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Online Appendix for Figures:

Impact of Hospital Readmissions Reduction Program Penalties on Hip and Knee Replacement
Readmissions: Comparison of Hospitals at Risk of Varying Penalty Amounts

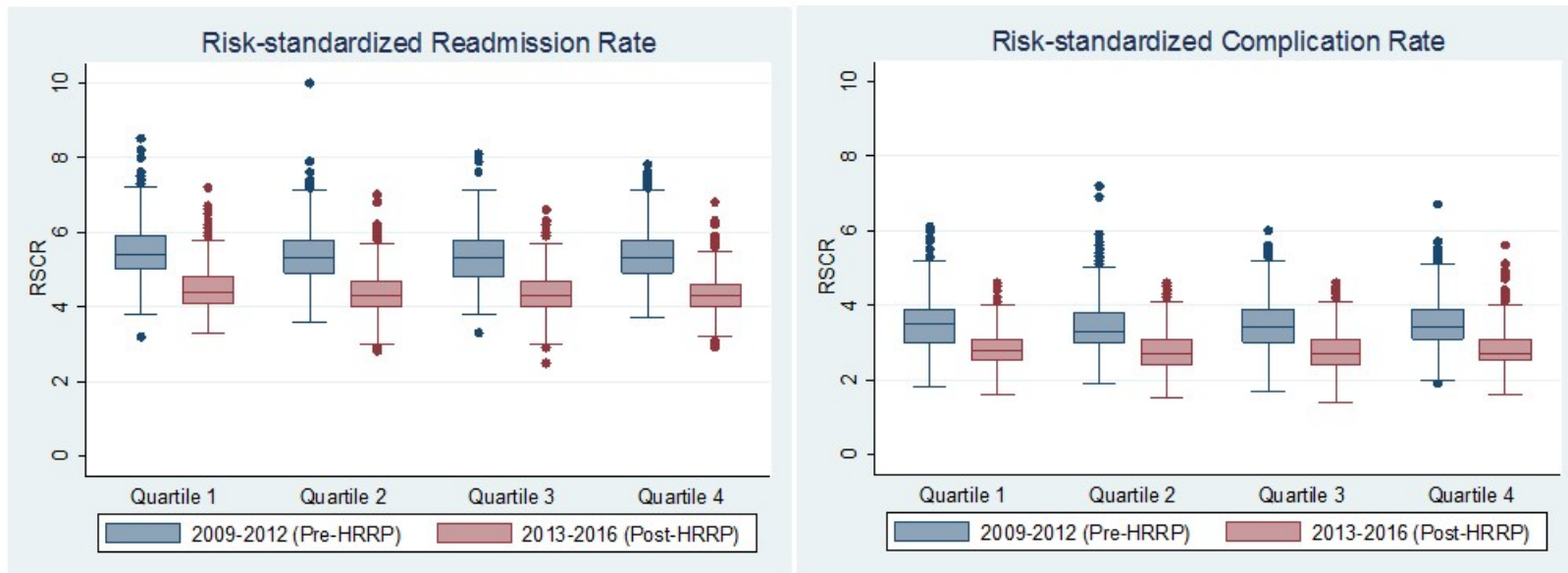
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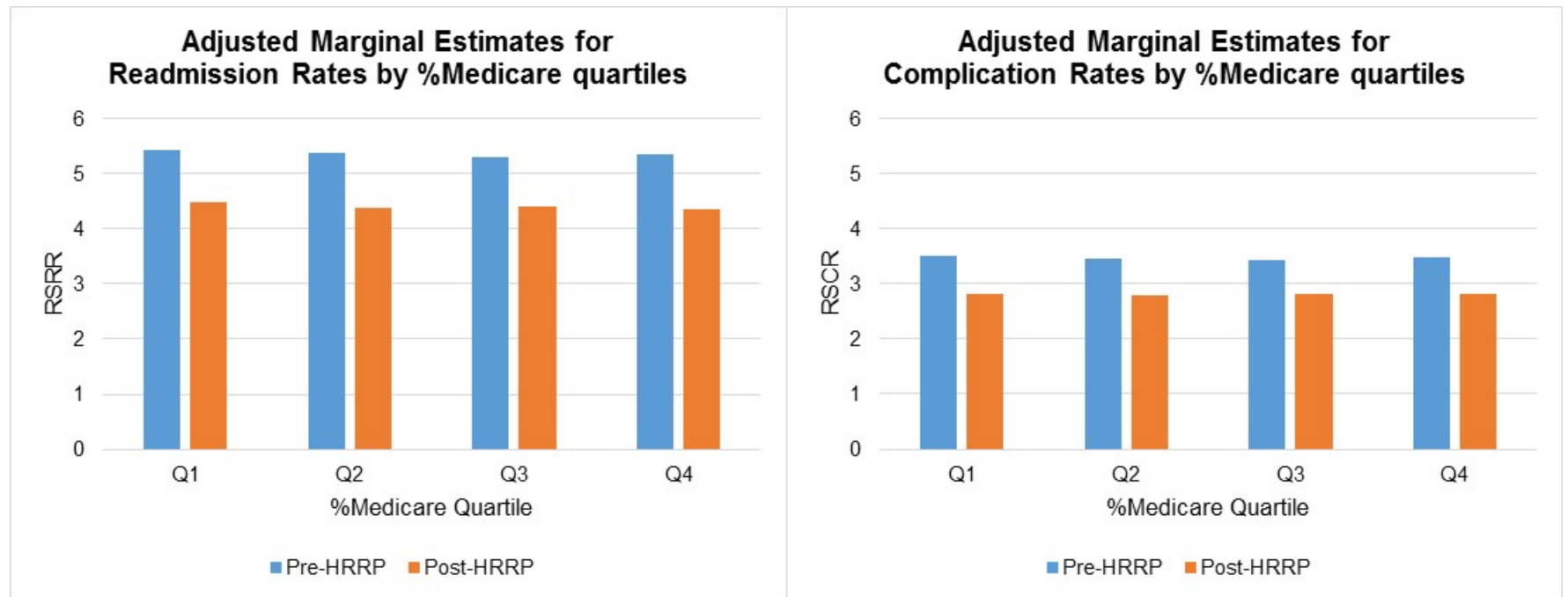
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Appendix Figure 1: Distribution of risk-standardized readmission and complication rates across hospitals with varying percentage of inpatient revenue attributed to Medicare

