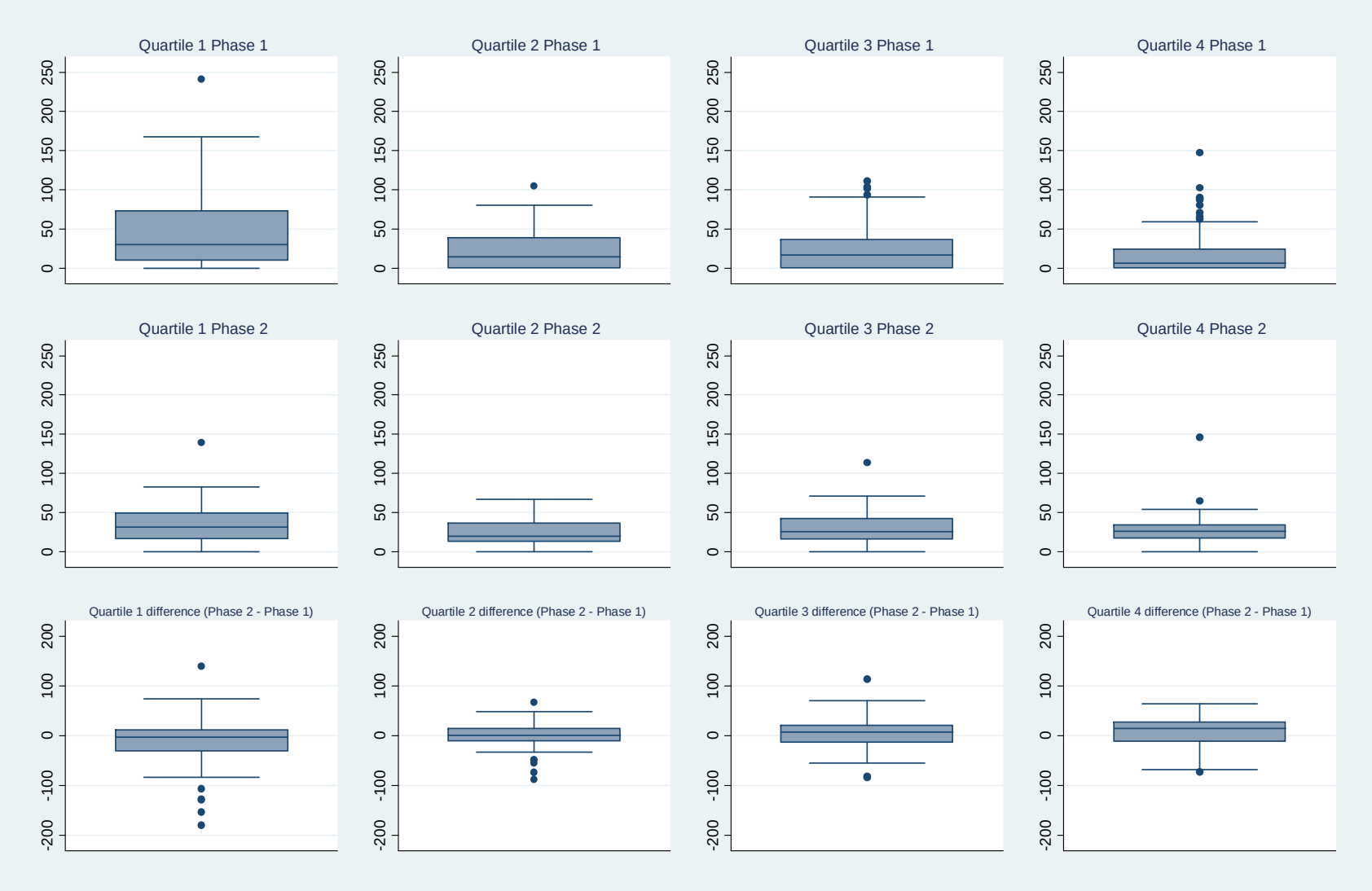
Appendix A. Distribution of Incentive payments

Figure 1. Distribution of incentive payments per discharge (in $) across Medicaid discharge quartiles during Phase 1 and Phase 2 of HQID



Note: Quartile 1 hospitals have the lowest Disproportionate Share Index values, indicating the least disadvantage

Appendix B. Sensitivity Analysis

We performed a number of additional analyses to determine whether our results were sensitive to alternative specifications.

