TECHNICAL APPENDIX

METHODS NOTES

Socioeconomic Status Measure

Evidence suggests that hospital readmission rates vary based on the racial, ethnic, and socioeconomic status mix of patients served by the hospital.[1-4] Linked 2009 MedPAR and Medicare Beneficiary Annual Summary files were used to determine the proportion of hospital patients who self-identified as Black or Hispanic (separately). We also determined the proportion of hospital admissions with Medicaid as the primary payer from the AHA data. The average socioeconomic status indicator for zip codes within the hospital service area was derived from 2006-2010 American Community Survey data using a composite measure of median household income, median value of housing units, proportion of households with interest, dividend, or rental income, proportion of adult residents completing high school, proportion of adult residents completing college, and proportion of employed residents with management, professional, and related occupations.[5, 6]

Matching approach

We used an optimal nonbipartite matching approach[7-9] to carry out a comparison of HRRP penalties between well-staffed hospitals versus otherwise similar hospitals with poor staffing levels. To create matched pairs, we categorized hospitals based on five quintiles of our nurse staffing variable.[7, 10, 11] We estimated a propensity score for each observation using an ordinal logit model.[7, 8] Subsequently, we generated a distance matrix where the distance between any two hospitals in the same nurse staffing quintile was set to infinity to preclude matching

within quintile. The distance formula was adjusted by dividing by the square of the difference in quintile so that the distance between two hospitals became smaller as the staffing quintile difference increased.[7] Thus, we created the optimal set of one-to-one matches that minimized the overall distance between pairs of hospitals while giving preference to pairs that differed most in nurse staffing. We allowed the matching algorithm to ignore up to 5% of outliers hospitals to avoid matching substantially dissimilar hospitals, i.e., hospitals that lack overlap in their distribution of covariates. This would require us to rely on extrapolation for inferences about the average treatment effect of staffing on the penalties.[12, 13] Following matching, we designated the better staffed hospital in each matched pair as having "high" staffing and the more poorly staffed hospital as having "low" staffing. We used Lu, et al.'s[8] *nbpMatching* package in R.

Balance diagnostics and Cross-match test

Before conducting any analysis or looking at any data related to the outcome, we examined balance diagnostics to ensure that our matching procedure resulted in hospital pairings that were equivalent in all respects except for staffing. First, we calculated absolute standardized differences between the high and low staffing groups to evaluate covariate balance after matching.[14] We also used the cross-match test to assess multivariate balance.[15] The cross-match test evaluates how well our matching compares to a randomized control trial in terms of balancing covariates; i.e., was covariate balance across groups with matching roughly similar or greater as that expected when each hospital in the pair is randomly assigned to either the high or low staffing group. The cross-match procedure uses nonbipartite matching to pair hospitals based on the covariates but ignoring treatment (in this case, staffing) category. The test then counts the cross-matches or the instances when a matched pair comprised a treated (high staffing) hospital and a control (low staffing) hospital based on the original matching procedures. The idea is that

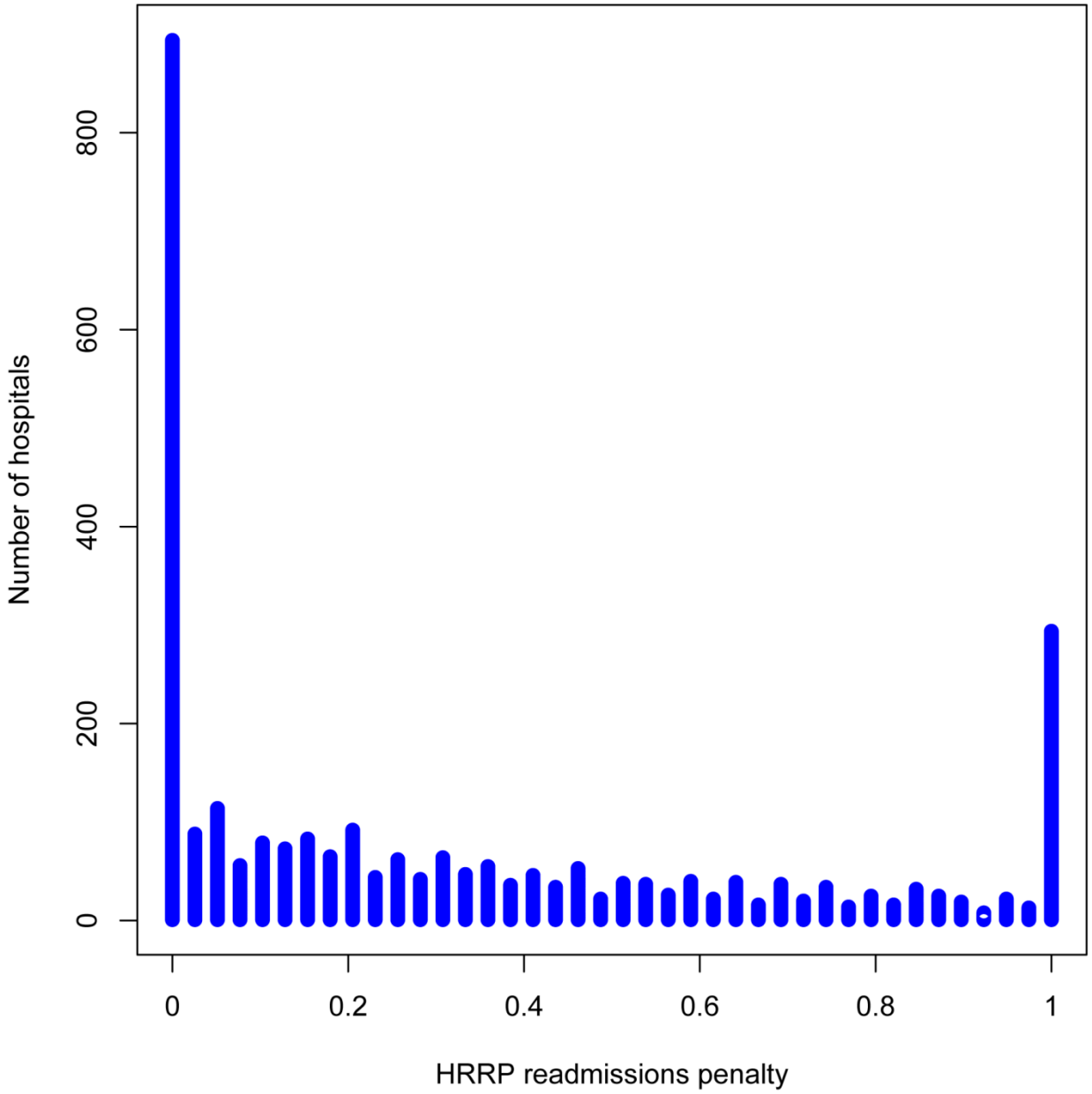
if treated hospitals are rarely paired with control hospitals using covariates alone, the covariate distributions of the treated and control hospitals must differ. The likelihood of a cross-match in a randomized control trial is one half, so any greater proportion of cross-matches signifies greater than expected balance. Our cross-match statistic of 0.60 ($p = 1.00$) indicates good covariate balance and suggests that if two hospitals with the same propensity score were chosen at random, one would have come from the high staffing group and one from the low staffing group 60% of the time — better than the 50% probability expected in a randomized control trial.

