

Supplemental Appendix

Disadvantaging Rivals: Vertical Integration in the Pharmaceutical Market

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Appendix A: Insurer Name Match and PBM Assignment Algorithm

Insurer Name Match Between CMS and MMS Data

The Managed Market Surveyor (MMS) data describe which PBMs each Medicare Part D plan uses each year. The MMS data also contain a variable that describes the parent insurer underwriting the Part D plan. In the CMS Part D PDP Landscape data from 2010 to 2018, there were 79 unique parent insurer names. To start, we perform a string match to find matches for the 79 PDP parent insurers within the MMS data. We use the user-written Stata command ‘reclink’ which uses a measure of string distance to determine the closest match. This allows us to match strings like “UnitedHealth” to “UnitedHealth Group, Inc.” We review these matches on a case-by-case basis to ensure that they are accurate.

Next, we identify in the MMS data if the parent insurer offers more than one Part D plan. For those insurers offering only one plan, we match that plan to CMS PDP data. For insurers offering more than one plan in the MMS data, we perform a string match of plan names between PDP plans and MMS plans. Again, we review these matches on a case-by-case basis to ensure accuracy.

PBM Assignment Algorithm

As described in the text, approximately 74% of our plan-region-year observations utilize only one PBM in a given year, either an external PBM or internal PBM. For an additional 24.3% of observations, a plan may use multiple PBMs, but it uses only 1 PBM for either rebate negotiations or formulary design. In those instances, we assign the rebate or formulary PBM as the primary PBM. For the remaining 1.7% of observations, a plan may use one PBM for rebate negotiations or another for formulary design. In these cases, we perform external research to

determine which PBM we believe is the primary PBM providing these services. We consulted industry experts, company filings, media reports, etc. to assign the PBM in these cases.

Sample Selection

Our difference-in-differences analysis requires that insurers have both pre- and post-2015 data (i.e., an insurer must offer PDP coverage both before and after the exit of Catamaran), so we exclude insurers that operate only in the pre- or post-period.¹ We also limit the sample to insurers that are clearly treated (i.e., not vertically integrated with a PBM) or are clearly part of the control group (i.e., use their own PBM) to avoid contamination in either group.² After making these sample restrictions, our final analytic sample covers 84% of the enrolled lives in the PDP market over our sample period and thus is likely to be representative of most Part D plans and beneficiaries.

Subgroup Analyses

We assess heterogeneity in the effects of Catamaran's exit across two groups of non-vertically integrated plans. The first group are plans that had been using Catamaran as its PBM in the quarter prior to its acquisition and were forced to switch to a rival's vertically integrated PBM after Catamaran's exit. Two insurers met this criterion: BlueCross BlueShield (BCBS) of Arizona and Wellcare.³ The second group of plans had already been using a vertically integrated

¹ This applies only to insurers and not to plans. We allow plans to enter and exit the sample throughout the study period.

² For instance, Cigna used the services of a standalone PBM (Catamaran) in 2015, but carved in its PBM services after Catamaran's exit. Thus, we exclude Cigna from our regression analyses as its plans do not cleanly belong to either the treated or control group for the entire time span. Additionally, Prime Therapeutics is vertically integrated with several BCBS insurers in Part D. However, it is unclear from our data, which BCBS insurers have an ownership stake in Prime and which simply use Prime for PBM services. Due to the ambiguity of these relationships, we omit insurers using Prime Therapeutics from our analysis.

³ As noted above Cigna also used Catamaran's PBM services in 2015. However, Cigna's financial reports indicate that it transitioned its core PBM functions (i.e., rebate negotiation and formulary management) internally following Catamaran's exit. All other insurers using Catamaran in 2015 did not have those internal capabilities and lacked the ability to substitute their PBM services away from a rival insurer's PBM. (Fein 2018). We also observe the exits of two small insurers who used Catamaran's services in 2015. The Health Alliance plans of Illinois and the Henry Ford plans of Michigan exit from the PDP market in 2016.

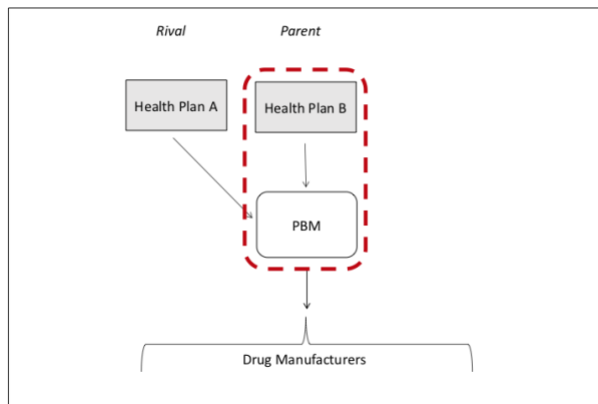
PBM owned by a rival insurer in 2015. These plans lost their remaining outside option of a standalone PBM when Catamaran exited. Fifteen insurers met this criterion.⁴

⁴ The insurers are Anthem, BCBS AL, BCBS AR, BCBS CT, BCBS MA, BCBS MI, BCBS RI, BCBS SC, BCBS TN, BCBS VT, Capital BlueCross, Educators, Healthnow NY, Highmark, and WI Physicians.