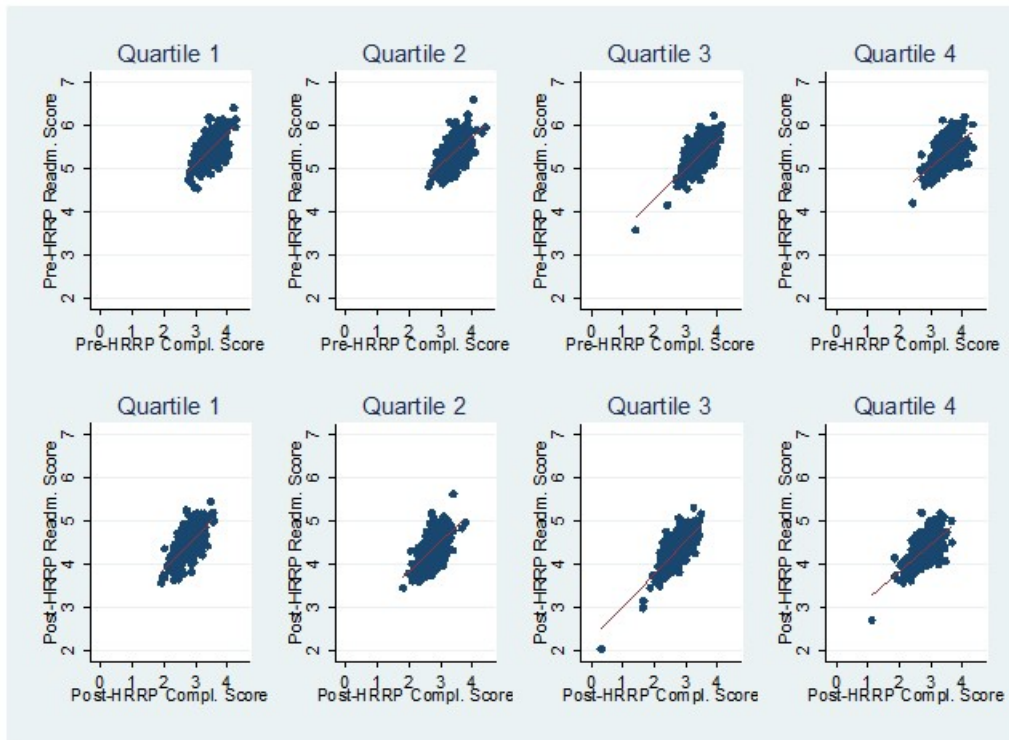


Appendix Figure 2: Adjusted marginal estimates of RSRR and RSCR with expansion of the Hospital Readmissions Reduction Program