Alternative specifications

We repeated analyses specifying the outcome to contrast hospitals that were fully penalized with those penalized less than the full 1%. We also conducted analyses without matching on the skilled nursing facility indicator. We repeated our analysis using FY2012 HRRP data and the September release of FY 2013 data to ensure that our findings were not the result of an isolated occurrence. We also used logistic regression without matching but adjusting for covariates. Each of these model results are presented in Appendix Exhibit C.

APPENDIX EXHIBIT A

Distribution of HRRP Penalties Across Sample Hospitals



SOURCE. Authors' analysis of data from 2,826 hospitals. **NOTES**. Each dot represents one hospital. The x-axis represents the percentage payment reduction where 0 represents no penalty and 1 represents the full 1% penalty.

APPENDIX EXHIBIT B

Characteristics of Hospitals Before and After Matching

Variable	Pre-Matching				Post-Matching				Standardized Difference in Means
	Initial Sample (N=2,976)		Analytic Sample (N=2,826)		Low Staffing (N=1,413)		High Staffing (N=1,413)		(Low vs. High)
	Number or mean	*% or SD*	*Number or mean*	*% or SD*	*Number or mean*	*% or SD*	*Number or mean*	*% or SD*	*%*
Registered nurse hours per adjusted day	6.4	2.5	6.5	2.3	5.1	1.5	8.0	2.0	164.1
Covariate balancing score	—		—		7,170	13,320	7,170	13,320	0
Covariates									
Number of beds	227	204	224	198	219	188	229	207	5.3
Resident/fellow physicians per bed	0.06	0.19	0.05	0.16	0.05	0.14	0.06	0.17	5.6
Operating profit margin	-0.02	0.23	-0.02	0.24	-0.02	0.15	-0.02	0.30	0.9
Percentage Black patients	11.6	15.7	11.6	15.8	11.6	16.0	11.7	15.7	0.9
Percentage Hispanic patients	2.3	5.3	2.4	5.4	2.4	5.7	2.4	5.1	0.5
Percentage Medicaid mix	19.1	12.6	17.7	10.4	17.3	10.6	18.0	10.1	6.3
Socioeconomic status indicator	-0.7	2.5	-0.6	2.5	-0.6	2.6	-0.6	2.4	1.0
Herfindahl-Hirschman Index	772	1,554	766	1,554	802	1,654	729	1,447	4.7
Technology level–no. (%)									3.5
High	1,049	35%	1,025	36%	498	35%	527	37%	
Low	1,927	65%	1,801	64%	915	65%	886	63%	
Ownership–no. (%)									0.4
For-profit	578	19%	575	20%	289	20%	286	20%	
Not-for-profit	2,398	81%	2,251	80%	1,124	80%	1,127	80%	
Geographic location–no. (%)									2.3
Urban	2,655	89%	2,548	90%	1,280	91%	1,268	90%	
Rural	321	11%	278	10%	133	9%	145	10%	
Skilled nursing facility–no. (%)									4.5
Yes	485	16%	360	13%	167	12%	193	14%	
No	2,491	84%	2,466	87%	1,246	88%	1,220	86%	

SOURCE. Authors' analysis of data from all 2,976 hospitals with data and analytic sample of 2,826 hospitals. **NOTES**. Standardized differences represent differences in means in units of standard deviation between the high and low staffing group for each covariate expressed as a percentage.

APPENDIX EXHIBIT C

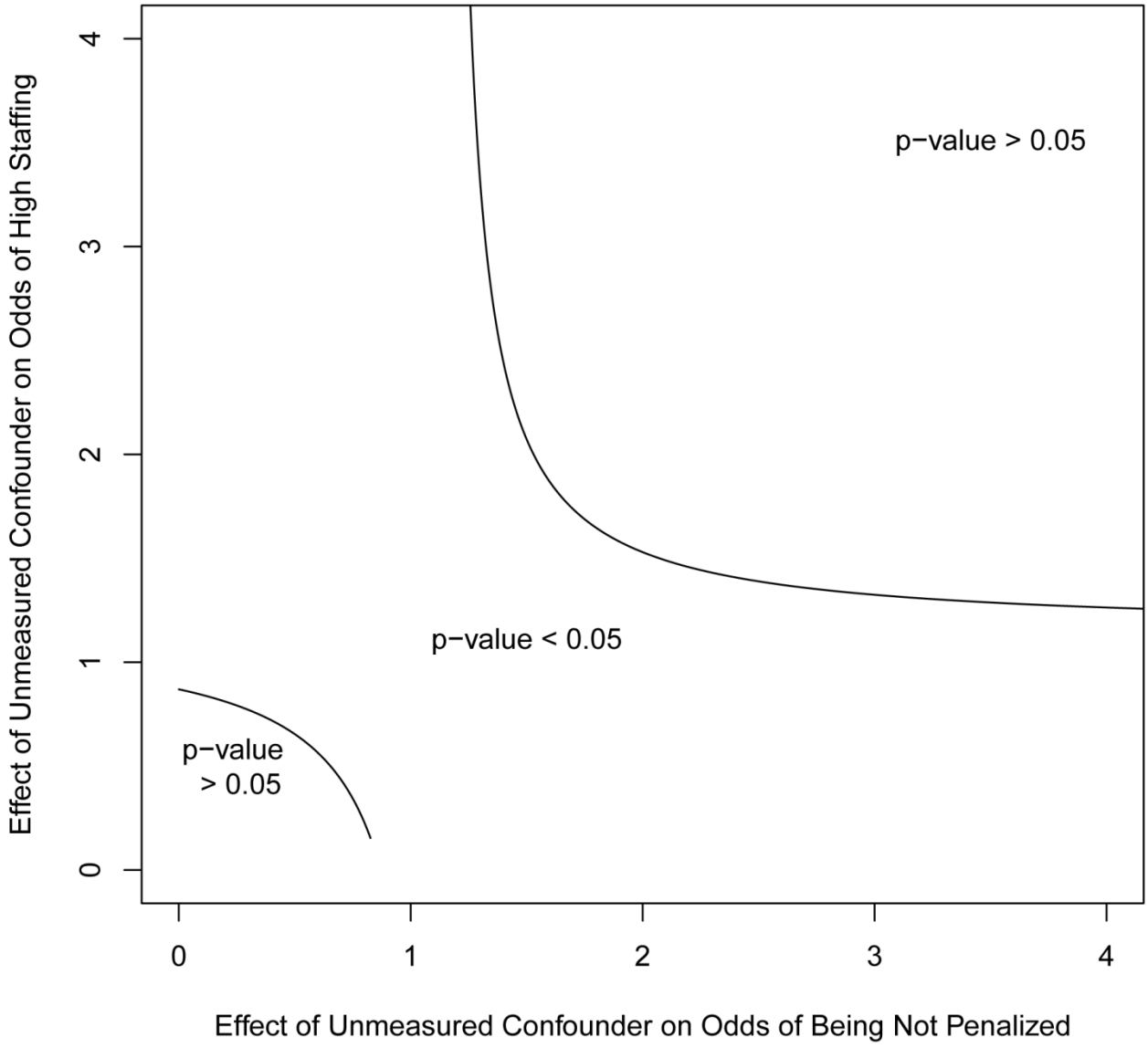
Effect of Registered Nurse Staffing on Odds of FY 2013 Hospital Readmissions Reduction Program Penalty