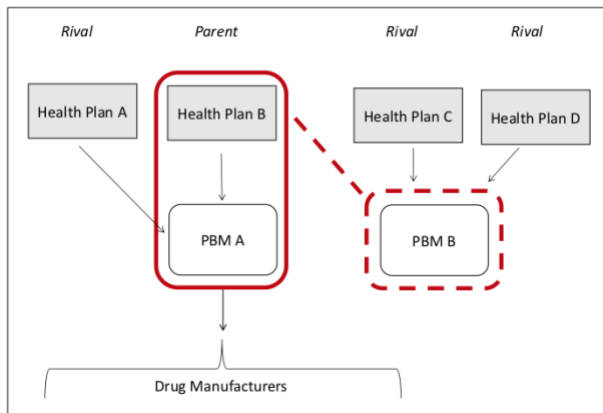
Appendix B: Supplementary Figures and Tables

Appendix Figure B.1– Illustration of Insurer-PBM Mergers

Panel A: Purely Vertical Merger (Case 1)

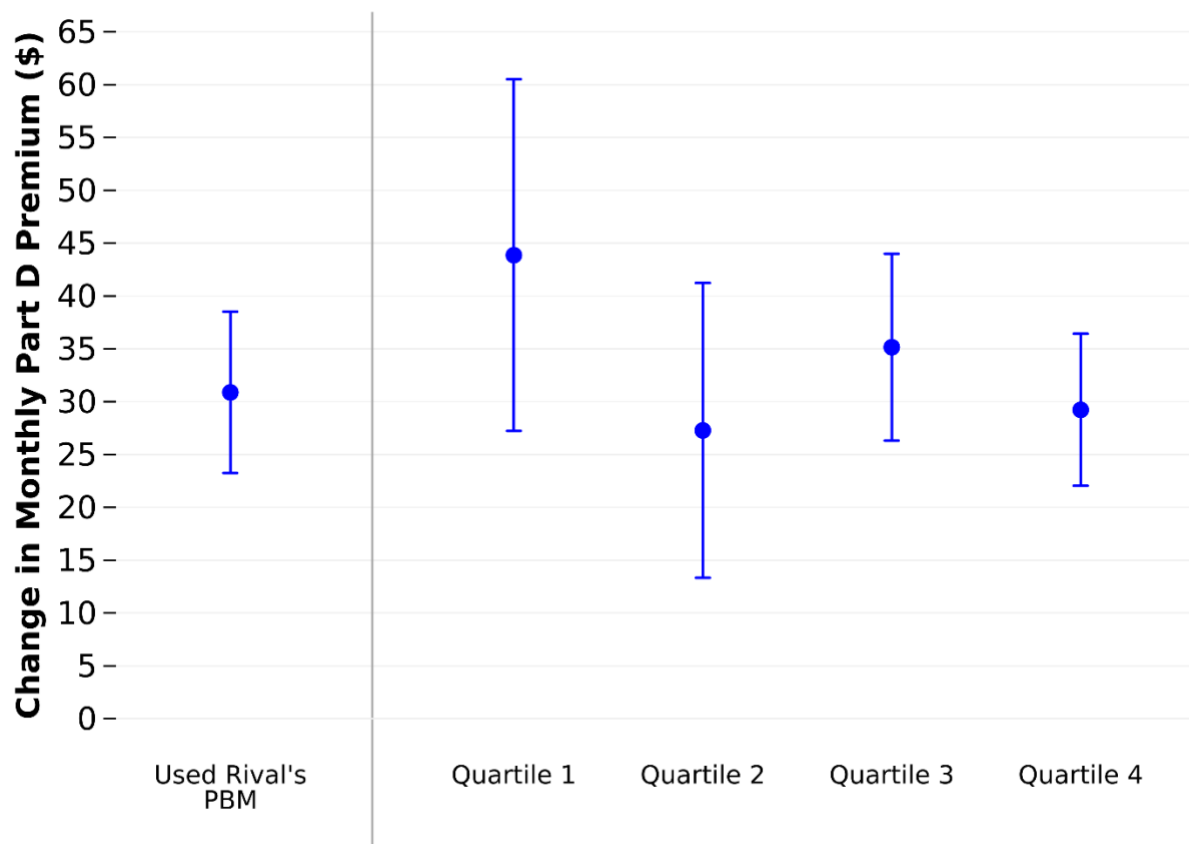


Panel B: Vertical and Horizontal Merger (Case 2)



Notes: There are two cases of vertical mergers. Panel A shows a merger between an insurer without PBM capabilities (Plan B) and a standalone PBM. Pre-merger, the PBM was providing services to Plans A and B (such as negotiating for rebates with drug manufacturers). Panel B shows a merger between a vertically integrated insurer (Plan B) and a standalone PBM (PBM B). Pre-merger, vertically integrated PBM A was providing services to its parent insurer (Plan B) and rival insurer Plan A. Standalone PBM B was providing services to Plans C and D. Post-merger, PBM A is combined with PBM B and provides services to its parent insurer (Plan B) and Plans A, C, and D.

