Disadvantaging Rivals: Vertical Integration in the Pharmaceutical Market*

Charles Gray
Bates White Economic Consulting

Abby Alpert
University of Pennsylvania and NBER

Neeraj Sood
University of Southern California and NBER

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Abstract

The pharmaceutical market has experienced a wave of vertical integration between pharmacy benefit managers (PBMs) and insurers in recent years. Using a unique dataset on insurer-PBM contracts, we document increasing vertical integration in Medicare Part D. Next, we evaluate the effects of a large insurer-PBM merger in 2015, assessing the trade-offs of vertical integration–harms to competition on the one hand and improved efficiency on the other. We find premium increases for rival insurers post-merger, consistent with vertically integrated PBMs raising costs through input foreclosure. We find no evidence of benefits to consumers of the merged firm from lower premiums.

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Vertical integration –i.e., integration between an upstream supplier and a downstream buyer— has grown substantially in the healthcare sector over the last few decades. While antitrust regulators have historically focused attention on horizontal integration, there is growing interest in understanding the effects of vertical relationships on market competition and consumer welfare. In theory, vertical integration can eliminate double marginalization, improve care coordination, and better align incentives resulting in lower prices (Spengler 1950; Williamson 1985; Grossman and Hart 1986). On the other hand, vertically integrated firms can engage in input foreclosure, leading to higher prices for rival firms (Salop and Scheffman 1983; Ordover, Saloner, and Salop 1990; Hart et al. 1990). The evidence on the effects of vertical integration in healthcare is quite limited and focuses largely on hospital-physician consolidation. In this study, we present some of the first empirical evidence of how vertical integration between pharmacy benefit managers (PBMs) and health insurers has impacted premiums in the Medicare Part D prescription drug insurance market.

PBMs are an important and controversial intermediary in the pharmaceutical supply chain. PBMs contract with insurers to manage their prescription drug benefits. A principal function of PBMs is negotiating with drug manufacturers and pharmacies on behalf of insurers to obtain discounts and rebates on prescription drugs. PBMs manage pharmaceutical benefits for almost 90% of insured Americans (Dowell 2022). PBMs are able to negotiate large rebates because they leverage enormous bargaining power from pooling together the enrollees of multiple insurers. However, PBMs have also drawn considerable criticism about the opacity of rebates and their potentially limited pass-through to insurers as well as perverse incentives that may encourage PBMs to give favorable formulary placement to drugs with higher list prices (Sood et al. 2020; Van Nuys et al. 2021; FTC 2024).

Underlying these concerns has been a trend towards increasing consolidation of PBMs. The initial wave of consolidation among PBMs was primarily horizontal, however, the last decade has brought vertical integration between PBMs and health insurers. In 2020, the three largest PBMs—who processed approximately 80% of prescription drug claims—were each integrated with an insurer (Fein 2021). While this integration could have the benefit of aligning PBM incentives with the interests of the insurers that own them, it also raises anticompetitive concerns through input and customer foreclosure.

Input foreclosure occurs when a PBM owned by an insurer increases the costs or reduces the quality of its services provided to insurers who compete with its parent insurer. For example, the PBM could pass through a larger share of manufacturer rebates to its parent insurer than it passes through to rival insurers. Customer foreclosure occurs when the downstream firm of a merged entity no longer purchases inputs from its upstream competitors. For instance, when an insurer and PBM consolidate, the insurer's plans will always use its own PBM, thus reducing the potential customer base for standalone PBMs. This reduction could ultimately lead standalone PBMs to exit the market, reducing competition.

In this study, we examine the consequences of vertical integration of PBMs and insurers in the Medicare Part D market. We ask whether vertical integration has harmed non-vertically integrated rival insurers through input foreclosure. This is the first study to link information on insurer-PBM contract relationships from a proprietary dataset to Centers for Medicare and Medicaid Services (CMS) data on Part D prescription drug insurance plans (PDPs). Using these unique data, we first highlight increasing trends in market shares of vertically integrated Part D plans from 2010 through 2018. Next, we highlight potential input foreclosure by showing increasing trends in premiums for non-vertically integrated plans relative to vertically integrated

plans, especially after the collapse of the standalone PBM market. This descriptive analysis motivates our main empirical strategy. We conduct a difference-in-differences analysis leveraging a large insurer-PBM merger in 2015 (UnitedHealth-Catamaran) which eliminated the last significant standalone PBM and shifted insurers into contracts with PBMs owned by rival insurers. This provides an opportunity to evaluate how premiums change when plans switch from a standalone PBM to a PBM that is vertically integrated with a rival insurer as well as how premiums change for all other non-vertically integrated plans when the main outside option for standalone PBM services is removed.