		Adjusted Through Matching		Adjusted Through Matching and Regression	
	No.	**Odds Ratio (95% CI)**	**P Value**	**Odds Ratio (95% CI)**	**P Value**
High vs. low registered nurse staffing	2826	0.75 (0.63-0.89)	<0.001	0.75 (0.63-0.88)	0.001
Sensitivity Analyses					
1) Full 1% penalty vs. no penalty or < 1% penalty	2826	0.62 (0.48-0.81)	<0.001	0.59 (0.44-0.77)	<0.001
2) Excluding skilled nursing facility variable	2826	0.79 (0.67-0.93)	0.005	0.78 (0.66-0.92)	0.004
3) FY 2013 (September 2012 revision)	2826	0.75 (0.63-0.88)	<0.001	0.74 (0.63-0.88)	0.001
4) FY 2012	2824	0.76 (0.64-0.90)	0.001	0.74 (0.62-0.87)	0.001
5) Logistic regression without matching using all hospitals with data	2976	0.95 (0.92-0.98)	<0.001	0.89 (0.86-0.93)	<0.001
6) Logistic regression without matching using matched hospital sample	2826	0.93 (0.89-0.96)	<0.001	0.90 (0.86-0.93)	<0.001

SOURCE. Author's analysis of data from 2,826 hospitals. **NOTES**. Analyses adjusted through matching are McNemar's test for matched, paired data evaluating the odds of readmissions penalty based on high versus low nurse staffing. The analyses adjusted through matching and regression represent conditional logistic models that reintroduce the covariates that were used for matching as covariates in the estimation of the effect of high versus low staffing on the odds of readmissions penalty. The sensitivity analyses follow the same format except use alternative specifications of the outcome (#1), matching without skilled nursing facility indicator covariate (#2), or different versions of the data (#3 & #4). The results for analysis #5 represent unpaired logistic regression model estimates of the effect of staffing (measured as registered nurse hours per patient day) on the odds of readmission penalty in the sample of all 2,976 hospitals with outcome and covariate data; analysis #6 is the same as #5 but is carried out using the 2,826 hospitals that were in the matched sample.

APPENDIX EXHIBIT D

Sensitivity Analysis to Unmeasured Confounders



SOURCE. Author's analysis of results from data on 2,826 hospitals. **NOTES**. Sensitivity analysis based on how unobserved confounders play a role in the odds of a hospital being not penalized and the odds of the hospital having a high staffing level. The x-axis is how much the odds of the hospital being not penalized increases for a high level of the unmeasured confounder and the y-axis measures how much the odds of the hospital having the high level of staffing increases for a high level of the unmeasured confounder. Points between the two curves correspond to effects by unmeasured confounders that result in a p-value of less than 0.05, meaning that there is strong evidence that high staffing reduces penalization. Any points outside the two curves correspond to effects by unmeasured confounders that result in a p-value of greater than 0.05.

Analysis of patient reported outcomes

APPENDIX EXHIBIT E

Difference in overall patient satisfaction and reports of receiving information about what to do during recovery at home between matched-pairs of high and low staffed hospitals

	Low Staffing (N=1,413)	High Staffing (N=1,413)	Average difference between matched-pairs of hospitals	Standardized Difference in Means
Percentage of patients who gave a rating of 9 or 10 (high)	65%	67%	2%***	28%
Percentage of patients who would definitely recommend the hospital	67%	70%	3%***	28%
Percentage of patients reporting, YES, they were given information about what to do during their recovery at home	81%	82%	1%***	22%

SOURCE. Author's analysis of matched pairs from data on 2,826 hospitals. **NOTES**. ***$p < 0.001$. Standardized differences represent differences in means in units of standard deviation between the high and low staffing group for each covariate expressed as a percentage.