Appendix Figure B.2: Heterogeneity of Treatment Effect, By Insurer Size



Notes: Column (1) is a reproduction of Column (3) from Figure 4. It displays the estimated treatment effect for insurers that used a rival insurer's PBM in 2015. Columns (2) through (5) show the estimated treatment effects when we split the insurers that use a rival's PBM into quartiles based on the insurer's "size"—i.e., average enrollment in 2013 and 2014. For instance, quartile 1 contains the smallest insurers who used a rival insurer's PBM in 2015. Standard errors are clustered at the insurer level. The error bars indicate 95% confidence intervals. We include a vector of plan-specific controls (annual deductible, indicators for LIS eligibility and gap coverage), year fixed effects, region fixed effects, and insurer fixed effects.

Appendix Table B.1: Trends in Average Monthly Part D Premiums – Tabular Form

Year	(a) VI Insurer	(b) Non-VI using Rival's PBM	(c) Non-VI using Standalone PBM	(d) VI Insurer with Exclusive PBM
2010	50.43	44.66	63.96	45.98
2011	54.45	58.03	72.83	54.11
2012	55.62	57.40	45.40	54.78
2013	53.88	58.41	44.83	53.85
2014	55.63	55.01	53.41	51.65
2015	47.77	60.47	51.82	52.96
2016	52.97	60.04	112.37	42.59
2017	49.33	75.23	95.43	43.55
2018	47.81	77.76	100.80	45.39

Notes: Each column displays the average premium for the four types of plans in our sample. Column (1) is for insurers vertically integrated with a PBM, Column (2) is for non-vertically integrated insurers using a rival's PBM, Column (3) is for non-vertically integrated insurers using a standalone PBM, and Column (4) is for vertically integrated insurers with a PBM that does not sell its services to rival insurers. Note that the number of plans using a standalone PBM drops precipitously in 2016 after the exit of Catamaran. In 2015, 254 different plans used a standalone PBM. That number decreased to 34 in 2016, 3 in 2017, and 1 in 2018.

Appendix Table B.2: Elasticity of Enrollment with Respect to Premiums

Functional Form:	Levels	Log-Log
<u>Dependent Variable in Parentheses:</u>		
<i>Reduced Form (Enrollment)</i>		
1(Treated) x 1(Year $\geq$ 2015)	-20,495** (8,990)	-0.236 (0.160)
<i>First Stage (Premium)</i>		
1(Treated) x 1(Year $\geq$ 2015)	22.315*** (5.742)	0.326*** (0.071)
<i>2SLS (Enrollment)</i>		
Premium (\$)	-918** (353)	-0.723 (0.456)
N	6,453	6,453
Avg. Dep. Variable	65,083	-

Notes: This table displays results from a 2SLS regression estimating the effect of premium changes on enrollment using Catamaran's exit (i.e., 1(Treated) x 1(Year $\geq$ 2015)) as an instrument for premium changes. The top panel shows the reduced form effect of Catamaran's exit on enrollment, the middle panel displays the first-stage effect of treatment on premiums (this is the same as our main DD estimate), and the bottom panel shows the 2SLS estimate. We estimate the regression in both level form (i.e., enrollment measured in lives and premiums measured in dollars) and log form (i.e., $\ln$ enrollment and $\ln$ premiums). We include a full set of plan characteristics as controls (annual deductible, indicators for LIS eligibility, gap coverage, and plans with enhanced benefits), year fixed effects, region fixed effects, and insurer fixed effects. Standard errors are clustered at the insurer level.

Appendix Table B.3: Difference-in-Differences Regression – Tabular Form

Dependent Variable = Monthly Part D Premium (\$)								
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
1(Treated)*1(Year ≥ 2015)	22.315*** (5.742)	--	--	--	19.509*** (6.505)	23.464*** (6.325)	22.279*** (5.735)	23.428*** (6.316)
1(Year ≥ 2015)*1(Used Catamaran in 2015)	--	15.395*** (3.666)	15.394*** (3.665)	15.397*** (3.672)	--	--	--	--
1(Year ≥ 2015)*1(Used VI PBM in 2015)	--	30.877*** (3.649)	--	--	--	--	--	--
1(Year ≥ 2015)*1(Used VI PBM in 2015)*1(Stayed with PBM)	--	--	31.849*** (3.843)	--	--	--	--	--
1(Year ≥ 2015)*1(Used VI PBM in 2015)*1(Switched PBMs)	--	--	18.241*** (3.855)	--	--	--	--	--
1(Year ≥ 2015)*1(Used VI PBM in 2015)*1(Size Quartile 1)	--	--	--	43.861*** (7.952)	--	--	--	--
1(Year ≥ 2015)*1(Used VI PBM in 2015)*1(Size Quartile 2)	--	--	--	27.280*** (6.670)	--	--	--	--
1(Year ≥ 2015)*1(Used VI PBM in 2015)*1(Size Quartile 3)	--	--	--	35.151*** (4.226)	--	--	--	--
1(Year ≥ 2015)*1(Used VI PBM in 2015)*1(Size Quartile 4)	--	--	--	29.226*** (3.440)	--	--	--	--
Average Premium			52.939		54.138	53.609	52.930	53.599
Number of Observations	6,453	6,453	6,453	6,453	4,047	5,545	6,449	5,541
R ²	0.660	0.663	0.663	0.663	0.710	0.639	0.660	0.639

