Appendix Table 1. Number of Qualifying Services Received and Number of TINs "Competing" for Assignment, by Decile of Per-beneficiary Spending[a]

Decile of Spending	CMS Attribution Algorithm		Attribution Based Only on Office Visits With PCPs	
	Mean Number of Qualifying Services Received by Beneficiary	Mean Number of TINs Providing Qualifying Services	Mean Number of Qualifying Services Received by Beneficiary	Mean Number of TINs Providing Qualifying Services
1 (lowest)	2.24	1.07	2.21	1.06
2	3.39	1.12	3.30	1.12
3	4.05	1.16	3.92	1.16
4	4.58	1.20	4.40	1.19
5	5.08	1.24	4.86	1.23
6	5.57	1.27	5.33	1.26
7	6.16	1.31	5.83	1.30
8	6.76	1.36	6.41	1.33
9	7.23	1.44	6.59	1.36
10 (highest)	9.20	1.68	6.53	1.37

Abbreviations: CMS, Centers for Medicare and Medicaid Services; PCP, primary care physician; TIN, tax identification number.

[a] Based on 2011 Medicare claims data.

Appendix Table 2. Falsification Tests of 439 Non-ACO TINs Large Enough to Participate in the MSSP, and of 2015 MSSP Entrants Prior to Entry

Hypothetical Entry Year	Differential Change in Spending in Hypothetical Performance Year, $/patient		
	2013	2014	2015
Large non-ACO TINs			
2012	14	3	12
2013	13	2	11
2014	-	-1	8
2015 MSSP entrants			
2012	143**	93	-
2013	115**	65	-
2014	-	39	-

Abbreviations: ACO, accountable care organization; MSSP, Medicare Shared Savings Program; TIN, tax identification number.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

Appendix Table 3. Gross Savings Estimates by ACO Type With and Without Adjustment for Non-ACO TIN/CCN Fixed Effects in Addition to ACO Fixed Effects[a]

Entry Cohort	2015 Savings: Physician Group ACOs, $		2015 Savings: Hospital-Based ACOs, $/Beneficiary	
	ACO Fixed Effects Only (95% CI)	ACO and non-ACO TIN/CCN Fixed Effects	ACO Fixed Effects Only (95% CI)	ACO and non-ACO TIN/CCN Fixed Effects
2012	−474 (−737, −212)	−381	−169 (−286, −52)	−82
2013	−342 (−494, −190)	−277	-18 (−144, 109)	75
2014	-156 (−272, −40)	−183	88 (−28, 204)	143

Abbreviations: ACO, accountable care organization; CCN, Centers for Medicare and Medicaid Services (CMS) Certification Number; CI, confidence interval; TIN, tax identification number.

[a]The computing environment did not support estimation of robust standard errors in models with thousands of TIN/CCN fixed effects. Therefore, 95% confidence intervals are not reported for point estimates adjusted for non-ACO fixed effects.

Appendix Table 4. Application of Baseline Assignment Approach in Falsification Tests Treating Large Non-ACO TINs or 2015 MSSP Entrants as Hypothetical Entrants in 2013

Hypothetical Treatment Group	Preperiod (2009-2012) Difference in Spending vs. Control Group, $/patient	Differential Change in Spending After Hypothetical Entry in 2013, $/Patient (Inflated Estimate)		
		2013	2014	2015
Large non-ACO TINs	39*	−3 (−5)	99** (174)	80** (150)
2015 MSSP entry cohort of ACOs	35	114** (186)	23 (40)	—

Abbreviations: ACO, accountable care organization; MSSP, Medicare Shared Savings Program; TIN, tax identification number.
*$p < 0.05$, **$p < 0.01$, ***$p < 0.001$

Appendix Table 5. Attribution Based on Referring PCP When Beneficiary Has No Office Visits With a PCP