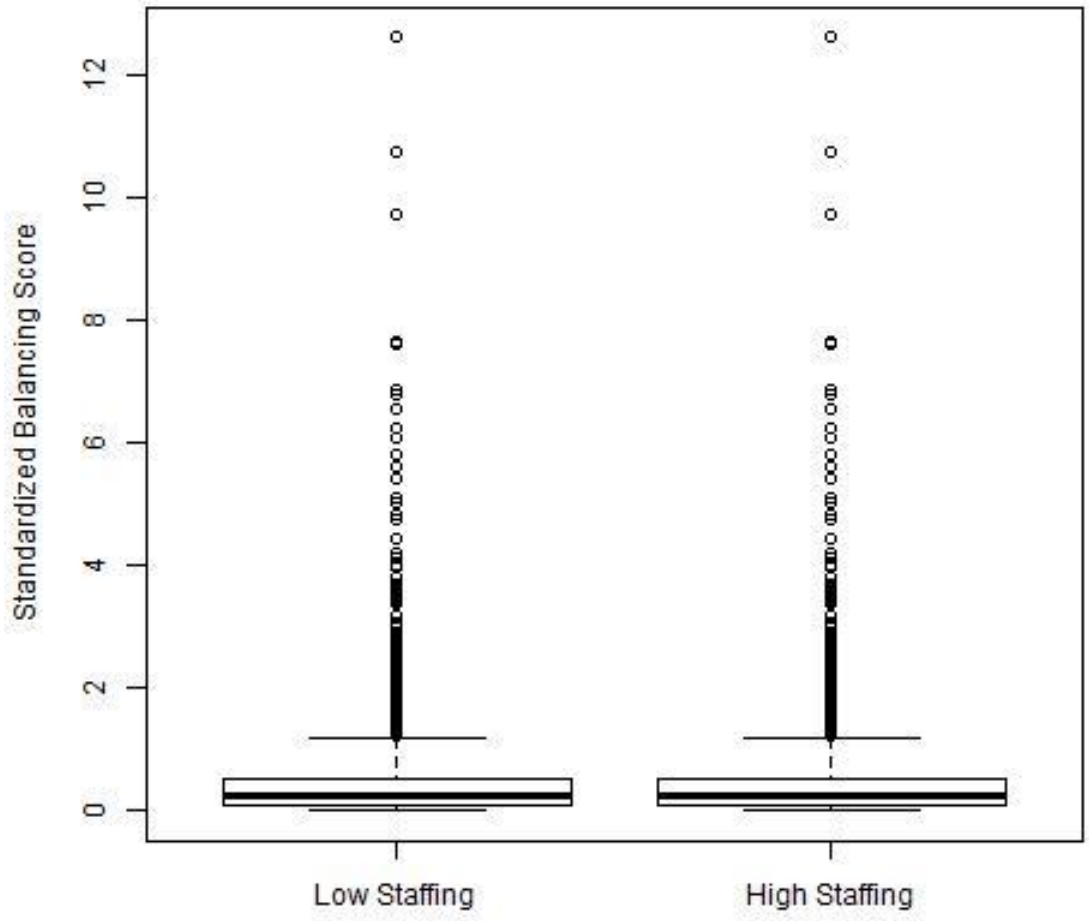
After evaluating whether the likelihood of readmission penalties differed for well-staffed and poorly staffed hospitals, we evaluated whether there was evidence that patient evaluations of care processes that have been suggested to be associated with readmissions and impacted by nurse staffing levels differed in our two groups of hospitals. We used linked data from the Hospital Consumer Assessment of Healthcare Providers and Systems (HCAHPS) survey data from the April 2009 – March 2010 reporting period with our matched set of hospitals. The HCAHPS survey is a national, standardized, publicly reported survey of patients' perspectives of hospital care that are reported on the Hospital Compare database. The data are aggregated and risk-adjusted before release and are reported publicly as a set of ten measures. An overall

HCAHPS score comprises one domain of measurement for determining incentive payments under CMS's Value-Based Purchasing Program.

Our primary goal was to evaluate whether a higher proportion of patients in better staffed hospitals reported being given information about what to do during recovery at home compared to patients in matched poorly staffed hospitals. We also examined overall patient satisfaction using the two global measures from the HCAHPS data: 1) the percentage of patients who gave the hospital a rating of 9 or 10 out of 10 (high), and 2) the percentage of patients who would definitely recommend the hospital to friends and family. We have shown in prior work using earlier HCAHPS data that higher proportions of patients in better staffed hospitals respond positively to these compared to poorly staffed hospitals.[16, 17] We assessed these global outcomes to confirm that the relationship is consistent in this sample of hospitals and because prior research has shown that they are associated with readmissions.[18] After merging these data, we evaluated matched-pair t-tests to determine the average difference in percentages of patients reporting each measure between well-staffed hospitals and their less well-staffed counterparts. The results (appendix exhibit E) indicated small but significant differences between the well-staffed and poorly staffed hospitals pairs for each of the HCAHPS outcomes.

SUPPLEMENTAL EXHIBIT 3

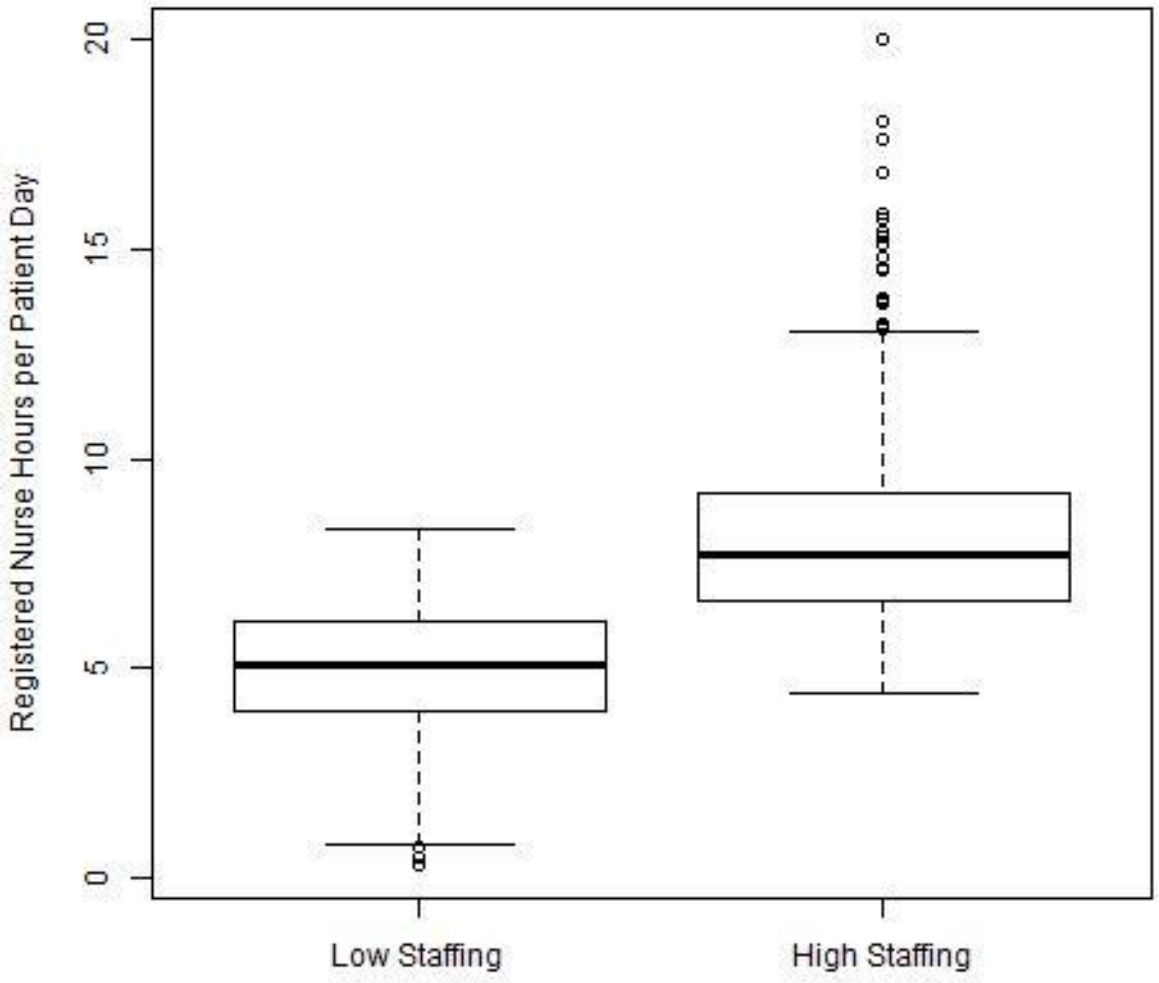
Distribution of Standardized Balancing Score by High and Low Staffed Hospital Groups After Matching