Notes: The treatment group in Column (1) is all non-vertically integrated plans: either plans that used Catamaran as their PBM in 2015 or used a rival insurer's PBM in 2015. Column (2) separates out these two groups to allow for group specific coefficients. Column (3) splits the insurers who used a rival's PBM into two groups: those that stayed with the same PBM post Catamaran's exit and those that switched PBMs post Catamaran's exit. Column (4) splits the insurers who used a rival's PBM into quartiles based on the insurer's "size"—i.e., average enrollment in 2013 and 2014. For instance, quartile 1 contains the smallest insurers who used a rival insurer's PBM in 2015. In columns (1) through (4), the control group is plans that use their own PBM (i.e., types (a) and (d)). The control group in column (5) excludes plans offered by insurers with PBM capabilities that they do not offer to rival insurers (i.e., type (d)). The control group in column (6) is plans that use their own PBM (i.e., types (a) and (d)) but excludes UnitedHealth/OptumRx. The treatment group in column (7) excludes insurers who used UnitedHealth/OptumRx as their PBM. Column (8) excludes both UnitedHealth from the control group and excludes insurers who used UnitedHealth/OptumRx as their PBM from the treatment group. Standard errors are clustered at the insurer level. We include a full set of plan characteristics as controls (annual deductible, indicators for LIS eligibility and gap coverage), year fixed effects, region fixed effects, and insurer fixed effects.

Appendix C: Robustness Tests

We assess the robustness of our findings in several ways. First, we test whether the results are sensitive to the inclusion of plan characteristics as control variables. Plan characteristics could change endogenously as a result of the merger. In Appendix Figures C.1 and C.2, we exclude plan characteristic controls from the main event study and corresponding difference-in-differences estimates. The results are similar with or without plan characteristic controls. Additionally, in Appendix Table C.1, we regress each plan characteristic as an outcome of Equation (1) to directly estimate the impact of the merger on plan characteristics. All of the estimates are small and not statistically significant. This suggests that the premium increases for non-vertically integrated insurers are not driven by changes in plan design, but rather by changes in underlying costs (e.g., rebates or administrative fees).⁵

Second, we show that the results are robust to weighting by insurer size in Appendix Table C.2. Column (1) repeats the unweighted baseline results showing the effect of the merger on non-vertically integrated insurers relative to vertically integrated insurers. Column (2) weights the regression by enrollment for insurer j in Part D region r in year t . Because current enrollment could be endogenous, we also weight by the pre-merger enrollment in 2014 in Column (3). In addition, we also weight by contemporaneous and 2014 Part D region market share (Columns (4) and (5), respectively). The main unweighted difference-in-differences estimates are similar to the weighted estimates across all weighting approaches.

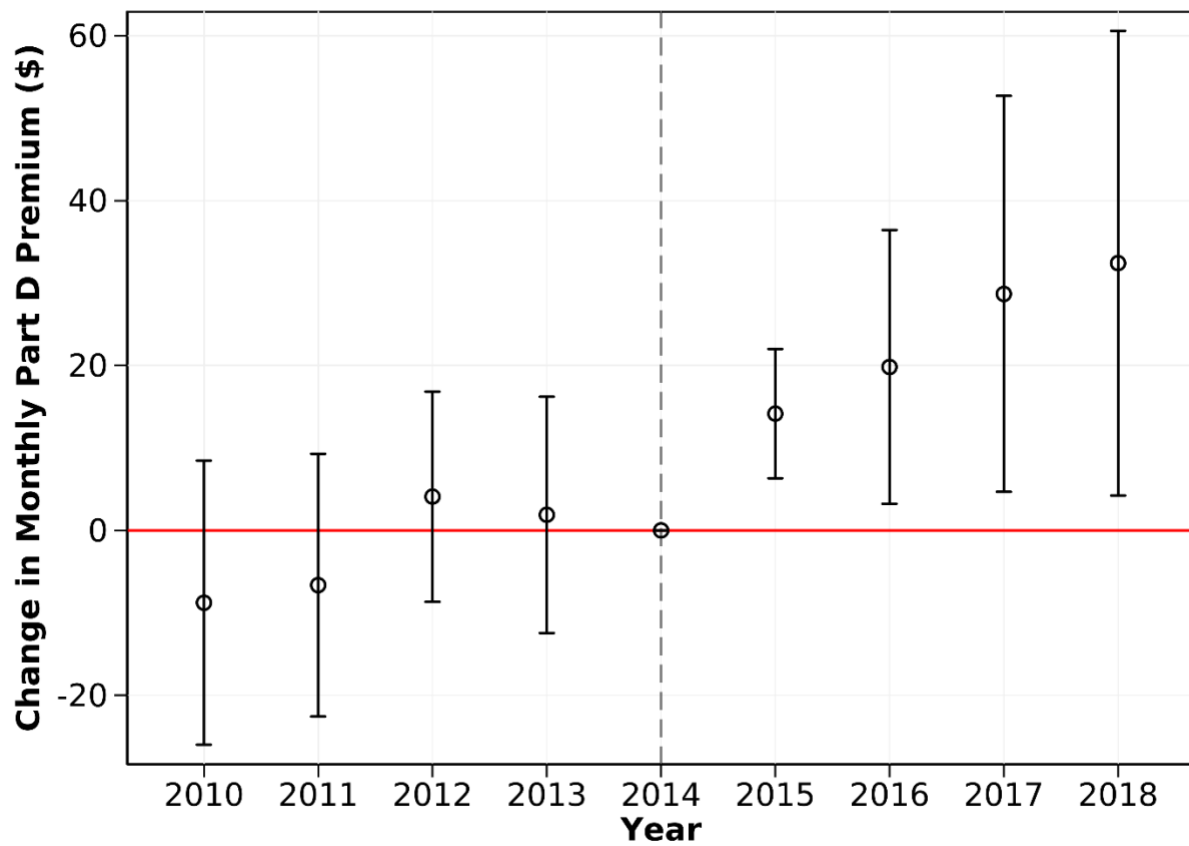
Third, we test the sensitivity of the results to an alternative control group that excludes insurers of type (d) who are outside the PBM market—i.e., those with PBM capabilities that are

