Supplementary Online Content

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This supplementary material has been provided by the authors to give readers additional information about their work.
**eAppendix 1. Matching Advertising Data to CMS Hospital Information**

Data on advertising expenditures came from Kantar Media, a market research firm which tracks organizations’ advertising expenditures at the Designated Market Area (DMAs) level. DMAs typically consist of a group of counties surrounding a metro area and were developed by Nielsen to track television viewership. DMAs also represent the unit at which media advertising is typically purchased, such that all households within a DMA have the potential to be exposed to a given advertisement. Currently there are 210 DMAs across the country.

We obtained advertising expenditure data on all health care providers between 2008 and 2016 and restricted the data to organizations classified as “Hospitals, Clinics & Medical Centers.” Advertisers under this umbrella designation included primary care clinics, free-standing emergency rooms, specialist offices, and other types of medical-adjacent providers (laser hair removal, vein clinics etc.). To restrict the data to only acute care hospitals, we developed a multi-step strategy to match Kantar data to a CMS list of hospitals included in publicly available quality reporting documents (henceforth referred to as the master list). This process was needed to overcome several challenges inherent in matching string names across datasets using automated computer algorithms.

First, advertising may occur at the system, rather than facility-level. The master list only identifies individual hospitals and does not include any information regarding system affiliations (nor are we aware of any dataset that does). Thus, any system-level advertising captured by Kantar will not easily be matched with the corresponding hospitals through automated matching algorithms. Second, advertiser names in Kantar often include abbreviations or locally used historic names which differ from the official names used in the master data set. Third, a significant number of the non-hospital advertisers under the “Hospitals, Clinics & Medical Centers” umbrella included common words or phrases in their name which correspond to a significant number of hospitals in the master list, meaning there is a high likelihood of a false match.

We overcame these challenges in several steps. First, we eliminated any observations from the Kantar data with names that included several-hundred key words or abbreviations that would not appear in the CMS list of hospitals. This reduced both the number of potential matches and the likelihood that a hospital from the master list would be erroneously matched with a non-hospital in the Kantar data. Second, we used Stata’s reclink2 command to implement a fuzzy matching algorithm between the remaining Kantar observations and the master list. We retained the best match between an advertiser and hospital in the master list based on a score which assesses the similarity between two strings or groups of strings. Approximately 20% of our matches were exactly matched based on the score. Third, we manually assessed whether all matches (even those that were exact matches) were correct based on the string name and the DMA in which the advertisement was purchased. For advertisements we determined were incorrectly matched, we used internet searches to determine whether the advertiser was a hospital or hospital system, and then identified all relevant hospitals within that system. Thus, while we used several data processing techniques to expedite matching across data sets, each advertiser included in the study’s final analytic sample has been manually verified and is the result of hundreds of hours of research.
eAppendix 2. Details on Composite Scores

| Measure                              | How Measure is Constructed                                                                                                                                                                                                 | Minimum Reporting Thresholds                                                                                                                                                                                                 |
|--------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Overall 5-Star Rating\(^a\)          | Overall star ratings are based on up to 57 measures from the following seven quality domains: patient experience, readmissions, mortality, safety of care, efficient use of medical imaging, effectiveness of care, and timeliness of care. CMS standardizes hospitals’ performance on each measure by calculating Z-scores to ensure all measures are on a common scale and direction. Group scores for each domain are calculated using a latent variable model to account for the correlation between measures within a given hospital. An overall star-rating is determined by using a k-means clustering approach using the weighted average of hospitals’ group scores. | For a hospital to receive a star rating, CMS sets the minimum measure threshold at three measures per group, for at least three of seven groups. At least one of the groups has to be an outcome group (e.g., mortality, safety of care, or readmissions). |
| CAHPS 5-Star Rating\(^a\)            | CMS averages 11 publicly reported HCAHPS star ratings to obtain a summary star rating. The constituent star-ratings measures are created by combining specific questions on the HCAHPS survey that are first converted to a 0-100 linear-scaled score. CMS adjusts scores based on patient mix, survey mode, and quarterly weighting. A clustering algorithm is used to assign stars to each quality measure, and then are averaged to determine the overall star rating. | Hospitals must have at least 100 completed HCAHPS surveys over a given four-quarter period to receive HCAHPS star ratings.                                                                                     |
| Overall Readmission Rate\(^a\)       | Medicare administrative data is used to capture unplanned readmissions that require rehospitalization within 30 days of discharge, regardless of cause. CMS reports risk standardized readmission rates by estimating hierarchical logistic regression models which adjust for selected clinical covariates and a hospital specific effect. | Hospitals must have at least 25 cases.                                                                                                                                                                                   |
| Mortality Composite\(^b\)            | The mortality composite combines hospital-level mortality rates for six conditions calculated by CMS: heart failure, acute myocardial infarction (AMI), pneumonia, stroke, chronic obstructive pulmonary disease, and coronary artery bypass grafting (CABG). To account for the correlation between reporting and performance on a measure, we constructed the composite as the z-score of the weighted sum of z-scores. Weights were proportional to the number of patients included in a condition-specific mortality rate, relative to the total number of patients across all conditions. We rescaled the composite by the overall mean and standard deviation of the mortality rate to facilitate interpretability. | Hospitals must have at least 25 patients with the mortality-specific condition.                                                                                     |

