Supplemental material for "The early effects of Medicare's mandatory hospital pay-for-performance program on quality"

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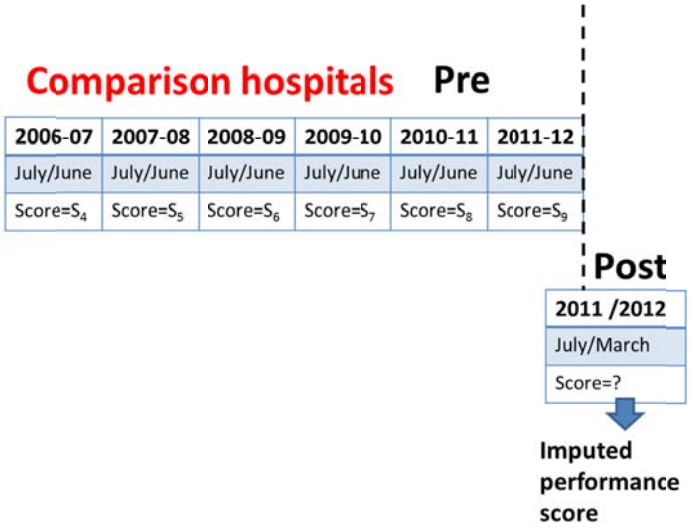
Data availability and imputation of quality data for the post-HVBP period

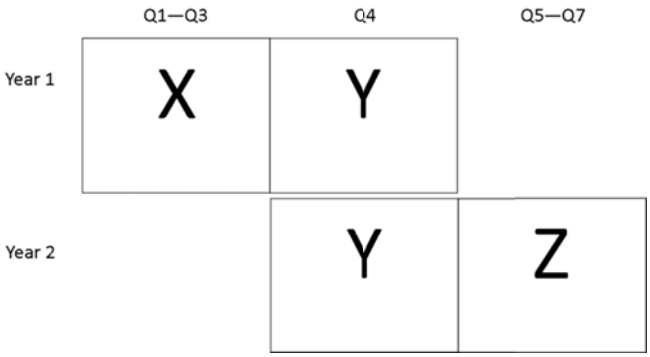
Data for discharges during the first post-HVBP implementation period (July 1, 2011 – March 31, 2012) were not publicly available on Hospital Compare (www.hospitalcompare.hhs.gov) for hospitals that did not participate in Hospital Value Based Purchasing. Figure A1 below shows the data that were available for these hospitals.

Figure A1. Hospital Compare data used for analysis



To address the fact that data were not reported for the precise post-HVBP period for comparison hospitals, we imputed quality performance for these hospitals during this interval using data from overlapping periods of hospital discharges (July 1, 2010 - June 30, 2011: April 1, 2011 - March 31, 2012). Between the last year of the pre-HVBP period (Q1-Q4) and the first 3 quarters of the post-HVBP period (Q5-Q7), we have access to hospital quality data over 7 quarters (Q1-Q7), including one overlapping quarter (Q4). See Figure A2 for a visual depiction of these data.

Figure A2. Data schematic for post-HVBP imputation



Because we do not have data for discharges in the Q5-Q7, we want to use the data we do have to solve for each hospital's score in quarters Q5-Q7. To do this, we assume that, pooling the data for both years of data (Q1-Q4: Q4-Q7), discharges are distributed equally across each quarter:

Figure A3. Depiction of imputation strategy

	Q1	Q2	Q3	Q4	Q5	Q6	Q7
% of discharges Q1-Q4	12.5%	12.5%	12.5%	12.5%			
% of discharges Q4-Q7				12.5%	12.5%	12.5%	12.5%

For a given hospital, we also assume that scores for the overlapping quarter (Q_4) are equal to the mean score for the two 4 quarter periods (Q1-Q4: Q4-Q7):

(1) $0.375 * \text{Score}_{Q1\text{-}Q3} + 0.25 * \text{Score}_{Q4} + 0.375 * \text{Score}_{Q5\text{-}Q7} = 0.50 * \text{Score}_{Year\ 1} + 0.50 * \text{Score}_{Year\ 2} = \text{Score}_{Q4}$