⁵ Additionally, it is unlikely that changes in insurer composition explain premium changes. Only one insurer in the analysis sample exited in the post-merger period and it is a small insurer, accounting for only 0.06% of enrollment for non-vertically integrated insurers.

not sold to rival insurers. These insurers may face different trends than vertically integrated insurers who participate in the PBM market. We find a similar event study pattern that is less precisely estimated due to the smaller sample size (Appendix Figure C.3). The premiums of non-vertically integrated plans increased by \$20 per month (Appendix Figure C.4) which is similar to the baseline estimate of \$22 per month.

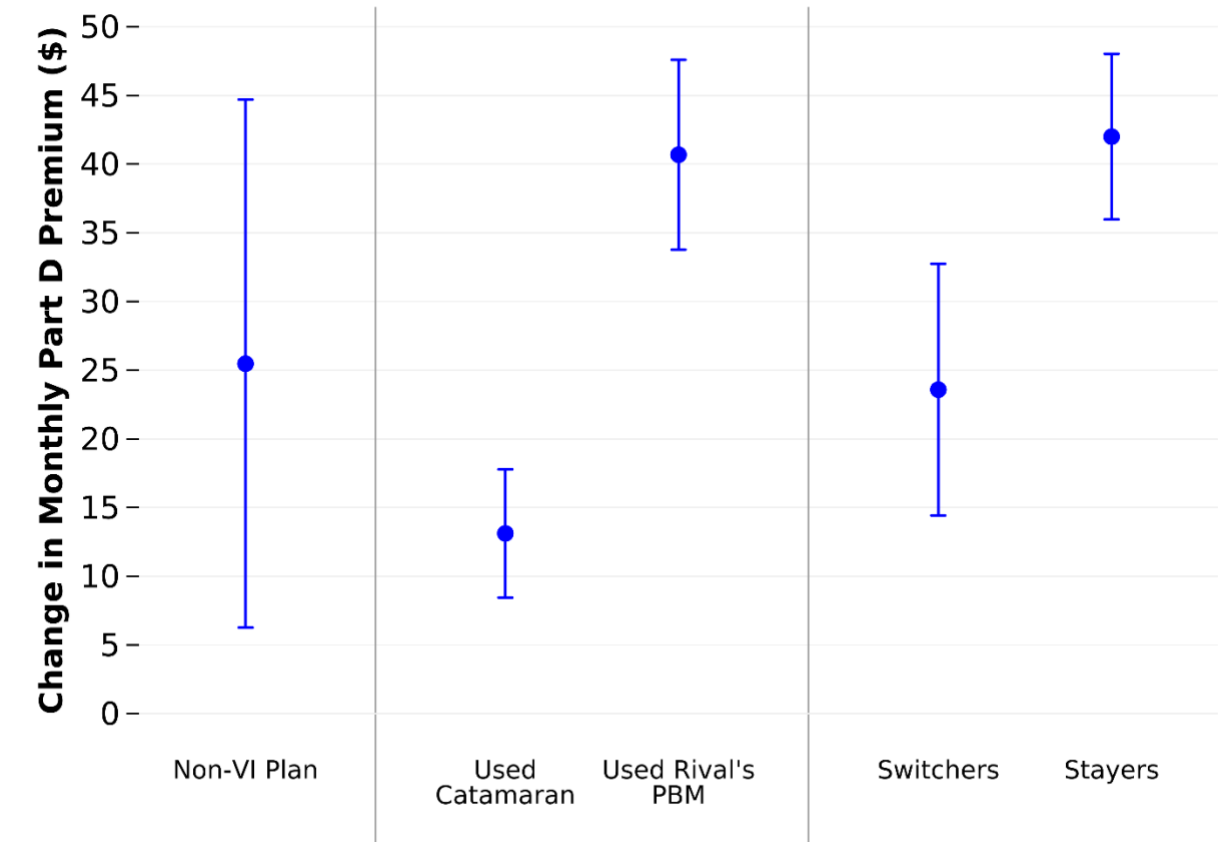
Finally, we test whether the results are driven by competitive dynamics in a particular Part D region. Appendix Figure C.5 shows the results from a leave-one-out analysis in which we estimate Equation (1) excluding each of the Part D regions in turn. The results are nearly identical across all regressions. Thus, the increase in premiums for non-vertically integrated insurers is widespread and not particular to a single market.

