used two proxies for price as the dependent variables: inpatient revenue per patient day and inpatient revenue per discharge. The results remain highly robust and significant.

Changes to text: Made changes to the review in Section 1.1 Background (lines 80-112). Alternative models mentioned in Section 2.3 Analytic Strategy (lines 203-204) and Section 3.2 Regression Results (lines 286-289). Added Appendix Tables A7 and A8.

Comment E.3: 2-a. Lines 139-140: Pricing/Profitability: Our outcome measure was the average hospital operating margin for each HMA that reflected hospital profitability and pricing in that market. -> Incorrect.

Response E.3: We agree. We changed the description of our main outcome variable to be “operating margin,” and use the two price proxies as robustness tests.

Comment E.4: 2-b. Are there any papers that have examined the relation between consolidation and operating margin? Based on the prior literature, you could include various control variables. For instance, control variables such as ownership status (government, nonprofit, or for-profit) or Medicare/Medicaid-based revenue ratio (e.g., Medicare revenue/total revenue) can provide more implications than simply excluding SNHs as you did in column (4) in table 2.

Response E.4: The positive association between consolidation and operating margin has been well documented in the economics literature since the development of the structure-conduct-paradigm in the 1960s/1970s (Weiss 1979). We additionally referenced this paper in Section 1.1 Background while discussing the positive association between consolidation and operating margins.

Reference: Weiss, L. W. (1979). The Structure-Conduct-Performance Paradigm and Antitrust. *University of Pennsylvania Law Review*, *127*(4), 1104-1140.

In our revised manuscript, we followed your suggestion and added hospital-level control variables including ownership status, bed size, rural/urban status, SNH status (time-invariant), and a time-varying county-level control variable for the unemployment rate for all our estimations. Our results remain highly robust to the addition of these controls.

Changes to text: Revised Section 2.3 Analytic Strategy for the models (lines 199-211) and Section 3.2 Regression Results for the robust results (lines 276-278).

Comment E.5: 2-c. Although you mentioned in your second limitation, it is hard to draw any research or policy-related implications without actually looking at the price data.
2-d. On a related note, some might argue that higher profitability reflects higher efficiency, rather than higher prices.

Response E.5: As explained in Response E.2, we generated two variables to proxy for price (inpatient revenue per patient day and inpatient revenue per discharge) and used them as alternative dependent variables. The results remain highly robust and significant, which indicates higher profitability indeed reflects higher prices. We draw our policy implications based on these results.

Minor Points:
Comment E.6: Lines 35-36. To shed light on the implications of recent trends in hospital market consolidation in New Jersey and the United States, … -> in the United States, particularly in NJ?

Response E.6: We revised the text in the manuscript according to this suggestion.

Changes to text: Revised Abstract (lines 31-34).

Comment E.7: Line 110. "anticompetitive effects of lower quality and reduced price?": Is the reduced price the anticompetitive effect?

Response E.7: We meant to say "higher price" as the anticompetitive effect. Thank you

for pointing out our mistake. We changed this in the revised manuscript.

Changes to text: Revised Section 1.3 Objective (lines 136-139).

Reviewer F

This paper measures the correlation between hospitals' operating margins and hospital market concentration during 2010-2020 in New Jersey, USA. The paper splits the New Jersey hospital market into eight Hospital Market Areas (HMAs) and uses the Ordinary Least Squares (OLS) technique for statistical analysis. The authors report that (1) hospital markets are highly concentrated and the concentration was growing over the years so that by 2020, 71% of all admissions were to hospitals in highly concentrated markets; (2) market concentration is positively correlated to operating margins in markets with HHI above 0.336, and (3) market concentration is negatively correlated to operating margins in markets with lower levels of HHI.

The topic of healthcare market concentration and ever-increasing healthcare spending is a pressing issue which is highly timely and hotly debated. So, the paper is investigating an important question. However, given the reasons below, I recommend a reconsideration of the paper for publication after a major revision.

Major points

Comment F.1: My main concern is the causality claim that is alluded to in multiple cases. Using OLS with a small sample size and very few covariates included, the results are correlations that may not be interpreted causally. In other words, the paper shows that HHI and operating margins were growing in tandem. This does not immediately indicate that the HHI increase has caused an increase in the operating margins. Other factors might explain this positive correlation. For example, hospitals who manage to generate higher profit margins may earn extra cash that allows them to acquire their rivals more easily (reverse causality). An alternative explanation is the presence of a latent cause. For example, hospitals who hire a better management team may be able to secure higher operating margins because they better advertise and position themselves to attract more (or wealthier) patients, and such a more sophisticated management team might be more eager to acquire rivals. To be clear on this point, I am not claiming that there is no causal link between market concentration and operating margins. Instead, my point is that using OLS with so few covariates is unable to measure causality. I doubt if the authors want to reduce their claim to a correlation study because correlation studies have little use in making policy implications and recommendations. If the authors want to make the causality claim more compelling, I suggest they use a fixed effects (FE) specification. The idea of FE is to examine the correlation between the variations in operating margins and

market concentration. FE can be implemented in Stata using the XTREG command with the FE option.