Notes: \(^a\) Scores constructed by CMS and obtained from Hospital Compare. \(^b\) Score constructed by authors with condition-specific mortality rates obtained from Hospital Compare.

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**eTable 1. Percentage of Advertising and Nonadvertising Hospitals (2008-2016)**

|                                | 2008 | 2009 | 2010 | 2011 | 2012 | 2013 | 2014 | 2015 | 2016 |
|--------------------------------|------|------|------|------|------|------|------|------|------|
| Percentage of hospitals advertising | 38.8 | 39.2 | 40.5 | 42.3 | 42.5 | 43.4 | 42.7 | 43.4 | 43.7 |
| Total number of hospitals       | 4423 | 4492 | 4527 | 4550 | 4639 | 4638 | 4652 | 4617 | 4579 |
| Percentage of hospitals that begin advertising who did not advertise in previous year | -    | 3.1  | 3.5  | 3.9  | 2.9  | 2.9  | 2.2  | 2.7  | 2.5  |
| Percentage of hospitals that stop advertising who did advertise in previous year     | -    | 2.5  | 1.7  | 2.2  | 1.9  | 1.9  | 2.8  | 2.3  | 2.5  |
### Table 2. Characteristics of Advertising and Nonadvertising Hospitals (Match within 3 years)

|                                      | No Advertising | Low Spend | Mid Spend | High Spend |
|--------------------------------------|----------------|-----------|-----------|------------|
| N (hospital-years)                   | 23,907         | 5,743     | 5,735     | 5,727      |
| Advertising Spend per Year ($)       | mean 0         | 13,980    | 73,069    | 504,791    |
|                                      | SD 0           | 10,280    | 28,781    | 664,628    |
| Net Income ($)                       | mean 107,588   | 9,778,111 | 13,948,016| 29,547,849 |
|                                      | SD 51,279,352  | 43,622,375| 38,505,013| 59,734,159 |
| Total Current Assets ($)             | mean 30692060  | 69108265  | 84615859  | 173502109  |
|                                      | SD 82795799    | 143436699 | 154550410 | 268916761  |
| All Inpatient Discharges             | mean 3,589.34  | 7,910.79  | 10,125.61 | 17,286.42  |
|                                      | SD 5,833.40    | 7,936.11  | 9,453.52  | 13,489.75  |
| Beds                                 | mean 84.53     | 164.85    | 202.85    | 334.27     |
|                                      | SD 110.10      | 148.69    | 174.67    | 254.24     |
| Bed Days Available (fully staffed)   | mean 30,334.00 | 59,420.01 | 73,547.17 | 121,243.6  |
|                                      | SD 39,979.31   | 53,978.81 | 63,435.31 | 92,780.07  |
| Occupancy                            | mean 0.41      | 0.52      | 0.56      | 0.65       |
|                                      | SD 0.20        | 0.19      | 0.18      | 0.17       |
| Employees Full Time Equivalents      | mean 496.61    | 969.25    | 1,262.97  | 2,316.31   |
|                                      | SD 817.46      | 1,215.17  | 1,429.40  | 2,360.80   |
| Medicaid Inpatient Day Share¹        | mean 0.16      | 0.19      | 0.19      | 0.21       |
|                                      | SD 0.13        | 0.13      | 0.12      | 0.12       |
| Major Teaching Hospital²            | mean 0.03      | 0.06      | 0.09      | 0.23       |
|                                      | SD 0.16        | 0.24      | 0.29      | 0.42       |
| Non-Profit                           | mean 0.51      | 0.63      | 0.64      | 0.72       |
|                                      | SD 0.50        | 0.48      | 0.48      | 0.45       |
| For-Profit                           | mean 0.20      | 0.24      | 0.25      | 0.17       |
|                                      | SD 0.40        | 0.43      | 0.43      | 0.37       |
| Public                               | mean 0.29      | 0.13      | 0.11      | 0.12       |
|                                      | SD 0.46        | 0.33      | 0.31      | 0.32       |