Appendix Figure C.1: Event Study Estimates of Premium Changes for Non-Vertically Integrated Plans After UnitedHealth-Catamaran Merger (No Plan Characteristic Controls)



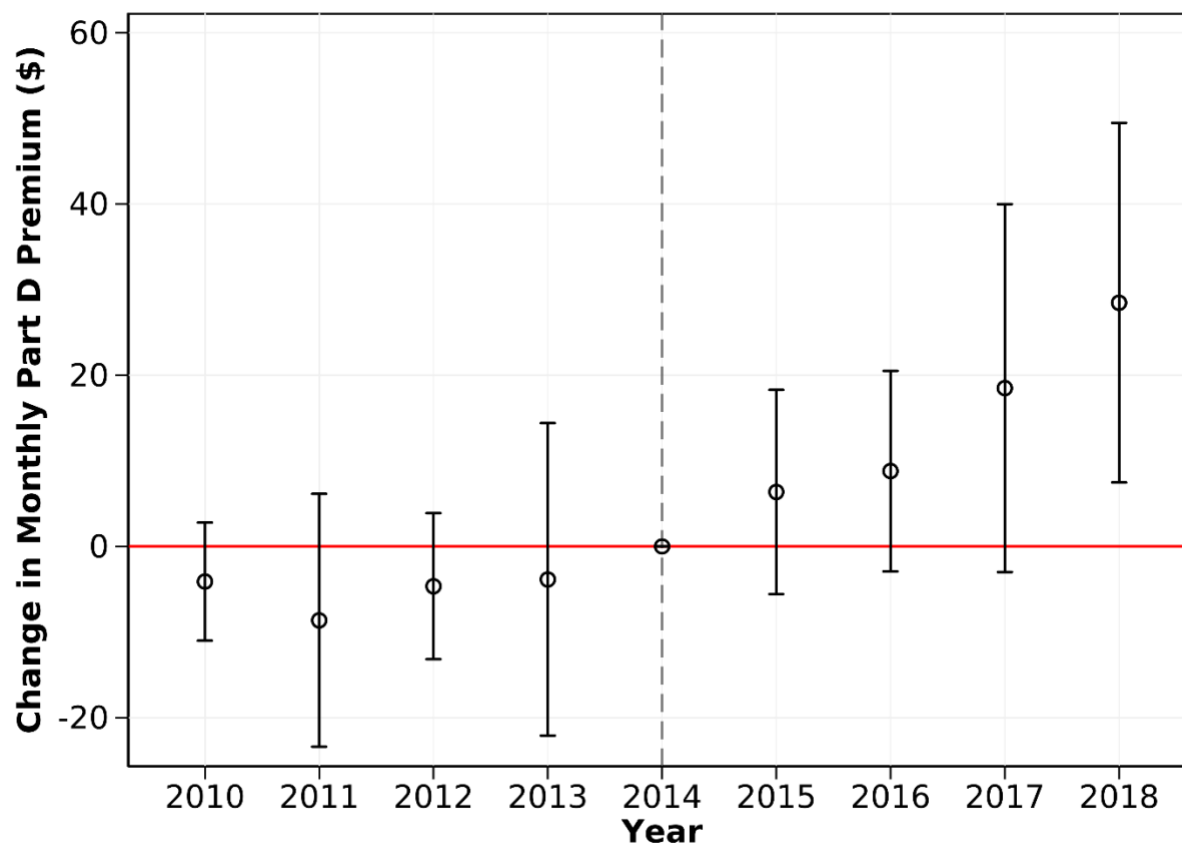
Notes: This figure replicates Figure 3 in the main paper, but excludes plan characteristic control variables. Standard errors are clustered at the insurer level. We include year fixed effects, region fixed effects, and insurer fixed effects.