SOURCE. Authors' analysis of data from 2,826 hospitals. **NOTES**. The figure demonstrates the outcome of matching in terms of achieving similarity across the balancing score for the low staffing and high staffing hospital groups.

SUPPLEMENTAL EXHIBIT 4

Distribution of Registered Nurse Hours Per Patient Day by High and Low Staffed Hospital Groups After Matching



SOURCE. Authors' analysis of data from 2,826 hospitals. **NOTES**. The figure demonstrates the outcome of matching in terms of achieving differences in registered nurse staffing levels between the high and low nurse staffing groups.

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```
***The following include full model results for primary analyses
(results presented in the text of the paper) as well as
alternative model specifications (results in Appendix Exhibit C.)
We show both McNemar's and bivariate clogit models for the
matching only models

**********************************************************
********PRIMARY ANALYSIS ************
**********************************************************
****MCNEMARS AND CONDITIONAL LOGISTIC REGRESSION WITH MATCHED PAIRS****
**MCNEMARS WITH MATCHED PAIRS*****

                 | Controls                |
Cases            |   Exposed   Unexposed   |      Total
-----------------+-------------------------+-----------
         Exposed |       728         247   |        975
       Unexposed |       329         109   |        438
-----------------+-------------------------+-----------
           Total |      1057         356   |       1413


McNemar's chi2(1) =     11.67    Prob > chi2 = 0.0006
Exact McNemar significance probability       = 0.0007

Proportion with factor
        Cases       .6900212
        Controls    .7480538     [95% CI]
                    ---------    --------------------
        difference -.0580326     -.0918927  -.0241724
        ratio       .9224219      .8806556   .9661691
        rel. diff. -.2303371     -.3768991  -.0837751

        odds ratio  .7507599      .6339595   .8881562   (exact)

**********************************************************
**********************************************************
****CLOGIT VERSION OF PRIMARY ANALYSIS**
**********************************************************
Conditional (fixed-effects) logistic regression   Number of obs =   2826
                                                  LR chi2(1)    =  11.71
                                                  Prob > chi2   = 0.0006
Log likelihood = -973.56028                       Pseudo R2     = 0.0060

------------------------------------------------------------------------------
    high | Odds Ratio   Std. Err.      z    P>|z|  [95% CI]
---------+--------------------------------------------------------------------
penalty  |   .7507599   .0632071    -3.40   0.001  .6365576 .8854508
------------------------------------------------------------------------------
```

```
************************************************************
****PRIMARY ANALYSIS*****************************************
**CONDITIONAL LOGISTIC REGRESSION ADJ. WITH MATCHING & REGRESSION
ADJUSTMENT**
************************************************************
************************************************************
```

Conditional (fixed-effects) logistic regression Number of obs = 2826
                                                 LR chi2(13)   = 55.60
                                                 Prob > chi2   = 0.0000
Log likelihood = -951.61811   Pseudo R2   = 0.0284

high	Odds Ratio	Std. Err.	z	P>|z|	[95% CI]	
penalty	.7453978	.0648972	-3.37	0.001	.6284623	.8840909
bdtot	1.022075	.006292	3.55	0.000	1.009817	1.034482
hightech	7.73e	5.48e	3.54	0.000	71767.92	8.32e
resprbed	1.37e	1.52e	3.56	0.000	4.96e	3.78e
ownership	8.96e-08	4.10e-07	-3.55	0.000	1.14e-11	.0007048
margin	186.883	280.6232	3.48	0.000	9.849332	3545.95
urb2	50486.89	158840.7	3.44	0.001	105.9615	2.41e
per_medcaid	1.90e-25	3.11e-24	-3.48	0.000	2.30e-39	1.57e-11
blackp	.0000229	.0000695	-3.52	0.000	5.92e-08	.0088236
hispanicp	2.33e	1.76e	3.48	0.001	90917.95	5.99e
sesi	12.41272	8.835677	3.54	0.000	3.07582	50.09253
snf	9.65e-14	8.26e-13	-3.50	0.000	5.01e-21	1.86e-06
hhi	.9991683	.0002298	-3.62	0.000	.9987179	.9996188

```
***********ALTERNATIVE ANALYSIS #1***************
*********************************************************
*********Full 1% Penalty Vs. No Penalty Or < 1 % Penalty ***
 ****MCNEMARS AND CONDITIONAL LOGISTIC REGRESSION WITH MATCHED PAIRS****
****MCNEMARS WITH MATCHED PAIRS--Full 1% Vs. No Penalty Or < 1 % Penalty

                | Controls              |
Cases           |   Exposed   Unexposed |      Total
----------------+-----------------------+-----------
         Exposed |        12          87 |         99
       Unexposed |       140        1174 |       1314
----------------+-----------------------+-----------
           Total |       152        1261 |       1413

McNemar's chi2(1) =     12.37    Prob > chi2 = 0.0004
Exact McNemar significance probability       = 0.0005

Proportion with factor
        Cases       .0700637
        Controls    .1075725     [95% CI]
                    ---------    --------------------
        difference -.0375088     -.0590235  -.0159942
        ratio       .6513158      .5119717   .8285853
        rel. diff. -.0420301      -.065935  -.0181253

        odds ratio  .6214286      .4699631   .8178539   (exact)