With these assumptions, we can solve for the score in quarters Q5-Q7 as follows:

(2) $\text{Score}_{Year\ 2} = 0.25 * \text{Score}_{Q4} + 0.75 * \text{Score}_{Q5\text{-}Q7}$

(3) $\text{Score}_{Year\ 2} - (0.25 * \text{Score}_{Q4}) = 0.75 * \text{Score}_{Q5\text{-}Q7}$

(4) $\text{Score}_{Q5\text{-}Q7} = (\text{Score}_{Year\ 2} - (0.25 * \text{Score}_{Q4}))/0.75$

We solved for these scores for each measure for each hospital in the sample, and used these as the post-HVBP scores in our analysis.

For the incentivized clinical process performance measures, the levels of performance for each measure were reported for each hospital on Hospital Compare, and we used these data in our analysis. For the patient experience measures, only the "achievement" and "improvement" points were publicly reported on Hospital Compare. Using published data on the achievement "benchmarks" and "thresholds," we converted achievement points to levels of performance. To do this, we identified the performance range associated with each achievement point for each measure, and set hospitals' scores to the midpoint of this range. To preserve the underlying variance of the level of performance, we then added random variation to the assigned midpoint, while ensuring that this added random variation did not result in hospitals' receiving a different achievement point value. For measures with achievement scores of 0 or 10, which did not have an associated range of performance, we imputed performance using the procedure described above for hospitals that were not subject to Hospital Value-Based Purchasing.

Descriptive statistics for the clinical process and patient experience measures in HVBP

Exhibit A1 shows the number of hospital-level observations and the means and standard deviations of each of the incentivized clinical process and patient experience measures during our pre and post-HVBP study periods.

Tests for trends in performance

The presence of common trends between treatment and comparison groups is an assumption of difference-in-differences analysis. We estimated the linear trends in performance for hospitals exposed to HVBP, all comparison hospitals, and the matched comparison cohorts over the pre-intervention period. Table A2 shows that, for the clinical process measures, trends were significantly different between hospitals exposed to HVBP and all comparison hospitals, but not different between hospitals exposed to HVBP and the matched comparison group. For the patient experience measures, pre-intervention trends in performance were not different between hospital exposed to HVBP, all comparison hospitals, and the matched comparison hospitals.

Effects of HVBP on individual measures

To assess variation in the effects of HVBP across performance measures, we re-estimated our models separately for each clinical process and patient experience measure. The specifications were identical to Equation 1. Table A3 shows that HVBP was significantly associated with improved performance for the two clinical process measures related to pneumonia (*blood cultures performed in the ED prior to initial antibiotic received in hospital* and *patients receiving appropriate initial antibiotic selection*). However, these effects were driven primarily by differences in performance between hospitals exposed and not exposed to HVBP prior to the start of the program (Figure A4). Hospital Value-Based Purchasing was not associated with improved performance for any of the patient experience measures.

Excluding hospitals in the Hospital Quality Incentive Demonstration

Sensitivity analysis that excluded the hospitals that participated in the Hospital Quality Incentive Demonstration yielded nearly identical results (Table A4).

Anticipation analysis for patient experience analysis

Figure A6 shows the results for analysis that assumed that the effects of HVBP began either 1 or 2 years prior to the commencement of financial incentives in the program. It shows no evidence that hospitals that were ultimately exposed to HVBP improved patient experience performance in advance of the program.