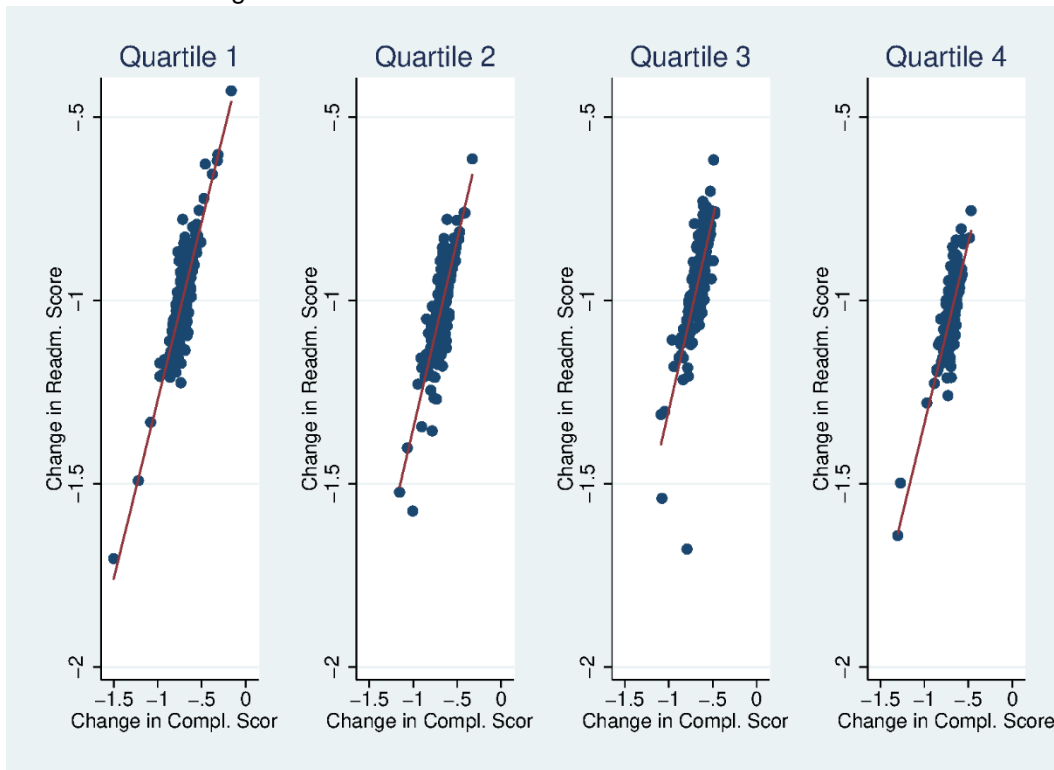


Appendix Figure 3: Scatter plots showing the adjusted correlations between the risk-standardized readmission and complication rates with expansion of the Hospital Readmissions Reduction Program

(A) Pre- and post-HRRP correlation of rates



(B) Correlation of change in rates with HRRP



Notes: HRRP: Hospital Readmissions Reduction Program. Pre-HRRP phase extends from 2009 to 2012; Post-HRRP phase extends from 2013 to 2016. The charts represent scatter plots for hospital-level predicted readmission and complication rates for hospitals in each of the HRRP phases, and the change with HRRP implementation.

Online Appendix for Text and Tables:

Impact of Hospital Readmissions Reduction Program Penalties on Hip and Knee Replacement Readmissions: Comparison of Hospitals at Risk of Varying Penalty Amounts

Details of Study Methodology

Datasets

We used the following datasets that were linked using the Centers for Medicare and Medicaid Services (CMS) Certification Number.

- Hospital Compare data for risk-standardized readmission rates (hereafter called readmission rate) and risk-standardized complication rates (hereafter called complication rate):¹ These hospital-level datasets are published by the CMS. These datasets document information about the quality performance of more than 4,000 hospitals that are certified to provide care to Medicare beneficiaries. These measures are also used by Medicare to reimburse providers.
- Medicare Provider Analysis and Review (MedPAR):² These patient-level files contain the claim information for Medicare beneficiaries admitted to hospitals. We used the 2012 MedPAR file to obtain the total revenue/payment that a hospital received from Medicare, which was the numerator for the key explanatory variable for the study.
- Medicare Cost Reports:³ These hospital-level datasets are published by Medicare and contain information about facility characteristics, utilization of services, and key financial data. We used the 2012 dataset to obtain the total inpatient revenue for a hospital which was the denominator for the key explanatory variable for the study.
- American Hospital Association (AHA) Annual Survey Database:⁴ These hospital-level datasets are published by the American Hospital Association and contain information from the annual survey of hospitals. We used these files to obtain information about hospital characteristics and payor-based volume that was used for the sensitivity analysis in the study.
- Medicare Impact Files:⁵ These hospital-level datasets contain the annual payment update information for hospitals certified by Medicare. We used the 2012 Impact files to obtain hospital characteristics.