Using the proportion of Medicaid discharges instead of the Disproportionate Share Index to operationalize socioeconomic disadvantage

We used the proportion of discharges from Medicaid patients as an alternative to DSH as a measure of socioeconomic disadvantage. Table B1 shows the results of this analysis. Compared to the analysis using DSH (Table 2 from the manuscript), when operationalizing socioeconomic disadvantage using the proportion of Medicaid admissions, there are somewhat smaller gaps in incentive payments in Phase 1 and somewhat smaller reductions in these gaps during Phase 2 (as seen by the difference-in-differences estimates), although the pattern of findings is very similar.

Excluding hospitals that were members of the Council of Teaching Hospitals

To examine whether results were sensitive to the inclusion of major teaching hospitals – which frequently have a higher DSH (Table 1) but may also have more resources to improve quality – we reran the analysis, excluding 33 hospitals that were members of the Council of Teaching Hospitals at any time during the five year study period. Table B2 shows that, for hospitals that were not major teaching hospitals, there were larger gaps in incentive payments during Phase 1 and larger reductions in incentive payments during Phase 2, suggesting that the effect of Phase 2 on the distribution of payments was larger among hospitals that were not major teaching hospitals.

Using different exclusions and analysis assumptions for hospitals that ultimately exited the HQID

To examine whether our results were sensitive to the exclusion of hospitals that exited the HQID, we estimated different models that excluded only observations after these hospitals left the HQID and models with an intent-to-treat assumption, which set incentive payments to 0 after hospitals left the HQID.

We examined whether hospitals that ultimately exited the HQID received smaller bonuses and cared for more disadvantaged patients than hospitals that did not ultimately exit the HQID. Table B3 shows that hospitals that ultimately dropped out of the HQID received lower incentive payments in the first year of the program and also had more disadvantaged patients (as seen by the higher value on the DSH index). The hospitals that ultimately exited the HQID are the hospitals that would have been more likely to receive incentive payments after the Phase 2 change in incentive design (higher disadvantage hospitals with lower incentive payments). Further, the 32 hospitals that ultimately exited the program missed a total of 85 years (of the possible 160 years of participation (32 * 5)), and 72% of these missed years occurred in Phase 2. Thus, we have the following facts:

1) The drop-out hospitals would have been more likely to benefit from the design change in Phase 2;

2) These hospitals were assumed to receive no incentive payments after dropping out in our intent to treat analysis

3) For the hospitals dropping out, the majority of observations after dropping out occurred in Phase 2

This leads us to believe that an intent-to-treat analysis, which would assume that the exiting hospitals did not receive incentive payments in Phase 2, is inappropriate.

To address this, we decided to exclude all of the observations from hospitals that ultimately dropped out of the HQID. As a sensitivity to check, we also excluded observations from exiting hospitals only after they withdrew from the HQID. Table B4 shows the difference-in-difference estimates from an intent-to-treat analysis, from the analysis excluding all observations from the exiting hospitals, and from an analysis excluding observations from exiting hospitals only after they withdrew from the HQID. In the latter analysis, the panel is now unbalanced, and with an unbalanced panel, fixed-effects and GEE models yield different results. Consequently, we have shown the results using both fixed effects and GEE.[1]

Table B4 shows that the DID estimates are larger, and tend to have smaller p-values when we do not perform the intent to treat analysis, and instead exclude either all of the observations from hospitals that ultimately drop-out, or exclude the observations from hospitals after dropping out. The DID estimates are generally similar when excluding all observations (GEE model on balanced panel) and the two specifications excluding some observations (GEE and fixed-effects on unbalanced panel).

To evaluate the consistency of the GEE and FE estimates from the unbalanced panel, we performed a test of sample attrition bias in both specifications using the procedure described by Wooldridge (p.581). In essence, this procedure involves estimating the panel model while including a dummy variable equal to 1 for drop-out hospitals in the period before they dropped out. If this variable is significant, it suggests bias because time-varying attrition is correlated with the error term. The results from this test indicate that, for each dependent variable, the GEE models with the unbalanced panel are biased by sample attrition ($p < .05$), but that the FE models perform better, with only marginal evidence of bias for one of the dependent variables (receipt of any payment: $p < .10$).

In addition, Table 2 shows that the results from the GEE models that exclude all observations from the exiting hospitals and the fixed-effects models that exclude only the observations from exiting hospitals after they withdraw (shown to be consistent), are virtually identical. This gives us reason to believe that the GEE estimates from the balanced panel that exclude all observations from exiting hospitals are good estimates of the overall program effect. Consequently, we have maintained our GEE modeling strategy among balanced panel of HQID hospitals that did not drop out of the program.