Appendix Figure C.2: Difference-in-Differences Estimates of Premium Changes for Non-Vertically Integrated Plans After UnitedHealth-Catamaran Merger, by Plan Subgroup (No Plan Characteristic Controls)



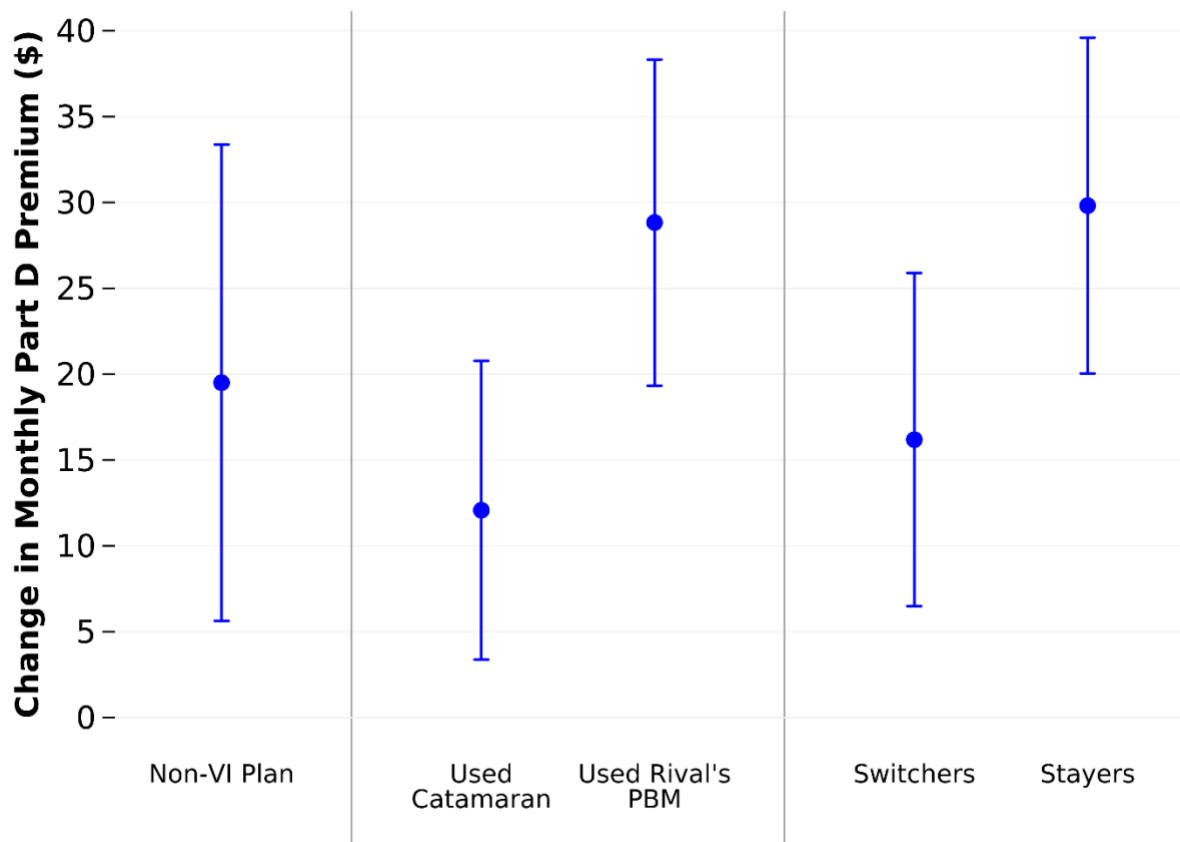
Notes: This figure replicates Figure 4 in the main paper, but excludes plan characteristic control variables. Standard errors are clustered at the insurer level. We include year fixed effects, region fixed effects, and insurer fixed effects.

Appendix Figure C.3: Event Study Estimates of Premium Changes for Non-Vertically Integrated Plans After UnitedHealth-Catamaran Merger (Alternative Control Group)