Outcomes

The two outcomes for the study were the readmission rate and complication rate. The values for these measures were obtained from the Hospital Compare website. These measures are constructed using validated algorithms developed by the Yale New Haven Health Services Corporation / Center for Outcomes Research and Evaluation (YNHHSC / CORE) and are endorsed by the National Quality Foundation (readmission rate: NQF #1551, complication rate: NQF # 1550).⁶ The readmission and complication rates are calculated as a ratio of the number of predicted to the number of expected readmissions/complications and the ratio is multiplied by the national unadjusted readmission/complication rate. Patient-level Medicare administrative claims data (MedPAR) and enrollment data are used for calculating the measures by employing

the hierarchical logistic regression modelling strategy. The methodology for calculating these measures is re-evaluated annually and can be found on the CMS website.⁶ In the sections below, we summarize the key aspects of this methodology:

Risk-standardized readmission rate:

- Cohort: The index inpatient stays are identified using a combination of Medicare enrollment (enrollment parts A and B of fee-for-service Medicare for 12 months prior to admission), age (65 or over), discharged alive, and undergoing an elective primary total hip replacement (THR) or total knee replacement (TKR) that is identified using International Classification of Diseases procedure/surgery code. The cohort excludes inpatient stays due to fractures, concurrent partial hip replacement procedure, concurrent revision or resurfacing or implanted device/prosthesis removal procedure, mechanical complications, malignant neoplasms, and transfers from other acute care facilities. The cohort also excludes inpatient stays without at least 30 days of post-discharge enrolment in Medicare, discharge against medical advice, transfer-out during the index stay, stays with two or more THR/TKR codes during the index admission, and THR/TKR admission within 30 days of discharge from the index admission.
- The computation of the readmission rate is risk-adjusted for age, sex, several condition categories such as diabetes mellitus, obesity and malnutrition, and for a hospital-specific effect.
- Any admission occurring within 30 days of discharge from the index admission qualifies to be included in the readmission rate calculations.

Risk-standardized complication rate:

- Cohort: The cohort inclusion and exclusion criteria for the complication rate measure are fairly similar to those listed for the readmission rate with the exception that transfer-out during the index stay and THR/TKR admission within 30 days of discharge from the index admission are not listed as exclusion criteria.
- The computation of the readmission rate is risk-adjusted for age, sex, several condition categories such as diabetes mellitus, obesity and malnutrition, and for a hospital-specific effect.
- Complications occurring during the index stay or during a readmission (except for deaths) are included in the calculation of the complication rate provided they meet additional criteria listed below:
 - o Complications within 7 days of the start of the index admission: Acute myocardial infarction, pneumonia, sepsis/septicemia/shock. These complications are identified using a combination of the International Classification of Diseases diagnoses codes and the present-on-admission indicators.
 - o Complications within 30 days of the start of the index admission: Surgical site bleeding and pulmonary embolism. These are identified using a combination of the International Classification of Diseases diagnoses codes, procedure/surgery codes (only for surgical site bleeding), and present-on-admission indicators.
 - o Complications within 90 days of the start of the index admission: Mechanical complications and peri-prosthetic joint infection or wound infection. These complications are identified using a combination of International Classification of Diseases diagnosis codes, procedure/surgery codes (only for peri-prosthetic joint infection or wound infection), and present-on-admission indicators.

Notably, both the readmission and complication measures are annually updated by the CMS for codes that are used to define the measures and for the risk-assessment models. The details of these updates can be found at the following links for readmissions (<https://www.qualitynet.org/dcs/ContentServer?cid=1228774371008&pagename=QnetPublic%2FPage%2FQnetTier4&c=Page>) and for complications (<https://www.qualitynet.org/dcs/ContentServer?c=Page&pagename=QnetPublic%2FPage%2FQnetTier3&cid=1228774719413>). Specifically, the 2018 update to the complication measure reports that “Conducted code surveillance to identify any specification changes warranted due to coding practices and patterns.” Moreover, these measures are used for determining hospital performance and payments to providers. Furthermore, Bozic et al.⁷ have conducted a medical record validation of the complication measure and have found “...99% agreement (635 of 644) after refining the measure specifications”