Allowing DSH quartiles to be time varying and treating

We examined whether our results were sensitive to classifying hospitals into DSH quartiles based on their values on the DSH Index each year, instead of their value on the DSH Index in the first year alone. Overall, there is very little time-variation for the DSH Index: the between hospital standard deviation is .161 while the within-hospital standard deviation is only .029. There is also limited movement within quartiles. Table B5 shows crosstabs of the DSH quartiles in year 1 and year 2 of the HQID (excluding the dropout hospitals), showing little movement across the quartiles. Nonetheless, we reran the analysis, allowing DSH quartile to vary over time. The results, in Table B6, show the same pattern of results, although a somewhat smaller program effect.

[1] There are different assumptions between GEE and fixed-effects models that are relevant here. GEE models use random-effects type assumptions, (i.e. the unobserved effect (including dropout) has to be "random" in that it is uncorrelated with the explanatory variables), while fixed effects models require only that the unobserved effect is time invariant.

Modeling the DSH index as a continuous variable

We also estimated models in which the DSH Index was treated as a continuous variable, rather than grouping hospitals into quartiles based on DSH values. For hospitals *j* at time *t*, we estimated the following equation using GEE:

$$g\{E(Y_{jt})\} = b_0 + b_1\, DSH\ Index_{jt} + b_2\, Phase\ 2_t + b_3\, DSH\ Index_{jt} \cdot Phase\ 2_t$$

We then calculated the elasticity of the DSH Index in both phases and tested whether the elasticity differed across the two periods. If it did, it would indicate that Phase 2 impacted the effect of the DSH Index on incentive payments. Table B7 shows the results of this analysis, and indicates that, in Phase 1, a higher DSH has a strong negative association with incentive payments, in Phase 2, there is almost no association between the DSH index and incentive payments, and that the difference between the Phase 1 and Phase 2 effects is large and significant at $p < .05$ for the receipt of any payment and payment per discharge and significant at $p < .10$ for total payments.

Table B1. Receipt of any payment, total payments, and payment per discharge by proportion of Medicaid admissions quartile in Phase 1 and Phase 2 of HQID

	Phase 1	Phase 1 Difference (Quartile $_i$ –Quartile $_1$)	Phase 2	Phase 2 Difference (Quartile $_i$ –Quartile $_1$)	Difference-in-differences
Receipt of any payment † ^					
Quartile 1 (reference)	61.0	-	96.6	-	-
	(4.9)		(2.0)		
Quartile 2	49.4	-11.6*	96.6	-0.1	11.5
	(4.8)	(6.9)	(2.1)	(2.9)	(7.1)
Quartile 3	40.7	-20.3***	91.5	-5.1	15.3**
	(4.6)	(6.7)	(3.2)	(3.8)	(7.1)
Quartile 4	37.4	-23.7***	89.7	-7.0	16.7**
	(4.8)	(6.9)	(3.6)	(4.1)	(7.0)
Total payment					
Quartile 1 (reference)	$48,495	-	$41,409	-	-
	(12,937)		(5,012)		
Quartile 2	$25,631	-$22,864*	$37,207	-$4,202	$18,661
	(4,489)	(13,694)	(3,546)	(6,139)	(12,219)
Quartile 3	$34,265	-$14,230	$3,7623	-$3,786	$10,444
	(9,005)	(15,762)	(3,961)	(6,388)	(13,621)
Quartile 4	$30,946	-$17,548	$42,256	$846	$18,395
	(7,808)	(15,110)	(5,929)	(7,764)	(13,249)
Payment per discharge †					
Quartile 1 (reference)	$41.29	-	$32.22	-	-
	(5.69)		(2.92)		
Quartile 2	$31.88	-$9.42	$28.17	-$4.05	$5.37
	(5.13)	(7.66)	(2.15)	(3.62)	(8.08)
Quartile 3	$23.16	-$18.13***	$27.13	-$5.09	$13.04*
	(3.73)	(6.8)	(2.61)	(3.91)	(7.83)
Quartile 4	$23.26	-$18.03**	$28.02	-$4.20	$13.83*
	(4.23)	(7.09)	(2.83)	(4.07)	(7.48)

***p<.01, **p<.05, *p<.10 for test of differences for levels and difference-in-differences estimates between a given quartile and Quartile 1