Entry Cohort	Unadjusted Preentry Sample Mean,[a] $/Patient	Adjusted Pre-entry Difference in Annual Spending Level Between ACOs and Control Group, $/Patient (95% CI)	Adjusted Pre-entry Difference in Annual Spending Trend Between ACOs and Control Group, $/Patient (95% CI)	Estimated Gross Savings (Adjusted Differential Change in Spending From Pre-Entry Period to Performance Year for ACOs vs. Control Group),[b] $/Patient (95% CI)		
				2013	2014	2015
2012	10,390	289 (63, 515)	−25 (−78, 28)	−191 (−329, -53)	−356 (−492, −219)	−408 (−561, −254)
2013	10,390	217 (58, 377)	−23 (−65, 18)	−37 (−141, 68)	−147 (−251, −44)	−251 (−356, −145)
2014	10,390	160 (10, 310)	8 (−21, 37)	—	−94 (−171, −16)	−86 (−179, 7)

Abbreviations: ACOs, accountable care organizations; CI, confidence interval; PCP, primary care physician.

Appendix Table 6. Tests of ACO Gaming of CMS Attribution Algorithm via Manipulation of TINs Used for Billing

Entry Cohort	Estimated Gross Savings in 2015 Using CMS Attribution Algorithm (Differential Change in Spending From Pre-entry Period to 2015 for ACOs vs. Control Group), $/Patient (95% CI)		
	ACOs Defined as Fixed Sets of TINs Over Time[a]		ACOs Defined as Fixed Sets of NPIs Over Time
	Unadjusted for Patient Characteristics	Adjusted for Patient Characteristics	Adjusted for Patient Characteristics
2012	−465 (−665, −266)	−438 (−588, −289)	−364 (−495, −233)
2013	−179 (−383, 26)	−238 (−385, −91)	−130 (−263, 2)
2014	−57 (−234, 121)	−42 (−170, 87)	21 (−96, 138)

Abbreviations: ACO, accountable care organization; NPI, National Provider Identifier; TIN, tax identification number.

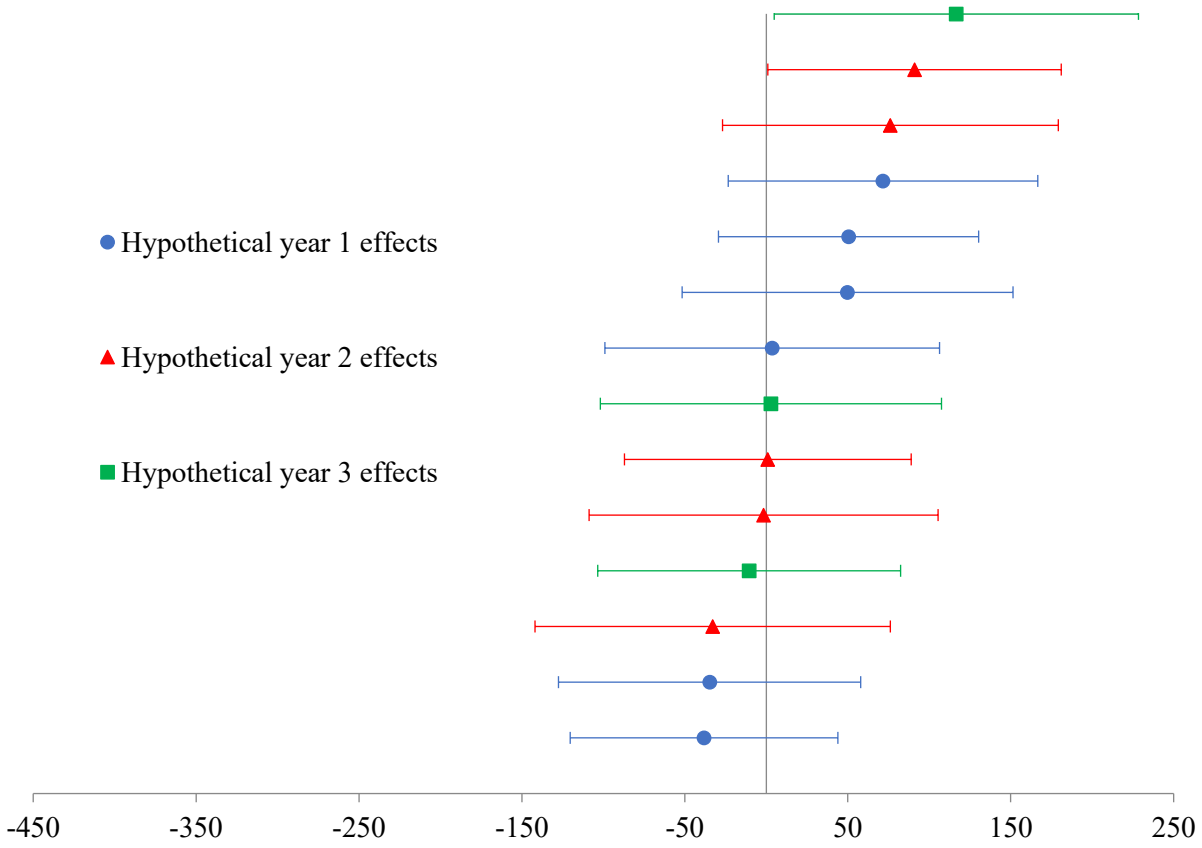
[a]As reported in Appendix Table 7, use of the CMS attribution algorithm induced significant differences in preperiod trends when ACOs were defined as fixed sets of TINs, with spending declining for ACOs relative to the control group. Thus, these estimates are likely biased away from the null. The differences in preperiod trends were minimized when ACOs were defined as fixed sets of NPIs instead; thus, the results in the rightmost column are less subject to this bias. Differences between the estimates therefore cannot be interpreted as the result of manipulation of the TINs used for billing.