Key Independent Variables

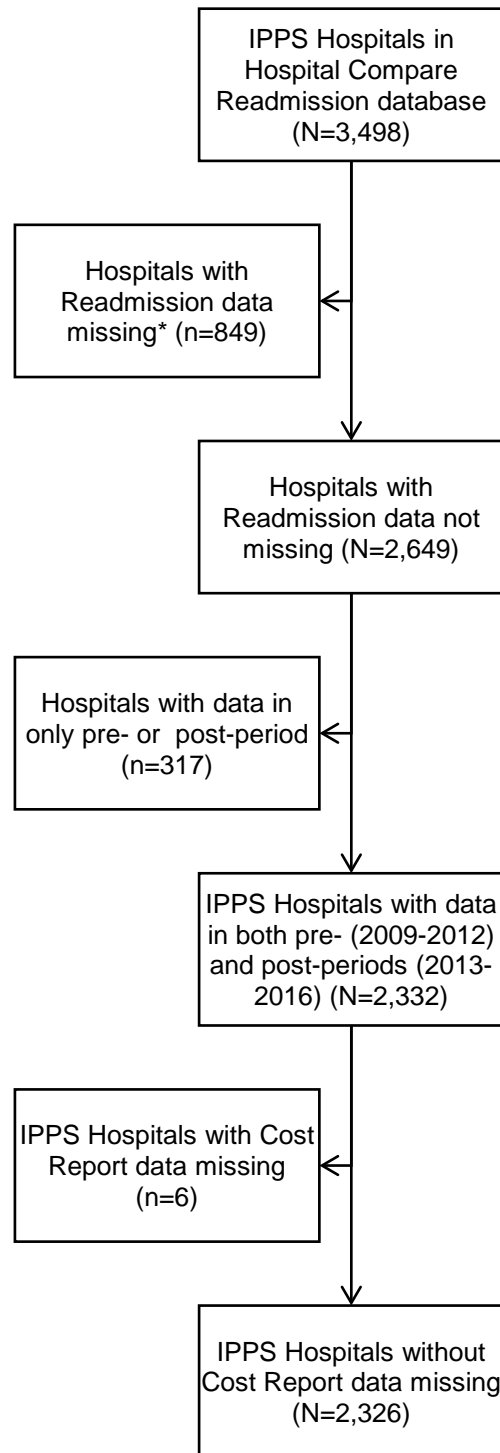
- The main independent variables for the study were the HRRP phase (pre-HRRP from 2009 to 2012, and post-HRRP from 2013 to 2016), the percent of total inpatient revenue of a hospital that can be attributed to Medicare (Medicare percentage), and the interaction between the two terms.
- The numerator for the Medicare percentage variable was the Medicare inpatient revenue for a hospital and was calculated from the 2012 MedPAR file. This was calculated as a hospital-level sum of revenue (variable name: pmt_amt) for all short-stay Medicare beneficiaries 66 years or older.
- The denominator for the Medicare percentage variable was the total inpatient revenue for a hospital and was obtained from the 2012 Medicare Cost Report. This variable was derived from worksheet G-2, line 28 (total patient revenues), column 1 (inpatient) of the Medicare Cost Report.

Covariates

Variable	Definition / Specifications	Source
Hospital location	Categorical: Northeast, South, Midwest, West, Territory	AHA Annual Survey database/Medicare Impact File
Geographic region	Categorical: Urban, Rural	
Hospital size	Categorical: <200 beds, 200 to 399 beds, and ≥400 beds	
Medical school affiliation	Categorical: Affiliated, not affiliated	
Ownership	Categorical: Private for-profit, private not-for-profit, Government	Medicare Hospital Compare
Volume of THRs/TKRs	Continuous	Medicare Impact File
Disproportionate patient percentage	Continuous. This is a marker of the volume of medically and socially vulnerable patients treated by a hospital. This measure is used by Medicare to reimburse	

Variable	Definition / Specifications	Source
	hospitals for the increased cost of treating vulnerable patients.	
Transfer-adjusted case-mix index	Continuous. This is the average Medical Severity – Diagnosis Related Group weight for all Medicare discharge in a hospital. This index represents the clinical complexity of patients and the resources used in care.	

Cohort Determination Diagram



* No or few cases meeting criteria for inclusion, or data not available in Hospital Compare for the reporting period. IPPS: Inpatient Prospective Payment System

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Appendix Table 6: Key multivariable estimates from hierarchical linear regression models using 2009-2012 as pre-phase and 2014-2017 as the post-phase

Appendix Table 1: Multivariable full model estimates from hierarchical linear regression models examining the impact of the Hospital Readmissions Reduction Program expansion on 30-day readmissions following hip and knee replacements

Variable	Risk-standardized readmission rate	Risk-standardized complication rate
	Estimate [95% CI] ^a	Estimate [95% CI]
N ^b	4,636	4,619
HRRP ^c phase		
<i>Pre- (2009-12)</i>	Ref ^d	Ref
<i>Post- (2013-16)</i>	-0.94*** [-1.00,-0.88]	-0.68*** [-0.74,-0.62]
Medicare percentage ^e quartile		
<i>Quartile 1</i>	Ref	Ref
<i>Quartile 2</i>	-0.06 [-0.13,0.01]	-0.05 [-0.12,0.03]
<i>Quartile 3</i>	-0.13*** [-0.21,-0.06]	-0.06 [-0.13,0.02]
<i>Quartile 4</i>	-0.09* [-0.17,-0.01]	-0.02 [-0.11,0.06]
HRRP phase x Medicare percentage quartile		
<i>Post- x Quartile 2</i>	-0.04 [-0.12,0.05]	0.02 [-0.07,0.11]
<i>Post- x Quartile 3</i>	0.05 [-0.04,0.14]	0.06 [-0.03,0.14]
<i>Post- x Quartile 4</i>	-0.04 [-0.13,0.04]	0.02 [-0.06,0.11]
Region		
<i>Northeast</i>	Ref	Ref
<i>South</i>	0.07* [0.00,0.13]	0.03 [-0.04,0.09]
<i>Midwest</i>	0.03 [-0.04,0.09]	-0.01 [-0.07,0.05]
<i>West</i>	-0.15*** [-0.23,-0.08]	-0.08* [-0.15,-0.01]
<i>US Territories</i>	-0.29 [-0.69,0.10]	-0.49* [-0.88,-0.09]
Location		
<i>Rural</i>	Ref	Ref
<i>Urban</i>	0.10** [0.04,0.15]	0.00 [-0.06,0.06]
Number of beds		
<i>Small (<200 beds)</i>	Ref	Ref
<i>Medium (200 to 399)</i>	0.08** [0.03,0.13]	0.05* [0.00,0.10]
<i>Large (≥400)</i>	0.21*** [0.13,0.28]	0.04 [-0.03,0.12]
Medical school affiliation		
<i>No</i>	Ref	Ref
<i>Yes</i>	0.02 [-0.02,0.07]	0.03 [-0.02,0.07]
Ownership		