1. Includes HMO
2. Interns and residents-to-bed > 0.25
### eTable 3. Adjusted Mean Differences in Performance By Year (2013-2015)

|                  | Differences between hospitals that do and do not advertise | Differences between advertising hospitals based on intensity of advertising |
|------------------|-------------------------------------------------------------|--------------------------------------------------------------------------|
|                  | Hospitals that do not advertise | Hospitals that do advertise | Significant differences between advertising groups (p-value)\(^a\) | Low spend | Mid spend | High spend | Significant differences across advertising intensity groups (p-value) \(^b\) |
|                  |                               |                        |                                                                     |          |           |            |                                                      |
| **2015**         |                               |                        |                                                                     |          |           |            |                                                      |
| CAHPS 5-Star Rating | 3.13                           | 3.06                     | 0.56                                                               | 3.03     | 3.01      | 3.14       | 0.008                                                  |
|                  | (1.14)                         | (1.02)                   |                                      | (1.05)   | (1.00)    | (1.00)     |                                                      |
| Mortality Composite | 11.55                          | 10.71                    | 0.004                                                              | 11.10    | 10.89     | 10.14      | 0.046                                                  |
|                  | (3.33)                         | (3.36)                   |                                      | (3.24)   | (3.37)    | (3.39)     |                                                      |
| Overall Readmission Rate | 15.19                          | 15.3                     | 0.34                                                               | 15.22    | 15.30     | 15.39      | 0.67                                                   |
|                  | (0.79)                         | (0.96)                   |                                      | (0.91)   | (0.89)    | (1.07)     |                                                      |
| **2014**         |                               |                        |                                                                     |          |           |            |                                                      |
| Mortality Composite | 12.39                          | 11.65                    | 0.004                                                              | 12.19    | 11.64     | 11.14      | 0.009                                                  |
|                  | (2.98)                         | (2.93)                   |                                      | (2.81)   | (2.73)    | (3.14)     |                                                      |
| Overall Readmission Rate | 15.58                          | 15.62                    | 0.007                                                              | 15.54    | 15.59     | 15.74      | 0.9                                                   |
|                  | (0.87)                         | (1.07)                   |                                      | (1.04)   | (1.03)    | (1.14)     |                                                      |
| **2013**         |                               |                        |                                                                     |          |           |            |                                                      |
| Overall Readmission Rate | 15.97                          | 16.01                    | 0.024                                                              | 15.98    | 15.94     | 16.10      | 0.42                                                   |
|                  | (0.92)                         | (1.19)                   |                                      | (1.19)   | (1.14)    | (1.23)     |                                                      |

**Notes:** Results reflect spending and performance data indicated by the year in each panel. \(^a\) Column reflects p-value from t-test on the coefficient for a dummy variable indicating any advertising spending in a model that controls for hospital beds, net-income and census region. Ordinal logit model used for CAHPS 5-star measure and linear regression model used for mortality and readmissions measures. \(^b\) Column reflects p-value from joint F-test of equality of spending category coefficients from model that controls for number of hospital beds, net-income, and census region. Ordinal logit model used for CAHPS 5-star measure and linear regression model used for mortality and readmissions measures. Standard deviations in parentheses.
**eFigure.** Relationship Between Ventile of Spending and Performance Measures