Table A1. Performance measures for first year of Hospital Value-Based Purchasing

		Pre-HVBP (July 2005-June 2011)		Post-HVBP (July 2011-March 2012)	
Measure type	**Measure**	N hospital observations	Mean (Sd)	N hospital observations	Mean (Sd)
Clinical process	AMI patients receiving fibrinolytic therapy within 30 minutes of hospital arrival *	290	59.6 (21.7)	6	88.1 (10.5)
	AMI patients receiving primary PCI within 90 minutes of hospital arrival *	6,778	80.2 (18.7)	1,443	93.8 (8.3)
	Heart failure patients receiving discharge instructions *	16,243	81.7 (18.1)	3,169	91.7 (11.3)
	Blood cultures performed in the ED prior to initial antibiotic received in hospital for pneumonia patients *	16,154	93.4 (6.2)	3,207	97.0 (3.9)
	Pneumonia patients receiving appropriate initial antibiotic selection *	16,375	90.3 (7.4)	3,238	94.8 (6.4)
	Surgery patients on a beta blocker prior to arrival that received a beta blocker during the perioperative period *	8,803	91.6 (10)	2,979	95.4 (7.3)
	Prophylactic antibiotic received within one hour prior to surgical incision *	16,879	91.4 (11.1)	3,330	97.6 (4.7)
	Prophylactic antibiotic selection for surgical patients *	16,873	94.8 (7.8)	3,330	97.8 (3.8)
	Prophylactic antibiotics discontinued within 24 hours after surgery end time *	16,828	88.2 (13.2)	3,325	96.6 (5.2)
	Cardiac surgery patients with controlled 6am postoperative serum glucose *	4,564	91.5 (7.6)	1,148	95.5 (4.0)
	Surgery patients with recommended venous thromboembolism prophylaxis ordered *	16,736	89.0 (13.4)	3,389	96.9 (7.2)
	Surgery patients who received appropriate venous thromboembolism prophylaxis within 24 hours prior to	16,714	86.6 (14.2)	3,385	96.3 (7.0)

		Pre-HVBP (July 2005-June 2011)		Post-HVBP (July 2011-March 2012)	
Measure type	**Measure**	N hospital observations	Mean (Sd)	N hospital observations	Mean (Sd)
	surgery to 24 hours after surgery *				
	Overall clinical process*	153,237	89.2 (13.0)	31,949	95.9 (6.9)
Patient experience	Patients who reported that their room were clean and quiet *	14,531	63.5 (8.2)	3,618	65.5 (7.4)
	Patients who reported that their nurses communicated well *	14,531	74.9 (6.4)	3,618	77.3 (5.4)
	Patients who reported that their doctors communicated well *	14,531	79.8 (5.6)	3,618	80.6 (5.0)
	Patients who reported that they received help as soon as they wanted *	14,531	62.8 (9.2)	3,618	65.3 (8.4)
	Patients who reported that their pain was well controlled *	14,531	68.7 (5.8)	3,618	70 (5.1)
	Patients who reported that staff explained about medicines before giving it to them *	14,531	59.6 (6.7)	3,618	62.2 (5.9)
	Patients at each hospital who reported that YES, they were given information about what to do during their recovery at home *	14,531	81.3 (5.2)	3,618	83.7 (4.4)
	Patients who gave their hospital a rating of 9 or 10 on a scale from 0 (lowest) to 10 *	14,531	65.9 (9.4)	3,618	68.9 (8.5)
	Overall patient experience*	116,248	69.6 (10.5)	28,944	71.7 (9.8)

*$p < .01$ for test of difference is scores across pre and post HVBP periods

Note: Includes data from all hospitals exposed to HVBP and comparison hospitals that met inclusion criteria

Note: Pre-HVBP patient experience measures are from 2007/2008 – 2010/2011

Table A2. Trends in clinical process and patient experience performance prior to start of HVBP

	Process performance		Patient experience	
Cohort	Exposed to HVBP	Not exposed	Exposed to HVBP	Not exposed
All hospitals	3.24	2.71***	0.79	0.74
	(3.16, 3.31)	(2.44, 2.97)	(0.74, 0.84)	(0.61, 0.88)
Matched comparison	3.23	3.28	0.80	0.62
	(3.16, 3.30)	(2.94, 3.62)	(0.74, 0.85)	(0.31, 0.93)

***Difference between hospitals exposed to HVBP and not exposed to HVBP different at $p < .01$

Note: 95% confidence intervals shown in ()

Note: Process performance data from 2006/7 – 2010/11; Patient experience data from 2007/8 – 2010/11.