Response F.1: Thank you for stressing this important observation about our empirical framework and interpretations of results. We agree, and we made the following major revisions to address these concerns.

First, we followed your suggestion and conducted a fixed-effects estimation by adding time-varying market-level characteristics (e.g. unemployment rate) and including hospital fixed effects as two of our main specifications. The results in Table 3 Columns 1, 2, and 3 show that the results remain highly robust and significant, suggesting the correlation between the variations in operating margins and market concentration over time.

(Note that in our original manuscript, the analysis was aggregated to HMA-year level. In the revised manuscript, we used hospital-year level observations and analysis. That is why the number of observations substantially increased. As shown in the revised paper, the results are highly consistent with the old ones.)

Second, we agree that even with the fixed-effects model, there could still be time-varying unobserved factors that might be associated with competition change and contribute to profit margin. We therefore modified our text acknowledging the possibility of non-causal associations rather than causality in some relationships.

Changes to text: Revised Section 2.3 Analytic Strategy for the new models (lines 199-211) and Section 3.2 Regression Results for their robust results (lines 276-278). Revised Section 4.3 Limitations for clear qualification (lines 357-358)

Comment F.2: Your data has variables such as the number of beds, total admissions, and operating income. If possible, it would be beneficial to include them as covariates in your regression.

Response F.2: We followed this suggestion and included hospital characteristics (bed size, rural/urban status, ownership status) as control variables.

Changes to text: As above, revised Section 2.3 Analytic Strategy for the new models (lines 199-211) and Section 3.2 Regression Results for their robust results (lines 276-278).

Comment F.3: Alongside calculating HHI based on beds and admissions, what happens if you calculate HHI using revenue? It might be important because, although calculating HHI using beds and admissions is reasonable, calculating HHI based on revenue is perhaps the most common approach. So, analyzing HHI

based on revenue would better connect your findings to the general body of studies in the literature.

Response F.3: We followed your suggestion and tested for an alternative model where HHIs are calculated based on revenue. The results remain highly robust. Since in the hospital market, it is more of a common practice to use number of beds to measure market share and construct HHI, we decided to keep our original measure of HHI.

Comment F.4: In the Analytic Strategy section, it would be highly beneficial if you show the model specification used in your OLS model. By that I mean you may want to show the regression equation and introduce the right/left-hand side variables.

Response F.4: We followed this suggestion and have specified the regression equations and explained all variables in the revised Section 2.3 Analytic Strategy.

Changes to text: Revised Section 2.3 Analytic Strategy, showing the equations for three main specifications (lines 199-211).

Comment F.5: As you correctly mentioned in lines 245-247, the later years in your data are contaminated by the effect of the COVID-19 pandemic which may affect the trends in unknown ways. I suggest you add a robustness check (sensitivity analysis) table in which you limit your data to pre-pandemic years, and compare the results to your baseline.

Response F.5: Thank you for this important observation. We followed this suggestion and added a robustness check by dropping the pandemic years. Appendix Table A5 suggests that the results remain highly robust and significant.

Changes to text: Mentioned in Section 2.3 Analytic Strategy (lines 213-215) and Section 3.2 Regression Results (lines 281-283). Added Appendix Table A5.

Comment F.6: In line 253, you point to the surprising finding that there is a negative relationship between HHI and operating margins when HHI is below 0.336. I doubt the validity of this finding. Very likely, this negative result has occurred because you imposed a quadratic specification on your model. I can offer two remedies. Remedy 1 is to include a robustness check table (maybe in the appendix) in which you limit your sample to markets whose HHI remained under 0.336 throughout 2010-2020, and re-estimate the correlation between HHI and operating margins for this subset of the data using only a linear (as opposed to a quadratic relationship). If the slope is negative in this linear specification, your point may be valid. But if the slope is positive or zero, then your claim (that the relation between HHI and operating margin is negative when HHI<0.336) would

be invalid. Remedy 2 is to replace your current quadratic specification by a logarithmic one. In other words, instead of regressing operating margins on HHI and HHI2, you can regress operating margin on the natural logarithm of HHI. Natural logarithm does a better job than quadratics in handling non-linear relationships. See Kwoka and Shumilkina, 2010; Hosken et al., 2016; Ashenfelter and Hosken, 2010; Rabbani 2021,2023.