**Notes:** All plots reflect variables that have been residualized on number of beds, net income, and census region. Spending winsorized above $1 million dollars. P-values reflect test of the null hypothesis that the coefficient from the best fit line is equal to zero.
eTable 4. Relationship Between Ad Spending and Quality Measures

|                       | Overall 5-Star | Overall 5-Star | CAHPS 5-Star | CAHPS 5-Star | Mortality Composite | Mortality Composite | Readmission Rate | Readmission Rate |
|-----------------------|----------------|----------------|--------------|--------------|---------------------|---------------------|------------------|------------------|
| **Ad Spending** ($000s) | 0.000061       | 0.000061       | 0.000070     | 0.00100*     | 0.00051             | 0.000090*         | 0.000021         |                  |
|                       | (0.00003)      | (0.00003)      | (0.00004)    | (0.00030)    | (0.00026)           | (0.000034)         |                  |                  |
| **Number of Beds**    | 0.00090*       | 0.00090*       | 0.00060*     | 0.0026*      | 0.00071*            | 0.000090*         |                  |                  |
|                       | (0.0005)       | (0.0005)       | (0.0003)     | (0.0003)     | (0.00039)           | (0.000090)         |                  |                  |
| **Net Income**        | 1.1e-09***     | 6.7e-10*       | -5.0e-10     | -9.5e-10***  | 0.000090*           | 0.000090*         |                  |                  |
|                       | (2.5e-10)      | (2.8e-10)      | (9.6e-10)    | (1.8e-10)    | (2.5e-10)           | (2.8e-10)          |                  |                  |
| **Constant**          | 3.06***        | 2.93***        | 3.27***      | 2.98***      | 12.5***             | 11.9***            | 15.6***          | 15.8***          |
|                       | (0.014)        | (0.041)        | (0.017)      | (0.046)      | (0.068)             | (0.18)             | (0.013)          | (0.043)          |
| **Census Region Dummies** | No             | Yes            | No           | Yes          | No                  | Yes                | No               | Yes              |

Notes: Coefficients reflect OLS regression model with advertising spending in thousands of dollars.
**eTable 5.** Comparison of Hospital Performance Between Advertisers and Nonadvertisers Within All HRRs

|                      | Overall 5-star rating | CAHPS 5-star rating | Mortality composite | Overall readmission rate |
|----------------------|-----------------------|---------------------|---------------------|-------------------------|
|                      | N         | %   | N         | %   | N         | %   | N         | %   |
| Advertisers perform better | 123   | 49% | 119   | 48% | 123   | 49% | 137   | 54% |
| Non-advertisers perform better | 127   | 51% | 127   | 52% | 129   | 51% | 117   | 46% |
| HRRs with hospitals that do and do not advertise | 250 | 246 | 252 | 254 |
| HRRs with no variation in hospital advertising | 54 | 58 | 52 | 50 |
| HRRs with missing performance data | 2 | 2 | 2 | 2 |
| Total                | 306 | 306 | 306 | 306 |
eTable 6. Comparison of Hospital Performance Between Advertisers and Nonadvertisers Within HRRs in Five or More Hospitals

| HRRs with Five or More Hospitals | Overall 5-star rating | CAHPS 5-star rating | Mortality composite | Overall readmission rate |
|----------------------------------|-----------------------|---------------------|---------------------|------------------------|
|                                  | N   | %   | N   | %   | N   | %   | N   | %   |
| Advertisers perform better       | 113 | 49% | 109 | 48% | 110 | 48% | 125 | 54% |
| Non-advertisers perform better   | 117 | 51% | 117 | 52% | 120 | 52% | 107 | 46% |
| HRRs with hospitals that do and do not advertise | 230 | 226 | 230 | 232 |
| HRRs with no variation in hospital advertising | 40 | 44 | 40 | 38 |
| HRRs with missing performance data | 2  | 2  | 2  | 2   |
| Total                            | 272 | 272 | 272 | 272 |

Notes: All percent values reflect using a denominator of HRRs with performance data.
References

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