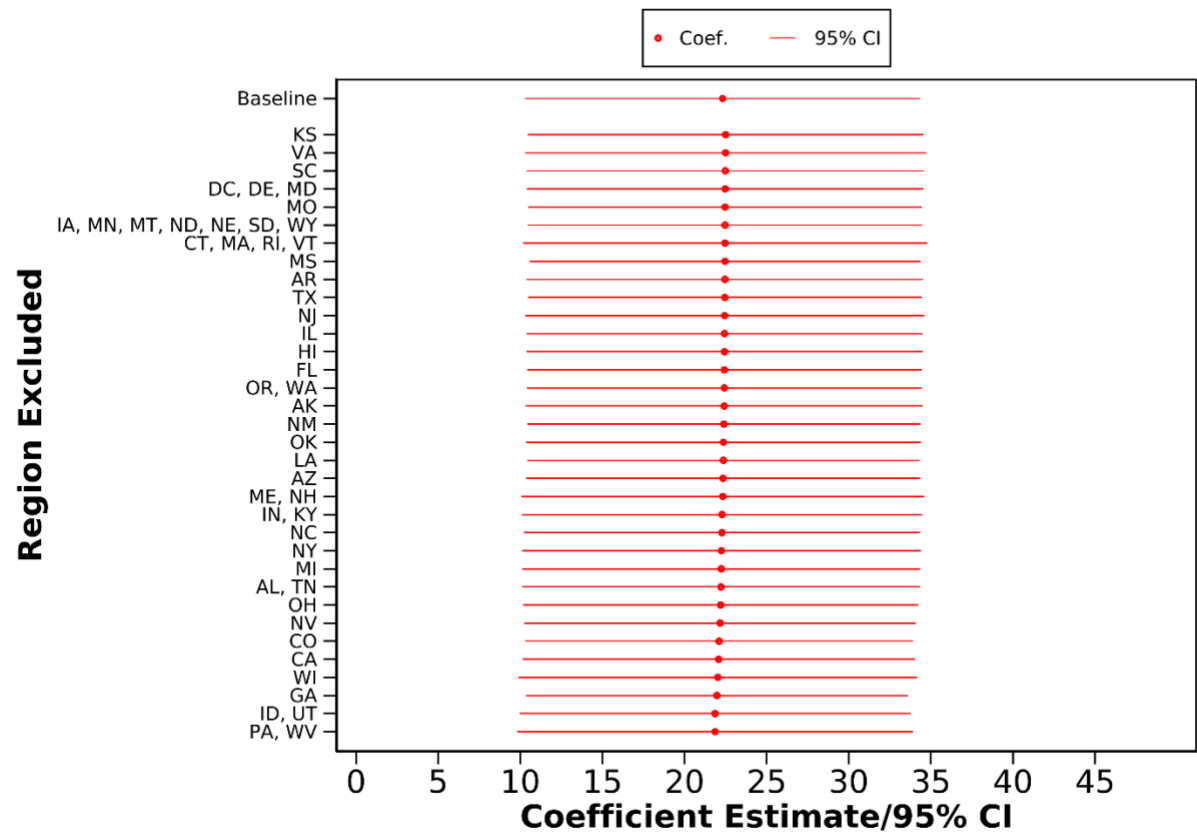
Notes: This figure replicates Figure 3 in the main paper, but uses an alternative control group. The control group is vertically integrated plans that sell their PBM services to other plans (group (a) only). Standard errors are clustered at the insurer level. We include a full set of plan characteristics as controls (annual deductible, indicators for LIS eligibility, gap coverage, and plans with enhanced benefits), year fixed effects, region fixed effects, and insurer fixed effects.

Appendix Figure C.4: Difference-in-Differences Estimates of Premium Changes for Non-Vertically Integrated Plans After UnitedHealth-Catamaran Merger, by Plan Subgroup (Alternative Control Group)



Notes: This figure replicates Figure 4 in the main paper, but uses an alternative control group. The control group is vertically integrated plans that sell their PBM services to other plans (group (a) only). Standard errors are clustered at the insurer level. We include a full set of plan characteristics as controls (annual deductible, indicators for LIS eligibility, gap coverage, and plans with enhanced benefits), year fixed effects, region fixed effects, and insurer fixed effects.

Appendix Figure C.5: Leave-One-Out Analysis: Excluding Each Part D Region



Notes: This figure displays point estimates and 95% confidence intervals from a leave-one out analysis in which we estimate our primary difference-in-differences regression (Equation (1)), excluding plans from one Part D region at a time. We include a full set of plan characteristics as controls (annual deductible, indicators for LIS eligibility, gap coverage, and plans with enhanced benefits), year fixed effects, region fixed effects, and insurer fixed effects.

Appendix Table C.1: Difference-in-Differences Effects on Plan Characteristics

Dependent Variable =	Annual Deductible (1)	1(Enhanced) (2)	1(Gap Coverage) (3)	1(LIS Subsidy) (4)
1(Treated)*1(Year $\geq$ 2015)	-17.064 (53.983)	0.049 (0.059)	0.055 (0.137)	-0.067 (0.045)
Average Dependent Variable	168.904	0.541	0.300	0.280
N	6,453	6,453	6,453	6,453
R2	0.141	0.035	0.113	0.063

Notes: This table displays point estimates from a difference-in-differences regression similar to our primary specification (i.e., Equation (1)). However, in these regressions, we use plan characteristics as the outcome variables. We do not include any plan characteristics as controls. We include year fixed effects, region fixed effects, and insurer fixed effects.

Appendix Table C.2 – Robustness of Baseline Results to Alternative Regression Weights

Dependent Variable = Monthly Part D Premium (\$)

	Unweighted (1)	Insurer's Contemporaneous Enrollment (2)	Insurer's 2014 Enrollment (3)	Insurer's Contemporaneous Mkt. Share (4)	Insurer's 2014 Mkt. Share (5)
1(Treated)*1(Year ≥ 2015)	22.315*** (5.742)	23.677*** (4.928)	22.192*** (5.280)	22.278*** (4.684)	20.717*** (4.938)
Average Premium (Weighted)	52.939	50.279	51.078	49.843	50.256
N	6,453	6,453	6,447	6,453	6,447
R2	0.660	0.700	0.707	0.703	0.708

Notes: This table displays point estimates from our difference-in-differences regression using different regression weights. Column (1) is the baseline result that is unweighted. Column (2) uses the insurer's contemporaneous regional enrollment. Column (3) uses the insurer's regional enrollment from 2014. Column (4) uses the insurer's contemporaneous regional market share. Column (5) uses the insurer's 2014 regional market share. We include a full set of plan characteristics as controls (annual deductible, indicators for LIS eligibility, gap coverage, and plans with enhanced), year fixed effects, region fixed effects, and insurer fixed effects.