Response F.6: We followed your suggestion (Remedy 1) and tested for the relationship between market concentration (HHI) and operating margin below the inflection point. The results shown in Appendix Table A2 confirmed that the relationship between HHI and operating margin is negative below the inflection point, and positive above the inflection point.

We believe that a negative association at lower levels of HHI (below the inflexion point) may arise due to lower hospital margins and profitability (due to market demand and supply-related factors) incentivizing M&A activities, that would increase market concentration reflected in increased HHI. We added more discussion in reference to previous literature on the relationship between margins and M&A activities. As consolidation activities continued to increase and correspondingly the resultant HHI, hospital market power and profitability increased as well resulting in a positive relation between HHI and hospital profitability.

Changes to text: Changes to text: Mentioned in 2.3 Analytic Strategy (lines 218-219) and added Appendix Table A2.

Comment F.7: You reported lagged results. It will be interesting to see lead results as well for the same reason that studying lags is relevant.

Response F.7: We followed your suggestion and conducted a robustness test using the lead HHI. The results were very similar to the lagged and non-lagged models, again underscoring the robustness of our analyses. We mention these results in the text (see Section 3.2 Regression Results) but since we do not have a hypothesis about the effect of lead models, we do not include them in the manuscript. Please see the below table for reference in terms of the first-lead model.

Lead Herfindahl-Hirschman Index (HHI) on Operating Margins, 2010-2020

		Dependent variable – Operating Margin	
	(1)	(2)	(3)
HHI_{t+1}	-1.4924***	-1.5330***	-1.1367***
	(0.3624)	(0.3527)	(0.3152)
HHI_{t+1}^2	2.0469***	2.1053***	1.4760***
	(0.4439)	(0.4334)	(0.3859)

Number of Beds		-0.0001**	
		(0.00002)	
Ownership Status			
Governmental		-0.0830***	
		(0.0269)	
Proprietary		-0.0413***	
		(0.0131)	
Urban Location		0.0710***	
		(0.0189)	
SNH Status		-0.0238**	
		(0.0095)	
Unemployment Rate		-0.2249	
		(0.4309)	
HMA Fixed Effect	Yes	Yes	No
Hospital Fixed Effect	No	No	Yes
Observations	788	788	788
R^2	0.0751	0.1382	0.3893

Note: *p<0.1; **p<0.05; ***p<0.01

Year fixed effect included in all models. Model (2) imposes controls on hospital characteristics, including number of maintained beds, ownership status (for which the basis is non-profit ownership), a dummy variable for urban location (RUCA code of 1), time-invariant safety-net hospital (SNH) status, and county-level unemployment rate. Standard errors in parentheses. Standard errors are level.

Minor points

Comment F.8: The majority of the literature reports the HHI in the scale of 0 to 10,000. While all the HHI values that this paper reports are easy to convert to this scale (simply by multiplying to 10,000), the authors may want to (1) use a scale that is consistent with the majority of the literature, or (2) briefly explain why they prefer reporting it in a scale of 0 to 1. Understandably, none of the findings will be affected, and it is just a matter of exposition.

Response F.8: We chose to report in the scale of 0 to 1 because the estimated coefficients for the HHI and HHI-squared term would become extremely small (less than 0.001).

Comment F.9: In section 1.2, the authors discuss the limited number of state-level studies, suggesting the need for more. Two points might be helpful to clarify in this section: (a) is there any advantage in doing state level analysis as opposed to national and international studies? My understanding is that studies that comprise a larger geography are more generalizable whereas state-level studies may or may not generalize nationally or globally; (b) a brief discussion of what has been done in the literature at the level of state, nation, or across multiple nations, what has been found, and what is left to be explored.

Response F.9: Each state has unique market and regulatory environments; thus, we believe that state-level analysis can add valuable insights to the literature. We have added the following text explaining the value of examining NJ: New Jersey offers a useful case example of the relationship between hospital consolidation and profitability. Hospitals in the state have undergone substantial consolidation over our study period and data available from state regulators allowed us to examine in detail the impact of such merger and acquisition activities on hospital profitability. In addition, our study contributes to the literature on the extent to which the link between consolidation and profitability holds even in markets dominated by not-for-profit hospitals, as over 80% of hospitals in New Jersey are not-for-profit.

Changes to text: Section 1.2 Rationale and Knowledge Gap (lines 127-137)

Comment F.10: Some subsections are numbered (such as sections 4.1, 4.2, etc.) whereas the subsections in other sections are not numbers (for example in sections 2 and 3). It helps if either all subsections are numbered or none are numbered.