Appendix Table 7. Comparison of Preperiod Differences in Spending Levels and Trends by Different Methods of Patient Attribution

	Unadjusted Pre-entry Sample Mean $/Patient	**Adjusted Pre-entry Difference in Annual Spending *Level* Between ACOs and Control Group, $/Patient** (95% CI)	**Adjusted Pre-entry Difference in Annual Spending *Trend* Between ACOs and Control Group, $/Patient** (95% CI)
Attribution Based on PCP Office Visits			
2012 cohort	9649	139 (-79, 357)	-3 (-58, 53)
2013 cohort	9649	31 (-84, 146)	-5 (-39, 29)
2014 cohort	9649	33 (-90, 155)	8 (-18, 34)
Attribution Based on PCP Office Visits or Office Visits With Specialists if No Visits With a PCP			
2012 cohort	9778	188 (-20, 396)	-6 (-60, 47)
2013 cohort	9778	92 (-23, 206)	-1 (-35, 33)
2014 cohort	9778	95 (-38, 228)	6 (-19, 30)
CMS Attribution Algorithm			
2012 cohort	10,038	98 (-51, 247)	-74 (-138, -10)
2013 cohort	10,038	78 (-127, 282)	-64 (-112, -16)
2014 cohort	10,038	-65 (-227, 97)	14 (-27, 55)

Abbreviations: Abbreviations: ACOs, accountable care organizations; CI, confidence interval; CMS, Centers for Medicare and Medicaid Services; PCP, primary care physician

Appendix Figure 1. Falsification Tests Estimating Differential Changes in Spending for ACOs Hypothetically Entering in Pre-entry Period Years[a]



[a]For each entry cohort of ACOs, we estimated all possible differential changes in pre-entry spending generated by treating each pre-entry year as a hypothetical entry year. For the 2013 entry cohort, for example, this allowed procedure generated 3 hypothetical effects of 1 year of participation (differential changes from 2009 to 2010, from 2009-2010 to 2011, and from 2009-2011 to 2012); 2 hypothetical year 2 effects (differential changes from 2009 to 2011 and from 2009-2010 to 2012); and 1 hypothetical year 3 effect (differential change from 2009 to 2012). Plotted are all the possible hypothetical effects across the 2012-2014 entry cohorts. The estimates were distributed evenly around zero, with a slight skew toward positive differential changes rather than negative differential changes. Moreover, hypothetical year 2 effects were not systematically more negative than hypothetical year 1 effects, and hypothetical year 3 effects were not systematically more negative they hypothetical year 1 or 2 effects.