*********************************************************
*********************************************************
**CLOGIT VERSION OF PRIMARY ANALYSIS*Full 1% Vs. No Penalty Or < 1 %
Penalty
*********************************************************
*********************************************************
Conditional (fixed-effects) logistic regression Number of obs = 2826
                                                LR chi2(1)    = 12.49
                                                Prob > chi2   = 0.0004
Log likelihood = -973.17226                     Pseudo R2     = 0.0064

------------------------------------------------------------------------
        high | Odds Ratio   Std. Err.      z    P>|z| [95% CI]
-------------+----------------------------------------------------------
     penalty |   .6214286   .0848361    -3.48   0.000 .47554 .8120736
------------------------------------------------------------------------
```

**********ALTERNATIVE ANALYSIS #1**********
****
****
CONDITIONAL LOGISTIC REGRESSION ADJ. WITH MATCHING & REGRESSION ADJUSTMENT
Full 1% Vs. No Penalty Or < 1 % Penalty ********
****

Conditional (fixed-effects) logistic regression Number of obs = 2826
                                                 LR chi2(13) = 58.89
                                                 Prob > chi2 = 0.0000
Log likelihood = -949.97286   Pseudo R2 = 0.0301

high	Odds Ratio	Std. Err.	z	P>|z|	[95% CI]	
penalty	.5854989	.082786	-3.79	0.000	.4437837	.7724686
bdtot	1.022796	.0064183	3.59	0.000	1.010294	1.035453
hightech	1.75e	1.27e	3.58	0.000	124470.4	2.47e
resprbed	5.20e	5.88e	3.61	0.000	1.23e	2.20e
ownership	5.33e-08	2.49e-07	-3.59	0.000	5.69e-12	.0004987
margin	218.2741	334.1061	3.52	0.000	10.86654	4384.427
urb2	70704.35	226717.7	3.48	0.000	131.8309	3.79e
per_medcaid	2.80e-26	4.67e-25	-3.53	0.000	1.83e-40	4.30e-12
blackp	.000015	.0000465	-3.59	0.000	3.49e-08	.0064868
hispanicp	5.56e	4.27e	3.52	0.000	163415.6	1.89e
sesi	13.44559	9.755734	3.58	0.000	3.243192	55.7426
snf	3.59e-14	3.13e-13	-3.55	0.000	1.35e-21	9.57e-07
hhi	.9991367	.0002341	-3.69	0.000	.9986779	.9995958

```
**********ALTERNATIVE ANALYSIS #2***************
*********************************************************
*********************************************************
*MCNEMARS AND CONDITIONAL LOGISTIC REGRESSION WITH MATCHED PAIRS***NOSNF
***MCNEMARS WITH MATCHED PAIRS*********NO SNF
*********************************************************
*********************************************************
                 | Controls              |
Cases            |   Exposed   Unexposed  |      Total
-----------------+-----------------------+-----------
         Exposed |       716         259  |        975
       Unexposed |       328         110  |        438
-----------------+-----------------------+-----------
           Total |      1044         369  |       1413

McNemar's chi2(1) =      8.11    Prob > chi2 = 0.0044
Exact McNemar significance probability       = 0.0050

Proportion with factor
        Cases       .6900212
        Controls    .7388535     [95% CI]
                  ---------     --------------------
        difference -.0488323       -.08305  -.0146145
        ratio       .933908      .8909704    .978915
        rel. diff. -.1869919     -.3271972  -.0467865

        odds ratio  .7896341      .6683083   .9322065   (exact)

*********************************************************
*********************************************************
****CLOGIT VERSION-**NO SNF**
*********************************************************
*********************************************************

Conditional (fixed-effects) logistic regression Number of obs = 2826
                                                LR chi2(1)    = 8.13
                                                Prob > chi2   = 0.0044
Log likelihood = -975.35221                     Pseudo R2     = 0.0042

------------------------------------------------------------
    high | Odds Ratio   Std. Err.      z    P>|z| [95% CI]
---------+--------------------------------------------------
penalty  |   .7896341   .0656384   -2.84  0.004 .6709184 .9293561
------------------------------------------------------------
```

```
**********ALTERNATIVE ANALYSIS #2***************
*********************************************************
*********************************************************
**CONDITIONAL LOGISTIC REGRESSION ADJ. WITH MATCHING (no SNF)
**AND REGRESSION (SNF included as covariate)**
*********************************************************
Conditional (fixed-effects) logistic regression Number of obs= 2826
                                                LR chi2(13)  = 115.28
                                                Prob > chi2  = 0.0000
Log likelihood = -921.77763                     Pseudo R2    = 0.0589

------------------------------------------------------------------
       high | Odds Ratio   Std. Err.      z    P>|z| [95% CI]
------------+-----------------------------------------------------
   penalty  |   .7560385   .0671761    -3.15   0.002 .6352026 .8998612
      bdtot |   1.009026   .0040029     2.27   0.024 1.001211 1.016902
   hightech |   1.16e      8.85e        2.14   0.033 3.827843 3.53e
   resprbed |   7.34e      1.10e        2.13   0.033 12.44244 4.33e
  ownership |   6.06e-06   .0000342    -2.13   0.033 9.40e-11 .3906624
     margin |   22.33093   32.58354     2.13   0.033 1.279088 389.8642
       urb2 |   728.1304   2292.571     2.09   0.036  1.52104 348560.2
per_medcaid |   7.06e-24   1.80e-22    -2.09   0.037 1.36e-45 .0367049
     blackp |   .1486923   .1348526    -2.10   0.036  .025137 .8795565
  hispanicp |   1.44e      2.17e        2.01   0.045 2.058128 1.00e
       sesi |   6.456811   5.616536     2.14   0.032 1.173789 35.51781
        snf |   .3154961   .0403107    -9.03   0.000 .2456047 .4052764
        hhi |   .9993677   .0002888    -2.19   0.029 .9988018 .9999339
------------------------------------------------------------------

 ****CONDITIONAL LOGISTIC REGRESSION ADJUSTED WITH MATCHING (no SNF)
 **AND REGRESSION ADJUSTMENT (NO SNF)******NO SNF MATCHING OR REGRESSION**

Conditional (fixed-effects) logistic regression Number of obs =2826
                                                LR chi2(12)   =21.75
                                                Prob > chi2   =0.0405
Log likelihood = -968.54419                     Pseudo R2     =0.0111