Table A3. Effects of HVBP for individual measures

Measure	N hospitals	Estimate
AMI patients receiving fibrinolytic therapy within 30 minutes of hospital arrival	Not enough hospitals reporting	.
AMI patients receiving primary PCI within 90 minutes of hospital arrival	568	2.16 (-3.78, 8.09)
Heart failure patients receiving discharge instructions	2,874	2.16 (-0.80, 5.12)
Blood cultures performed in the ED prior to initial antibiotic received in hospital for pneumonia patients	2,868	1.38*** (0.53, 2.23)
Pneumonia patients receiving appropriate initial antibiotic selection	2,901	1.13** (0.08, 2.17)
Surgery patients on a beta blocker prior to arrival that received a beta blocker during the perioperative period	2,797	1.51* (-0.27, 3.29)
Prophylactic antibiotic received within one hour prior to surgical incision	2,975	0.66 (-0.52, 1.83)
Prophylactic antibiotic selection for surgical patients	3,006	0.60* (-.01, 1.21)
Prophylactic antibiotics discontinued within 24 hours after surgery end time	2,995	1.21 (-0.48, 2.89)
Cardiac surgery patients with controlled 6am postoperative serum glucose	563	-1.58 (-5.46, 2.31)
Surgery patients with recommended venous thromboembolism prophylaxis ordered	3,021	-0.04 (-1.29, 1.21)
Surgery patients who received appropriate venous thromboembolism prophylaxis within 24 hours prior to surgery to 24 hours after surgery	3,022	1.27* (-0.16, 2.69)
Patients who reported that their room and bathroom were clean and quiet	3,082	-0.29 (-0.76, 0.19)
Patients who reported that their nurses communicated well	3,037	-0.44 (-1.02, 0.14)
Patients who reported that their doctors communicated well	3,017	-0.05 (-0.55, 0.46)
Patients who reported that they received help as soon as they wanted	3,057	-0.45 (-0.96, 0.07)
Patients who reported that their pain was well controlled	3,054	0.06 (-0.26, 0.37)
Patients who reported that staff explained about medicines before giving it to them	3,050	-0.51**

Measure	N hospitals	Estimate
		(-0.94, -0.09)
Patients at each hospital who reported that YES, they were given information about what to do during their recovery at home	3,096	0.15 (-0.21, 0.50)
Patients who gave their hospital a rating of 9 or 10 on a scale from 0 (lowest) to 10	3,079	-0.09 (-0.47, 0.30)

*$p<.05$

Note: 95% Confidence intervals are shown in ()

Note: estimates are based on difference-in-differences models with matched comparison groups

Table A4. Sensitivity estimates of effects of Hospital Value-Based Purchasing on clinical process and patient experience performance, excluding hospitals in the Hospital Quality Incentive Demonstration

	Specification features			**Model Results**		
Estimate	Outcome	Comparison group	Control for measure mix	Number of hospitals	Number of observations	Effect Estimate (95% CI)
1	Process	All non-exposed hospitals	No	2,839	17,034	0.61
						(-0.07, 1.30)
2	Process	All non-exposed hospitals	Yes	2,839	17,034	0.27
						(-0.41, 0.95)
3	Process	Propensity score matched	No	2,809	16,854	0.16
						(-0.59, 0.92)
4	Process	Propensity score matched	Yes	2,809	16,854	-0.20
						(-0.97, 0.57)
5	Patient experience	All non-exposed hospitals	No	2,928	11,712	0.17
						(-0.11, 0.45)
6	Patient experience	Propensity score matched	No	2,814	11,256	-0.32
						(-0.79, 0.15)