Response F.10: We revised the manuscript and made the subsection numbering consistent throughout.

Comment F.11: In lines 250-264 you discuss the shape of the relationship between HHI and operating margins. It will be highly beneficial if you put it in the perspective of the literature, i.e., a brief discussion of what the literature has found about the shape of this relationship. There are some papers discussing this topic. See Kwoka and Shumilkina, 2010 and Alpanda 2019.

References

Alpanda, S. (2019). Business cycles with oligopsonistic competition in labor markets. [citation info missing]

Ashenfelter, O., Hosken, D., 2010. The effect of mergers on consumer prices: evidence from five mergers on the enforcement margin. J. Law Econ.

Hosken, D.S., Olson, L.M., Smith, L.K., 2016. Can entry or exit event studies inform horizontal merger analysis? Evidence from grocery retailing. Econ. Inq.

Kwoka, J., Shumilkina, E., 2010. The price effect of eliminating potential competition: evidence from an airline merger. J. Ind. Econ. 767–793.

Rabbani, M., 2021. Non-profit hospital mergers: the effect on healthcare costs and utilization. Int. J. Health Econ. Manag. 427–455.

Rabbani, M., 2023. Mergers with future rivals can boost prices, bar entry, and intensify market concentration. Int. J. Industrial Organization.

Response F.11: Thank you for suggesting this important literature. We have revised our discussion with the suggested literature in Section 1.1 Background. The original discussion between HHI and Operating Margins mentioned have been dropped from Section 4.1 Key Findings as we have updated our models to base on hospital-year units and as we have dropped the original Figure 3 in response to Comment C.8.

Changes to text: Revised Section 1.1 Background (lines 80-112).

Comment F.12: In Table 1, the HHI and C$ for the overall state are incorrectly specified. The state-level HHI (or C4) should be a weighted average of HMA level HHIs (or C4). You seem to have recalculated HHI and C4 at the state level. This may not be a correct approach because the state is not a market and measuring market concentration at the state level would result in extremely low and misleading numbers.

Response F.12: We followed your suggestion and changed the measure to the weighted average of HMA level HHIs.

Changes to text: Edited Table 1.

Comment F.13: In Table 1, what is the definition of a "system"? I am asking for an explicit definition because it seems that, in line 5, when measuring the number of hospitals per system, solo hospitals (those that do not belong to a hospital chain) are counted as a hospital system, whereas in Line 8, in measuring the percentage of admissions to systems, solo hospitals are not counted as systems.

Response F.13: We define systems as including two or more licensed hospitals. Individual hospitals are not considered systems. The number of systems declined as system size grew through consolidation among systems.

Comment F.14: It would be beneficial if, in an appendix, you report the full regression results with all the covariates such as HMA and year fixed effects.

Response F.14: We followed your suggestion and included the full regression results with all the covariates including HMA and year fixed effects in the Appendix Table A3.

As suggested, we have added a model with hospital fixed effects as an additional robustness specification. Hence, we report the full regression results with all covariates including HMA fixed effects, hospital fixed effects, and year fixed effects in the below table, for your reference.

Herfindahl-Hirschman Index (HHI) on Operating Margins, 2010-2020

	Dependent variable: Operating Margin		
Variables	(1)	(2)	(3)
HHI	-1.5580***	-1.6134***	-1.2274***
	(0.4191)	(0.4072)	(0.3601)
HHI^2	2.1600***	2.2216***	1.5914***
	(0.4647)	(0.4533)	(0.4017)
Number of Beds		0.0001**	
		(0.00002)	
Ownership Status			
Governmental		-0.0845***	
		(0.0269)	
Proprietary		-0.0412***	
		(0.0131)	
Urban Location		0.0710***	
		(0.0189)	
SNH Status		-0.0235**	
		(0.0095)	
Unemployment Rate		-0.2035	
		(0.4295)	
Hospital Fixed Effects			
0002			0.0661
			(0.0536)
0003			-0.0588
			(0.0425)
0005			0.0128
			(0.0451)
0006			-0.0546
			(0.0425)
0008			0.0263
			(0.0425)
0009			0.0626
			(0.0536)
0010			-0.0112
			(0.0451)
0011			0.0077
			(0.0468)
0012			0.0711*
			(0.0425)