Variable	Risk-standardized readmission rate	Risk-standardized complication rate
	Estimate [95% CI] ^a	Estimate [95% CI]
<i>Private for-profit</i>	Ref	Ref
<i>Private not-for-profit</i>	-0.07* [-0.12,-0.01]	0.00 [-0.05,0.06]
<i>Government</i>	-0.06 [-0.13,0.01]	0.07 [-0.00,0.14]
Volume of hip/knee replacements	-0.00*** [-0.00,-0.00]	-0.00*** [-0.00,-0.00]
Disproportionate Patient Percent	0.00 [-0.00,0.00]	0.00 [-0.00,0.00]
Transfer-adjusted case-mix index	-0.29*** [-0.38,-0.20]	-0.07 [-0.16,0.02]

* p<0.05, ** p<0.01, *** p<0.001

Notes: ^a Beta estimate and 95% Confidence Interval; ^b Number of observations; ^c Hospital Readmissions Reduction Program; ^d Reference group; ^e Percent of a hospital's inpatient revenue that is attributed to Medicare. The multivariable models also controlled for the clustering of observations within hospitals.

Appendix Table 2: Key multivariable estimates from hierarchical linear regression models testing for the parallel trends assumption prior to expansion of the Hospital Readmissions Reduction Program

Variable	Risk-standardized readmission rate	Risk-standardized complication rate
	Estimate [95% CI] ^a	Estimate [95% CI]
N ^b	4,572	4,564
Medicare percentage ^c quartile		
<i>Quartile 1</i>	Ref ^d	Ref
<i>Quartile 2</i>	-0.06 [-0.14,0.03]	-0.05 [-0.13,0.03]
<i>Quartile 3</i>	-0.13** [-0.22,-0.04]	-0.06 [-0.15,0.02]
<i>Quartile 4</i>	-0.10* [-0.20,-0.00]	-0.04 [-0.13,0.06]
Time trend ^e	-0.22*** [-0.25,-0.18]	-0.15*** [-0.19,-0.12]
Medicare percentage quartile x Time trend		
<i>Quartile 1 x Time trend</i>	Ref	Ref
<i>Quartile 2 x Time trend</i>	0.03 [-0.02,0.08]	0.02 [-0.03,0.07]
<i>Quartile 3 x Time trend</i>	0.05 [-0.00,0.10]	0.02 [-0.03,0.07]
<i>Quartile 4 x Time trend</i>	0.04 [-0.01,0.09]	0.03 [-0.02,0.08]

* p<0.05, ** p<0.01, *** p<0.001

Notes: This analysis is used for testing the parallel trends assumption (in the pre-expansion period) of the difference-in-differences strategy where the periods from 2009-2012 and 2010-2013 are used as the time trend dummies. ^a Beta estimate and 95% Confidence Interval; ^b Observations; ^c Percent of a hospital's inpatient revenue that is attributed to Medicare; ^d Reference; ^e Year of data extract (2009 to 2012, and 2010 to 2013) from Hospital Compare prior to the expansion of the Hospital Readmissions Reduction Program for hip and knee replacements. The multivariable models also controlled for geographic region, urban location, number of beds, medical school affiliation, ownership status, volume of hip and knee replacements, disproportionate patient percent, and transfer-adjusted case-mix index, and for the clustering of observations within hospitals.

Appendix Table 3: Key multivariable estimates from hierarchical linear regression models using varying specifications of the key exposure variable – Medicare Percentage