Note 1: ***$p<.01$, **$p<.05$

Figure A4. Results from individual process measures

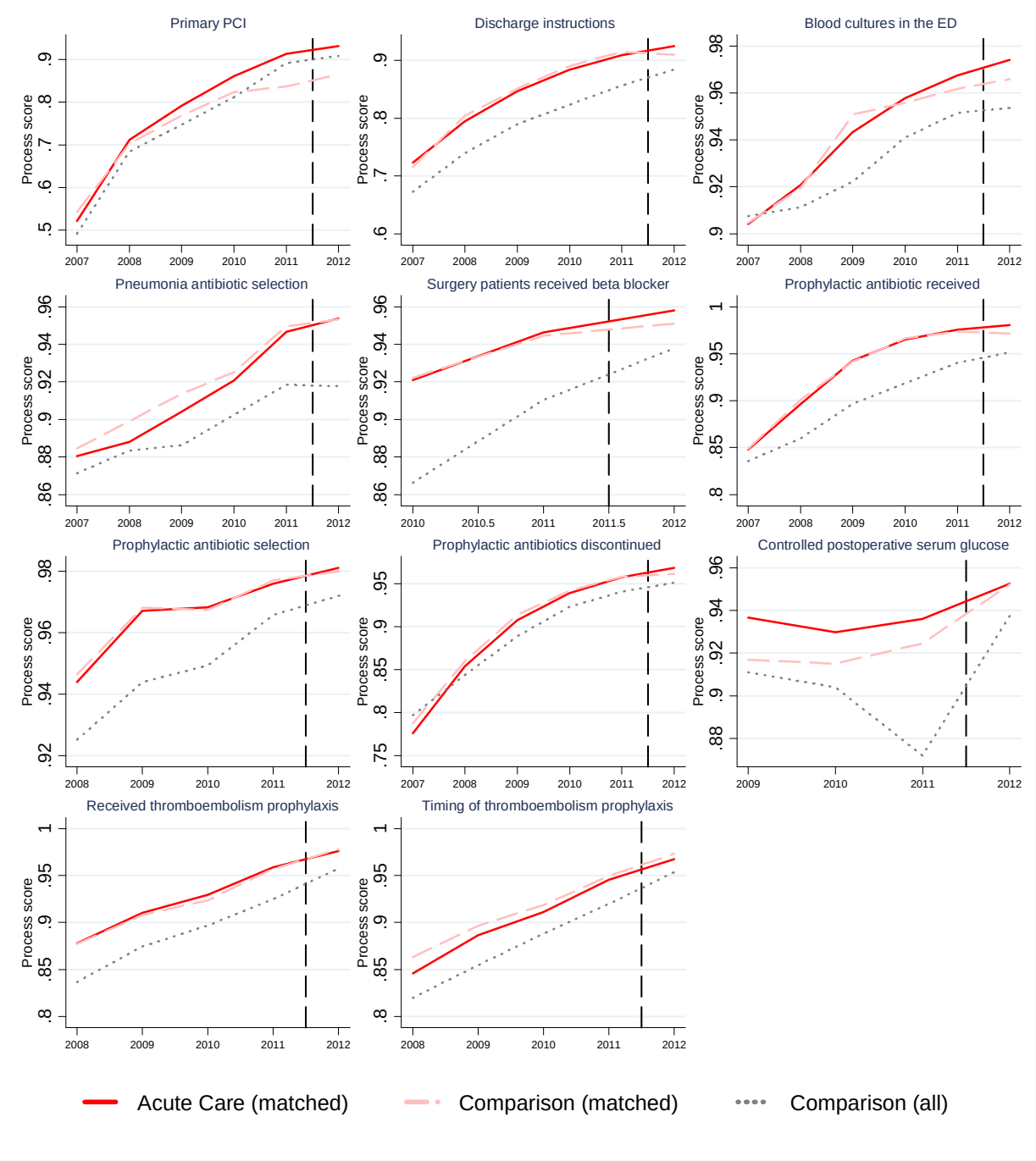


Figure A5. Results from individual patient experience measures