------------------------------------------------------------------
       high | Odds Ratio   Std. Err.    z   P>|z|  [95% CI]
------------+-----------------------------------------------------
   penalty  |   .7791063   .0668009  -2.91  0.004  .6585887 .9216777
      bdtot |   1.008341   .0039536   2.12  0.034  1.000622 1.01612
   hightech |    5503745   4.15e      2.06  0.040  2.080879 1.46e
   resprbed |   2.16e      3.21e      2.07  0.039  4.776689 9.77e
  ownership |   .0000101   .0000566  -2.06  0.040  1.74e-10 .5869334
     margin |   18.56472   26.83052   2.02  0.043  1.092688 315.414
       urb2 |    494.352   1541.977   1.99  0.047  1.093902 223405.7
per_medcaid |   4.22e-23   1.07e-21  -2.04  0.042  1.29e-44 .1382124
     blackp |   .2094934   .1870341  -1.75  0.080  .0364103 1.20536
  hispanicp |   9.20e      1.37e      2.00  0.046  1.733918 4.88e
       sesi |   5.968826   5.143728   2.07  0.038  1.102434 32.31655
        hhi |   .9993997    .000286  -2.10  0.036  .9988392 .9999605
------------------------------------------------------------------
```

```
***********ALTERNATIVE ANALYSIS #3***************
*********************************************************
*****MCNEMARS AND CONDITIONAL LOGISTIC REGRESSION WITH MATCHED PAIRS*****
***** SEPTEMBER DATA
******MCNEMARS WITH MATCHED PAIRS******* SEPTEMBER DATA
*********************************************************
*********************************************************
```

Cases	Controls: Exposed	Controls: Unexposed	Total
Exposed	730	246	976
Unexposed	329	108	437
Total	1059	354	1413

```
McNemar's chi2(1) =     11.98    Prob > chi2 = 0.0005
Exact McNemar significance probability       = 0.0006

Proportion with factor
        Cases       .6907289
        Controls    .7494692     [95% CI]
                   ---------     --------------------
        difference -.0587403      -.092568  -.0249125
        ratio       .9216242      .8799887   .9652295
        rel. diff. -.2344633      -.381972  -.0869545

        odds ratio  .7477204      .6312614   .8847296   (exact)

*********************************************************
*********************************************************
****CLOGIT VERSION***FY2013 - SEPTEMBER DATA RELEASE
*********************************************************
*********************************************************

Conditional (fixed-effects) logistic regression Number of obs=2826
                                                LR chi2(1)   =12.02
                                                Prob > chi2  =0.0005
Log likelihood = -973.40555                     Pseudo R2    =0.0061

------------------------------------------------------------
    high | Odds Ratio   Std. Err.     z  P>|z| [95% CI]
---------+--------------------------------------------------
 penalty |   .7477204   .0630242   -3.45 0.001 .633859 .8820348
------------------------------------------------------------
```

```
**********ALTERNATIVE ANALYSIS #3***************
************************************************************
************************************************************
**CONDITIONAL LOGISTIC REGRESSION ADJ. WITH MATCHING & REGRESSION
***- SEPTEMBER DATA RELEASE
************************************************************
************************************************************
Conditional (fixed-effects) logistic regression   Number of obs=2826
                                                  LR chi2(13)  =55.94
                                                  Prob > chi2  =0.0000
Log likelihood = -951.44903                       Pseudo R2    =0.0286

------------------------------------------------------------
        high | Odds Ratio   Std. Err.     z  P>|z| [95% CI]
-------------+----------------------------------------------
     penalty |   .7418896   .0646958  -3.42 0.001 .6253325 .8801721
       bdtot |   1.022064   .0062907   3.55 0.000 1.009809 1.034469
    hightech |   7.62e      5.40e      3.54 0.000 70966.65 8.18e
    resprbed |   1.34e      1.49e      3.56 0.000 4.88e    3.69e
   ownership |   9.03e-08   4.13e-07  -3.54 0.000 1.15e-11 .0007092
      margin |   186.3128   279.7168   3.48 0.000 9.824468 3533.265
        urb2 |   50174.83   157830.1   3.44 0.001 105.4248 2.39e
per_medcaid |   1.96e-25   3.20e-24  -3.48 0.001 2.39e-39 1.61e-11
      blackp |    .000023   .0000699  -3.51 0.000 5.97e-08 .0088767
   hispanicp |   2.33e      1.75e      3.48 0.001 90932.95 5.96e
        sesi |   12.39519   8.821571   3.54 0.000 3.072265 50.00892
         snf |   9.81e-14   8.39e-13  -3.50 0.000 5.11e-21 1.88e-06
         hhi |   .9991687   .0002298  -3.62 0.000 .9987183 .9996192
------------------------------------------------------------------
```

```
***********ALTERNATIVE ANALYSIS #4***************
*********************************************************
*********************************************************
*****MCNEMARS AND CONDITIONAL LOGISTIC REGRESSION WITH MATCHED
PAIRS*****FY2012
******MCNEMARS WITH MATCHED PAIRS********FY2012
*********************************************************
*********************************************************
                 | Controls              |
Cases            |   Exposed   Unexposed  |      Total
-----------------+------------------------+-----------
         Exposed |       738         241  |        979
       Unexposed |       319         114  |        433
-----------------+------------------------+-----------
           Total |      1057         355  |       1412

McNemar's chi2(1) =     10.86    Prob > chi2 = 0.0010
Exact McNemar significance probability       = 0.0011

Proportion with factor
        Cases       .6933428
        Controls    .7485836     [95% CI]
                   ---------     --------------------
        difference -.0552408     -.0886703  -.0218113
        ratio       .9262062      .8849245   .9694138
        rel. diff. -.2197183     -.3640107  -.0754259

        odds ratio  .7554859      .6364405   .8958611   (exact)


*********************************************************
*********************************************************
****CLOGIT VERSION***FY2012
*********************************************************
*********************************************************


Conditional (fixed-effects) logistic regression Number of obs=2824
                                                LR chi2(1)   =10.90
                                                Prob > chi2  =0.0010
Log likelihood = -973.27397                     Pseudo R2    =0.0056

------------------------------------------------------------
    high | Odds Ratio   Std. Err.    z  P>|z|  [95% CI]
---------+--------------------------------------------------
 penalty |   .7554859   .0644787  -3.29 0.001  .6391143 .8930467
------------------------------------------------------------
```

```
***********ALTERNATIVE ANALYSIS #4***************
*************************************************************
**CONDITIONAL LOGISTIC REGRESSION ADJ. WITH MATCHING & REGRESSION
***FY2012
*************************************************************
*************************************************************
Conditional (fixed-effects) logistic regression Number of obs=2824
                                                LR chi2(13)  =73.31
                                                Prob > chi2  =0.0000
Log likelihood = -942.07054                     Pseudo R2    =0.0375