Key exposure variable: Medicare percentage	Continuous specification		Tertiles		Quintiles	
	RSRR ^a	RSCR ^b	RSRR	RSCR	RSRR	RSCR
Outcome	<i>Estimate</i> [95% CI] ^c	<i>Estimate</i> [95% CI]	<i>Estimate</i> [95% CI]	<i>Estimate</i> [95% CI]	<i>Estimate</i> [95% CI]	<i>Estimate</i> [95% CI]
N ^d	4,636	4,619	4,636	4,619	4,636	4,619
HRRP ^e phase						
Pre- (2009 – 2012)	Ref ^f	Ref	Ref	Ref	Ref	Ref
Post- (2013 – 2016)	-0.92*** [-0.98,-0.85]	-0.69*** [-0.75,-0.62]	-0.95*** [-1.00,-0.89]	-0.67*** [-0.72,-0.62]	-0.94*** [-1.01,-0.87]	-0.72*** [-0.78,-0.65]
Medicare percentage ^g						
Continuous	0.00 [-0.01,0.00]	0.00 [-0.01,0.00]				
Tertile 1			Ref	Ref		
Tertile 2			-0.08** [-0.15,-0.02]	-0.03 [-0.10,0.03]		
Tertile 3			-0.08* [-0.15,-0.01]	-0.02 [-0.09,0.05]		
Quintile 1					Ref	Ref
Quintile 2					-0.07 [-0.15,0.01]	-0.10* [-0.18,-0.02]
Quintile 3					-0.10* [-0.18,-0.02]	-0.05 [-0.13,0.04]
Quintile 4					-0.12** [-0.20,-0.03]	-0.10* [-0.19,-0.02]
Quintile 5					-0.10* [-0.19,-0.01]	-0.04 [-0.13,0.05]
HRRP phase x Medicare percentage						
Post- x Medicare percentage	0.00 [-0.01,0.00]	0.00 [-0.00,0.01]				
Post- x Tertile 2			0.03 [-0.05,0.10]	0.02 [-0.05,0.10]		
Post- x Tertile 3			-0.03 [-0.10,0.05]	0.03 [-0.04,0.11]		
Post- x Quintile 2					-0.03 [-0.12,0.07]	0.10* [0.01,0.20]
Post- x Quintile 3					0.01 [-0.09,0.10]	0.04 [-0.05,0.14]
Post- x Quintile 4					0.00 [-0.09,0.10]	0.10* [0.00,0.20]
Post- x Quintile 5					0.00 [-0.01,0.00]	0.00 [-0.00,0.01]

* p<0.05, ** p<0.01, *** p<0.001

Notes: ^a RSRR: Risk-standardized readmission rate; ^b RSCR: Risk-standardized complication rate; ^c Beta estimate and 95% Confidence Interval; ^d Number of observations; ^e Hospital Readmissions Reduction Program; ^f Ref: Reference group; ^g Percent of a hospital's inpatient revenue that is attributed to Medicare. The multivariable models also controlled for geographic region, urban location, number of beds, medical school affiliation, ownership status, volume of hip and knee replacements, disproportionate patient percent, and transfer-adjusted case-mix index, and for the clustering of observations within hospitals.

Appendix Table 4: Key multivariable estimates from hierarchical linear regression models for alternate definitions of exposure

Key exposure variable:	Medicare hip and knee inpatient revenue as a percent of total inpatient revenue		Medicare inpatient volume as a percent of total inpatient volume	
	RSRR ^a	RSCR ^b	RSRR	RSCR
Outcome	<i>Estimate</i> <i>[95% CI]</i> ^c	<i>Estimate</i> <i>[95% CI]</i>	<i>Estimate</i> <i>[95% CI]</i>	<i>Estimate</i> <i>[95% CI]</i>
N ^d	4,634	4,619	4,636	4,619
HRRP ^e phase				
Pre- (2009 – 2012)	Ref ^f	Ref	Ref	Ref
Post- (2013 – 2016)	-0.99*** [-1.05,-0.93]	-0.72*** [-0.78,-0.65]	-0.96*** [-1.02,-0.89]	-0.67*** [-0.73,-0.60]
Exposure				
Quartile 1	Ref	Ref	Ref	Ref
Quartile 2	-0.14*** [-0.22,-0.07]	-0.12*** [-0.20,-0.05]	-0.06 [-0.13,0.01]	-0.06 [-0.13,0.01]
Quartile 3	-0.20*** [-0.27,-0.12]	-0.15*** [-0.22,-0.07]	-0.05 [-0.12,0.02]	-0.02 [-0.10,0.05]
Quartile 4	-0.32*** [-0.40,-0.23]	-0.23*** [-0.32,-0.15]	-0.05 [-0.15,0.06]	-0.08 [-0.18,0.02]
HRRP phase x Exposure				
Post- x Quartile 2	0.02 [-0.06,0.11]	0.07 [-0.02,0.15]	0.03 [-0.05,0.11]	0.03 [-0.05,0.11]
Post- x Quartile 3	0.05 [-0.03,0.14]	0.07 [-0.01,0.16]	-0.01 [-0.09,0.08]	0.02 [-0.07,0.10]
Post- x Quartile 4	0.07 [-0.02,0.16]	0.11* [0.02,0.19]	0.00 [-0.12,0.12]	-0.01 [-0.13,0.11]

* p<0.05, ** p<0.01, *** p<0.001

Notes: ^a RSRR: Risk-standardized readmission rate; ^b RSCR: Risk-standardized complication rate; ^c Beta estimate and 95% Confidence Interval; ^d Number of observations; ^e Hospital Readmissions Reduction Program; ^f Ref: Reference group. The multivariable models also controlled for geographic region, urban location, number of beds, medical school affiliation, ownership status, volume of hip and knee replacements, disproportionate patient percent, and transfer-adjusted case-mix index, and for the clustering of observations within hospitals.