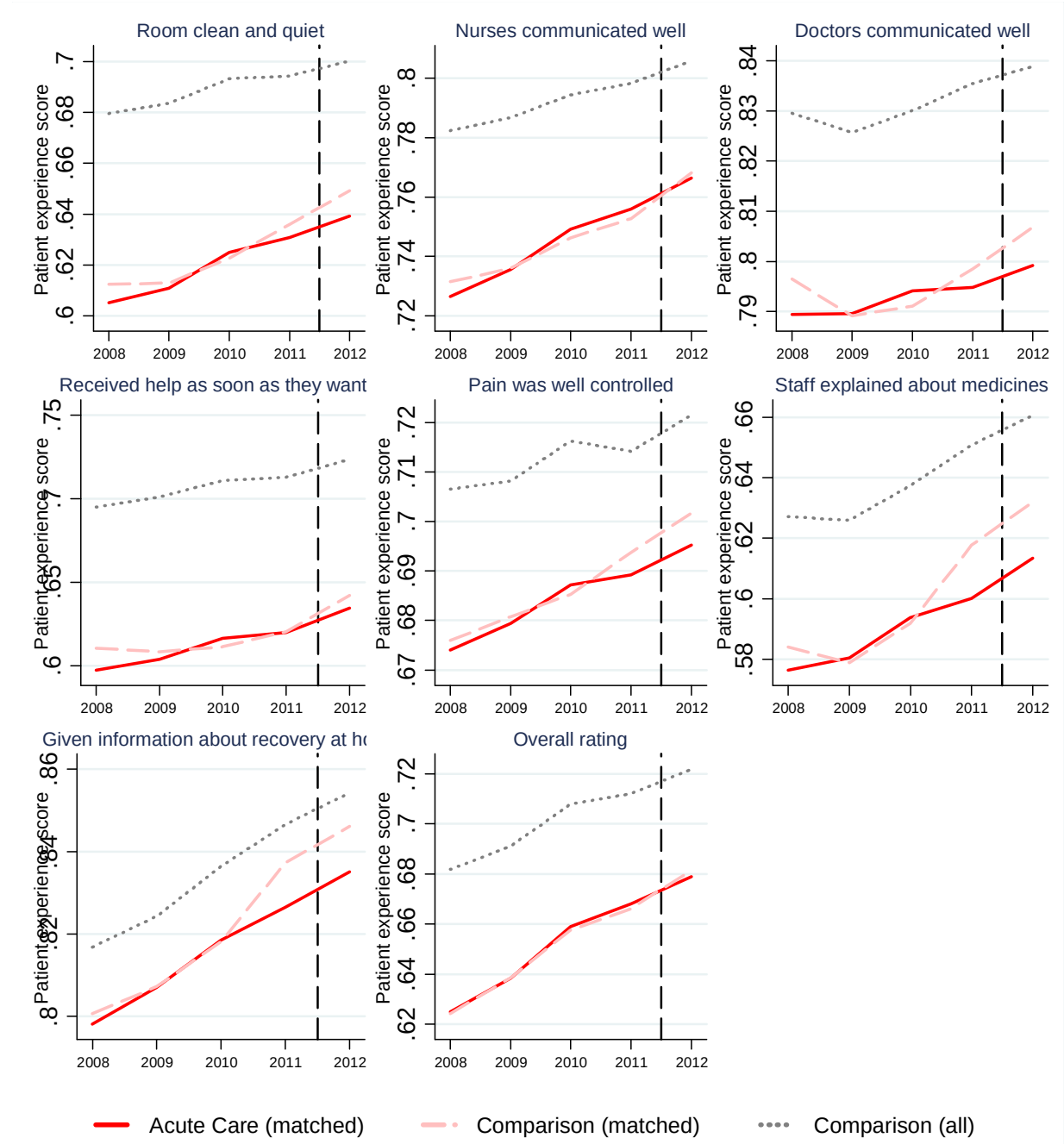


Figure A6. Estimated effects of Hospital Value-Based Purchasing on patient experience performance assuming effects began between 2009/10 and 2011/12