------------------------------------------------------------------
       high | Odds Ratio   Std. Err.      z    P>|z|  [95% CI]
------------+-----------------------------------------------------
    penalty |   .7354047   .0651205   -3.47   0.001  .6182327   .874784
      bdtot |   1.029829   .0067896    4.46   0.000  1.016608  1.043223
   hightech |   6.47e      4.94e       4.47   0.000  2.05e     2.04e
   resprbed |   1.75e      2.09e       4.46   0.000  1.09e     2.79e
  ownership |   3.99e-10   1.94e-09   -4.45   0.000  2.87e-14  5.56e-06
     margin |   5757.213   11046.81    4.51   0.000  133.9513  247444.5
       urb2 |    4010126   1.38e       4.43   0.000  4836.205  3.33e
per_medcaid |   6.84e-34   1.19e-32   -4.40   0.000  1.13e-48  4.14e-19
     blackp |   2.84e-07   9.66e-07   -4.43   0.000  3.61e-10  .0002235
  hispanicp |   1.42e      1.28e       4.40   0.000  3.26e     6.23e
       sesi |   29.34076   22.17025    4.47   0.000  6.672563  129.0179
        snf |   1.25e-18   1.16e-17   -4.45   0.000  1.65e-26  9.50e-11
        hhi |   .9988998    .000247   -4.45   0.000  .9984158  .9993841
------------------------------------------------------------------
```

```
**********ALTERNATIVE ANALYSIS #5***************
*********************************************************
*********************************************************
**UNMATCHED LOGISTIC REGRESSION EVALUATING EFFECT OF HRS/PATIENT DAY ON
PENALTY
**USING 2976 HOSPITALS THAT HAD OUTCOME AND COVARIATE DATA****
*********************************************************
*********************************************************

Logistic regression                     Number of obs   =   2976
                                        LR chi2(1)      =  11.15
                                        Prob > chi2     =  0.0008
Log likelihood = -1762.5555             Pseudo R2       =  0.0032

------------------------------------------------------------
 penalty  | Odds Ratio   Std. Err.    z   P>|z|  [95% CI]
----------+-------------------------------------------------
  hrs_day |   .9467159   .0155177  -3.34  0.001   .916785  .9776239
    _cons |    3.63677   .4157734  11.29  0.000  2.906714  4.550188
------------------------------------------------------------

Logistic regression                     Number of obs   =  2976
                                        LR chi2(13)     = 204.82
                                        Prob > chi2     = 0.0000
Log likelihood =  -1665.719             Pseudo R2       = 0.0579

------------------------------------------------------------------
   penalty  | Odds Ratio   Std. Err.    z   P>|z|  [95% CI]
------------+-----------------------------------------------------
    hrs_day |   .8997855   .0183749  -5.17  0.000  .8644826  .93653
      bdtot |   1.000952   .0003329   2.86  0.004    1.0003  1.001605
   hightech |   .7409915   .0839291  -2.65  0.008  .5934731  .9251782
   resprbed |   3.836227   1.494707   3.45  0.001  1.787521  8.232989
  ownership |   .5886687   .0719417  -4.34  0.000  .4632814  .7479922
     margin |   1.156952   .2181799   0.77  0.439  .7994553  1.674312
       urb2 |     .93687    .138997  -0.44  0.660  .7004746  1.253044
per_medcaid |   .6962138   .2814595  -0.90  0.370  .3152289  1.537656
     blackp |   21.75037   8.975031   7.46  0.000  9.687875  48.83203
  hispanicp |   25.48487   26.21186   3.15  0.002  3.394685  191.3223
       sesi |    1.01698   .0198812   0.86  0.389  .9787508  1.056703
        hhi |   .9999795   .0000275  -0.75  0.456  .9999257  1.000033
        snf |   .7298916   .0908025  -2.53  0.011  .5719582  .9314348
      _cons |   5.652269   1.324586   7.39  0.000   3.57065  8.947432
------------------------------------------------------------------
```

```
***********ALTERNATIVE ANALYSIS #6***************
*********************************************************
*********************************************************
**UNMATCHED LOGISTIC REGRESSION EVALUATING EFFECT OF HRS/PATIENT DAY
**ON PENALTY USING 2826 MATCHED HOSPITALS ONLY**
*********************************************************

Logistic regression                       Number of obs   =   2826
                                          LR chi2(1)      =  18.62
                                          Prob > chi2     = 0.0000
Log likelihood = -1668.9366               Pseudo R2       = 0.0055

------------------------------------------------------------------
 penalty  | Odds Ratio   Std. Err.      z    P>|z|     [95% CI]
----------+-------------------------------------------------------
  hrs_day |   .9257766   .0165337    -4.32   0.000     .8939318   .9587558
    _cons |   4.264816   .5413265    11.43   0.000     3.325513   5.469429
------------------------------------------------------------------


Logistic regression                       Number of obs   =  2826
                                          LR chi2(13)     = 206.45
                                          Prob > chi2     = 0.0000
Log likelihood = -1575.0227               Pseudo R2       =0.0615

------------------------------------------------------------------
   penalty  | Odds Ratio   Std. Err.      z    P>|z|     [95% CI]
------------+-----------------------------------------------------
    hrs_day |   .8963059    .018683    -5.25   0.000     .8604257   .9336822
      bdtot |   1.000664   .0003424     1.94   0.052     .9999932   1.001335
   hightech |   .7659572   .0876939    -2.33   0.020     .6119994   .9586454
   resprbed |   7.873335   4.007368     4.05   0.000      2.90345   21.35026
  ownership |   .5840313   .0717028    -4.38   0.000     .4591265   .7429165
     margin |    1.21777   .2286369     1.05   0.294     .8428528   1.759457
       urb2 |   .8221062   .1329059    -1.21   0.226     .5988504   1.128593
per_medcaid |   .7721201   .3945263    -0.51   0.613     .2836291   2.101934
     blackp |   25.83541   11.22091     7.49   0.000     11.02856   60.52179
  hispanicp |   17.71427   18.07265     2.82   0.005     2.398286   130.8415
       sesi |    1.02578    .020529     1.27   0.203     .9863228   1.066816
        hhi |   .9999803   .0000282    -0.70   0.485     .9999251   1.000036
        snf |   .7918039   .1044381    -1.77   0.077     .6114276   1.025393
      _cons |   6.571581   1.595571     7.75   0.000     4.083187   10.57646
------------------------------------------------------------------
```