Appendix Table 5: Key multivariable estimates from hierarchical linear regression models among high volume hospitals and with alternate definition of pre-HRRP phase

Outcome	Estimation among hospitals with hip and knee replacement volume above median (233)		Estimation with pre-HRRP phase specified as 2010-2013	
	RSRR ^a	RSCR ^b	RSRR	RSCR
	<i>Estimate</i> [95% CI] ^c	<i>Estimate</i> [95% CI]	<i>Estimate</i> [95% CI]	<i>Estimate</i> [95% CI]
N ^d	2,333	2,180	4,572	4,569
HRRP ^e Policy				
Pre- (2009 – 2012)	Ref	Ref	--	--
Pre- (2010 – 2013)	--	--	Ref	Ref
Post- (2013 – 2016)	-0.88*** [-0.97,-0.78]	-0.59*** [-0.69,-0.50]	-0.76*** [-0.82,-0.70]	-0.52*** [-0.58,-0.47]
Medicare percentage ^f				
Quartile 1	Ref	Ref	Ref	Ref
Quartile 2	-0.06 [-0.17,0.04]	-0.06 [-0.18,0.05]	-0.02 [-0.09,0.06]	-0.02 [-0.09,0.05]
Quartile 3	-0.14* [-0.25,-0.02]	-0.1 [-0.21,0.02]	-0.06 [-0.14,0.01]	-0.04 [-0.11,0.03]
Quartile 4	-0.11 [-0.24,0.02]	-0.09 [-0.22,0.05]	-0.03 [-0.11,0.06]	0.01 [-0.07,0.09]
HRRP Policy x Medicare percentage				
Post x Quartile 2	-0.06 [-0.18,0.07]	0.00 [-0.12,0.13]	-0.07 [-0.16,0.01]	-0.01 [-0.09,0.07]
Post x Quartile 3	-0.03 [-0.15,0.10]	0.01 [-0.11,0.14]	-0.01 [-0.09,0.08]	0.03 [-0.05,0.11]
Post x Quartile 4	-0.04 [-0.18,0.09]	0.06 [-0.07,0.20]	-0.08 [-0.16,0.01]	-0.01 [-0.09,0.07]

* p<0.05, ** p<0.01, *** p<0.001

Notes: ^a RSRR: Risk-standardized readmission rate; ^b RSCR: Risk-standardized complication rate; ^c Beta estimate and 95% Confidence Interval; ^d Number of observations; ^e Hospital Readmissions Reduction Program; ^f Ref: Reference group; ^g Percent of a hospital's inpatient revenue that is attributed to Medicare. The multivariable models also controlled for geographic region, urban location, number of beds, medical school affiliation, ownership status, volume of hip and knee replacements, disproportionate patient percent, and transfer-adjusted case-mix index, and for the clustering of observations within hospitals.

Appendix Table 6: Key multivariable estimates from hierarchical linear regression models using 2009-2012 as pre-phase and 2014-2017 as the post-phase

	Risk-standardized readmission rate	Risk-standardized complication rate
	Estimate	Estimate
	[95% CI] ^a	[95% CI]
N ^b	4,576	4,559
HRRP ^c phase		
<i>Pre- (2009-12)</i>	Ref ^d	Ref
<i>Post- (2014-17)</i>	-1.11*** [-1.20,-1.02]	-0.89*** [-0.98,-0.80]
Medicare percentage ^e quartile		
<i>Quartile 1</i>	Ref	Ref
<i>Quartile 2</i>	-0.06 [-0.13,0.01]	-0.05 [-0.12,0.02]
<i>Quartile 3</i>	-0.13*** [-0.20,-0.06]	-0.06 [-0.14,0.01]
<i>Quartile 4</i>	-0.10* [-0.18,-0.02]	-0.04 [-0.12,0.04]
HRRP x Medicare percentage quartile		
<i>Post x Quartile 2</i>	-0.02 [-0.11,0.06]	0.00 [-0.09,0.08]
<i>Post x Quartile 3</i>	0.07 [-0.02,0.15]	0.05 [-0.04,0.13]
<i>Post x Quartile 4</i>	-0.03 [-0.12,0.06]	0.03 [-0.06,0.12]

* p<0.05, ** p<0.01, *** p<0.001

Notes: ^a Beta estimate and 95% Confidence Interval; ^b Number of observations; ^c Hospital Readmissions Reduction Program; ^d Reference group; ^e Percent of a hospital's inpatient revenue that is attributed to Medicare. The multivariable models also controlled for geographic region, urban location, number of beds, medical school affiliation, ownership status, volume of hip and knee replacements, disproportionate patient percent, and transfer-adjusted case-mix index, and for the clustering of observations within hospitals.

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