0014	0.0609 (0.0502)
0015	0.0622 (0.0764)
0016	0.0221 (0.0536)
0017	-0.0290 (0.0425)
0019	-0.0566 (0.0425)
0021	-0.0290 (0.0642)
0024	0.0571 (0.0536)
0025	0.0127 (0.0536)
0027	0.0343 (0.0536)
0028	-0.0024 (0.0764)
0029	0.0378 (0.0502)
0031	0.0316 (0.0502)
0034	0.1140* (0.0658)
0037	-0.0756 (0.0464)
0038	0.0003 (0.0451)
0040	-0.0109 (0.0425)
0041	0.0841 (0.0658)
0044	-0.0224 (0.0642)
0045	-0.0239 (0.0425)
0047	0.0192 (0.0468)
0048	0.0075

	(0.0451)
0050	-0.0282
	(0.0764)
0051	0.0634
	(0.0764)
0052	0.1085*
	(0.0658)
0054	0.1027*
	(0.0536)
0057	0.0941*
	(0.0502)
0058	-0.0639
	(0.0425)
0060	0.0755
	(0.0764)
0061	0.0277
	(0.0502)
0069	0.1401***
	(0.0468)
0070	-0.0050
	(0.0451)
0073	0.0922
	(0.0658)
0074	0.0505
	(0.0536)
0075	0.1213*
	(0.0658)
0076	0.1158**
	(0.0536)
0081	0.0356
	(0.0506)
0083	-0.1530***
	(0.0536)
0084	0.0436
	(0.0658)
0091	-0.2386***
	(0.0468)
0092	0.0207
	(0.0642)
0096	-0.0478
	(0.0536)

0108	0.0058
	(0.0442)
0110	0.0359
	(0.0642)
0111	0.0728
	(0.0658)
0112	0.0777
	(0.0658)
0113	0.0240
	(0.0468)
0115	-0.0254
	(0.0764)
0116	0.0627
	(0.0425)
0118	-0.0505
	(0.0425)
0119	-0.0746
	(0.0536)
0120	-0.4074***
	(0.0842)
0221	0.1205**
	(0.0502)
0222	-0.1946***
	(0.0597)
0224	0.0868*
	(0.0502)
0324	0.0656
	(0.0468)
0391	-0.1008**
	(0.0451)
0392	0.0957**
	(0.0451)
0502	0.0480
	(0.0764)
0641	0.0775*
	(0.0468)
0642	0.0219
	(0.0468)
0861	0.0600
	(0.0502)
0862	-0.0123

			(0.0502)
0863			0.0155
			(0.0502)
1069			-0.1306
			(0.0845)
HMA Fixed Effects			
Camden	0.0247	0.0036	
	(0.0184)	(0.0203)	
Hackensack, Ridgewood and Paterson	-0.0441	-0.0616**	
	(0.0277)	(0.0303)	
Morristown	-0.0453	-0.0591	
	(0.0588)	(0.0591)	
New Brunswick	-0.0162	-0.0525**	
	(0.0184)	(0.0234)	
Newark/Jersey City	0.0080	0.0052	
	(0.0225)	(0.0242)	
Toms River	0.0680	0.0358	
	(0.0413)	(0.0421)	
Trenton	-0.0176	-0.0379	
	(0.0407)	(0.0429)	
Year Fixed Effects			
2011	0.0064	0.0063	0.0059
	(0.0196)	(0.0191)	(0.0167)
2012	0.0112	0.0118	0.0106
	(0.0197)	(0.0191)	(0.0167)
2013	-0.0224	-0.0227	-0.0223
	(0.0197)	(0.0199)	(0.0168)
2014	0.0151	0.0090	0.0098
	(0.0199)	(0.0232)	(0.0170)
2015	0.0329	0.0247	0.0249
	(0.0201)	(0.0260)	(0.0171)
2016	0.0341	0.0269	0.0293*
	(0.0208)	(0.0290)	(0.0177)
2017	0.0213	0.0124	0.0159
	(0.0209)	(0.0303)	(0.0178)
2018	0.0251	0.0148	0.0198
	(0.0224)	(0.0331)	(0.0191)
2019	0.0084	-0.0028	0.0053
	(0.0230)	(0.0352)	(0.0196)

2020	0.0034	0.0045	-0.0011
	(0.0230)	(0.0224)	(0.0196)
Constant	0.2434***	0.2220**	0.1868***
	(0.0705)	(0.0871)	(0.0509)
Observations	789	789	789
R^2	0.0792	0.1422	0.3917
Note:	*p<0.1; **p<0.05; ***p<0.01		

Model (2) imposes controls on hospital characteristics, including number of maintained beds, ownership status (for which the basis is non-profit ownership), a dummy variable for urban location (RUCA code of 1), time-invariant safety-net hospital (SNH) status, and county-level unemployment rate. Standard errors in parentheses. Standard errors are level.

Changes to text: Mentioned in 3.2 Regression Results (lines 275-276) and added Appendix A3.