† $p < .05$ for joint test of difference across quartiles of the Disproportionate Share Index in Phase 1

‡ $p < .05$ for joint test of difference across quartiles of Disproportionate Share Index in Phase 2

ζ $p < .05$ for joint test of whether difference-in-difference estimates are equal to 0

^ $p < .10$ for joint test of whether difference-in-difference estimates are equal to 0

Note: Standard errors shown in ()

Note: Table includes 234 hospitals each with 5 years of data

Note: Quartile 1 hospitals have the lowest Disproportionate Share Index values, indicating the least disadvantage

Table B2. Receipt of any payment, total payments, and payment per discharge by Disproportionate Share Index quartile in Phase 1 and Phase 2 of HQID excluding hospitals that are members of the Council of Teaching Hospitals

	Phase 1	Phase 1 Difference (Quartile $_i$ –Quartile $_1$)	Phase 2	Phase 2 Difference (Quartile $_i$ –Quartile $_1$)	Difference-in-differences
Receipt of any payment †ζ					
Quartile 1 (reference)	66.0	-	96.2	-	-
	(4.6)		(2.3)		
Quartile 2	41.2	-24.9***	90.2	-6.0	18.8**
	(5.1)	(6.9)	(3.7)	(4.3)	(7.4)
Quartile 3	48.0	-18.0***	96.0	-0.2	17.8**
	(5.1)	(6.9)	(2.4)	(3.3)	(7.0)
Quartile 4	27.0	-39.1***	91.7	-4.6	34.5***
	(5.2)	(6.9)	(3.7)	(4.4)	(7.6)
Total payment‡					
Quartile 1 (reference)	$34,259	-	$33,723	-	-
	(5,607)		(3,981)		
Quartile 2	$21,181	-$13,078*	$26,459	-$7,264	$5,814
	(5,358)	(7,755)	(3,365)	(5,213)	(7,946)
Quartile 3	$30,603	-$3,656	$38,680	$4,957	$8,613
	(6,170)	(8,337)	(4,196)	(5,784)	(8,507)
Quartile 4	$26,547	-$7,712	$42,027	$8,304	$16,016
	(9,237)	(10,805)	(4,909)	(6,320)	(10,429)
Payment per discharge †ζ					
Quartile 1 (reference)	$47.63	-	$32.55	-	-
	(6.60)		(2.59)		
Quartile 2	$22.95	-$24.68***	$23.71	-$8.84**	$15.84**
	(3.71)	(7.57)	(2.30)	(3.46)	(7.72)
Quartile 3	$28.49	-$19.14**	$28.48	-$4.07	$15.07*
	(4.42)	(7.94)	(2.68)	(3.73)	(8.23)
Quartile 4	$16.75	-$30.88***	$28.12	-$4.43	$26.45***
	(4.24)	(7.85)	(2.27)	(3.45)	(8.37)

***p<.01, **p<.05, *p<.10 for test of differences for levels and difference-in-differences estimates between a given quartile and Quartile 1

† $p < .05$ for joint test of difference across quartiles of the Disproportionate Share Index in Phase 1

‡ $p < .05$ for joint test of difference across quartiles of Disproportionate Share Index in Phase 2

ζ $p < .05$ for joint test of whether difference-in-difference estimates are equal to 0

^ $p < .10$ for joint test of whether difference-in-difference estimates are equal to 0

Note: Standard errors shown in ()

Note: Table includes 196 hospitals each with 5 years of data

Note: Quartile 1 hospitals have the lowest Disproportionate Share Index values, indicating the least disadvantage

Table B3. Comparison of incentive payments in the first year of the HQID between hospitals that ultimately dropped out of the HQID and hospitals that stayed in the HQID.

	Ultimately dropped out of HQID	Stayed in HQID
n	32	229
DSH Index	.29	.23
Receipt of any payment in first year of HQID	25%	49%
Total payments in first year of HQID	$11003.75	$37612.83
Payment per discharge in first year of HQID	$14.37	$29.33

Table B4. Difference-in-differences estimates for receipt of any payment, total payments, and payment per discharge by Disproportionate Share Index quartile in Phase 1 and Phase 2 of HQID for alternative exclusions of hospitals leaving the HQID

	No exclusion (intent to treat)	Exclude all observations from drop-out hospitals	Excluding observations from drop-out hospitals only after they exited	Excluding observations from drop-out hospitals only after they exited
Modeling specification	**GEE**	**GEE**	**GEE**	**Fixed Effects**
n	**1,305**	**1,145**	**1,220**	**1,220**
Receipt of any payment †ζ				
Quartile 1 (reference)	-	-	-	-
Quartile 2	9.9	17.5**	19.0***	18.5***
	(7.4)	(7.0)	(6.6)	(6.9)
Quartile 3	13.8*	18.1***	20.8***	19.5***
	(7.2)	(6.9)	(6.5)	(6.7)
Quartile 4	22.5***	28.3***	30.8***	29.2***
	(7.0)	(7.0)	(6.6)	(6.8)
Total payment				
Quartile 1 (reference)	-	-	-	-
Quartile 2	$9,542	$14,629	$12,785	$12,844
	(10,947)	(12199)	(11,470)	(11,656)
Quartile 3	$15,205	$19,979	$18,295	$18,116
	(11,382)	(12,541)	(11,919)	(12,124)
Quartile 4	$15,639	$16,664	$18,442	$17,707
	(12,834)	(14,978)	(13,862)	(14,170)
Payment per discharge †‡				
Quartile 1 (reference)	-	-	-	-
Quartile 2	$9.93	$14.92*	$11.89	$11.84
	(7.15)	(7.83)	(7.43)	(7.60)
Quartile 3	$15.51**	$17.34**	$17.22**	$16.66**
	(7.34)	(8.32)	(7.70)	(7.87)
Quartile 4	$18.46**	$21.31***	$20.25**	$19.53**
	(7.24)	(8.20)	(7.66)	(7.84)

***$p<.01$, **$p<.05$, *$p<.10$ for test of differences for levels and difference-in-differences estimates between a given quartile and Quartile 1

Note: Standard errors shown in ()

Note: Quartile 1 hospitals have the lowest Disproportionate Share Index values, indicating the least disadvantage

Table B5. Crosstabs of quartiles of the Disproportionate Share Index in year 1 and year 2 of HQID

		Year 1			
		Quartile 1	Quartile 2	Quartile 3	Quartile 4
Year 2	Quartile 1	53	9	0	0
	Quartile 2	10	38	8	0
	Quartile 3	0	7	42	9
	Quartile 4	0	0	7	45

Table B6. Difference-in-differences estimates for receipt of any payment, total payments, and payment per discharge by Disproportionate Share Index quartile in Phase 1 and Phase 2 of HQID allowing DSH index to vary over time

	DSH based on 1st year (original specification)	Allowing time-varying DSH
Receipt of any payment †ζ		
Quartile 1 (reference)	-	-
Quartile 2	17.5**	9.8
	(7.0)	(7.1)
Quartile 3	18.1***	17.1**
	(6.9)	(6.8)
Quartile 4	28.3***	21.6***
	(7.0)	(6.9)
Total payment		
Quartile 1 (reference)	-	-
Quartile 2	$14,629	$3,802
	(12199)	(9,312)
Quartile 3	$19,979	$5,489
	(12,541)	(10,974)
Quartile 4	$16,664	$16,693
	(14,978)	(10,378)
Payment per discharge †‡		
Quartile 1 (reference)	-	-
Quartile 2	$14.92*	$4.39
	(7.83)	(8.72)
Quartile 3	$17.34**	$10.31
	(8.32)	(7.44)
Quartile 4	$21.31***	$16.16**
	(8.20)	(7.15)

***p<.01, **p<.05, *p<.10 for test of differences for levels and difference-in-differences estimates between a given quartile and Quartile 1

Note: Standard errors shown in ()

Note: Quartile 1 hospitals have the lowest Disproportionate Share Index values, indicating the least disadvantage

Table B7. Elasticity of Disproportionate Share Index in Phase 1 and Phase 2, and the difference in elasticity between the phases

	Elasticity of DSH Index in Phase 1	Elasticity of DSH Index in Phase 2	Difference (Phase 2 – Phase 1)
Receipt of any payment	-0.39***	-0.02	0.38***
	(0.11)	(0.03)	(0.11)
Total payment	-0.21	0.10	0.31*
	(0.20)	(0.07)	(0.16)
Payment per discharge	-0.51***	-0.02	0.48***
	(0.17)	(0.06)	(0.16)

***p<.01, **p<.05, *p<.10

Note: Standard error in ()

Note: Elasticity is interpreted as the percentage change the dependent variable associated with a percentage change in the DSH Index

Note: Quartile 1 hospitals have the lowest Disproportionate Share Index values, indicating the least disadvantage