We focus on the Part D standalone PDP market for several reasons. First, insurer-PBM integration has been a long-standing feature of this market compared to the commercial market, giving us a longer time horizon in which to observe its impacts. Since Part D's inception, some PBMs have simultaneously provided services to insurers offering PDPs while also underwriting their own competing prescription drug plans (e.g., CVS Caremark operates as both an insurer and a PBM). In this sense, some PBMs have operated as vertically integrated insurer-PBMs within Part D. Second, unlike most commercial health insurance and Medicare Advantage plans, PDPs offer only prescription drug coverage rather than bundled medical and drug benefits. This provides a clean setting for isolating the effects of insurer-PBM relationships on prescription drug premiums. Finally, the Part D market is important to study with 53 million Medicare beneficiaries enrolled and estimated spending of $137 billion, representing 15% of Medicare spending (KFF 2024).

We find that the share of Part D beneficiaries enrolled in vertically integrated plans increased substantially from about 30% to 80% between 2010 and 2018. At the same time, premiums increased for non-vertically integrated insurers who obtained PBM services from a

rival plan. The exit of Catamaran, the last significant standalone PBM in Part D, led to premium increases for former clients of the standalone PBM who had to switch to using a rival insurer's PBM. Additionally, the loss of this outside option for standalone PBM services resulted in premium increases for other non-vertically integrated insurers already using a PBM owned by a rival insurer. Overall, our difference-in-differences estimates show that non-vertically integrated insurers experienced premium increases of $22 per month (about 40%) when compared to vertically integrated insurers. These findings are consistent with vertically integrated PBMs engaging in input foreclosure. Another possibility is that acquiring Catamaran could have enhanced UnitedHealth's bargaining power in negotiations with drug manufacturers. However, we do not find any evidence of cost savings being passed through to consumers, as premiums of UnitedHealth's plans did not change after the merger.

This paper contributes to several lines of research. First, we contribute to the literature on vertical integration in healthcare. Most of this literature has focused on hospital-physician integration, finding that prices increase with little or no improvement in the quality of care (Cuellar and Gertler 2006; Ciliberto and Dranove 2006; Baker, Bundorf, and Kessler 2014; Koch, Wendling, and Wilson 2017; Capps, Dranove, and Ody 2018; Richards, Seward, and Whaley 2022). We are unaware of any empirical research that has studied the consequences of vertical integration between insurers and PBMs. This paper will be the first to consider this important understudied area.

Second, we contribute to the nascent research on PBMs. The existing literature has introduced theoretical models on the operations of PBMs (Conti et al. 2021; Brot-Goldberg, Che, and Handel 2022; Feng and Maini 2023). Most relevant to our study, Brot-Goldberg, Che, and Handel (2022) show simulation results from a game-theoretic model of a PBM negotiating with

drug manufacturers on behalf of two competing insurers. Their simulation results show that when the PBM integrates with one of the insurers, the PBM disadvantages the rival insurer by passing through a smaller proportion of the rebate, leading to higher premiums (i.e., input foreclosure). The few empirical studies on PBMs focus on how they affect net drug spending through rebates (Olssen and Demirer 2021; Feng and Maini 2023; Ho and Lee 2024) and R&D investments (Agha, Kim, and Li 2022). While there has been substantial debate about the potential consequences of increasing vertical consolidation (e.g., FTC 2024), we are unaware of any empirical evidence on how insurer-PBM vertical integration affects consumer welfare. We aim to fill this gap by considering how this integration impacts premiums in Medicare Part D.

Finally, this paper contributes to the literature studying competition in the Part D market. Prior research has studied the effects of horizontal insurer mergers on Part D premiums (Chorniy, Miller, and Tang 2020; Hill and Wagner 2021). We broaden our understanding of insurer competition in Part D by considering how vertical PBM-insurer mergers can have downstream effects on competition among insurers.

I. Background

A. Medicare Part D

Medicare Part D is a voluntary benefit that has provided prescription drug insurance to Medicare beneficiaries since 2006. Plans are designed and managed by private insurers who compete to enroll Medicare beneficiaries. Medicare beneficiaries choose plans offered in 34 regional insurance exchanges. Plans are offered as either standalone prescription drug plans (PDPs) or Medicare Advantage prescription drug plans (MA-PDs). We focus on PDPs, which account for about 48% of enrollees.[1] MA-PDs provide prescription drug insurance bundled with

[1] In 2018, 48% of Part D enrollees were enrolled in a standalone PDP while 36% were enrolled in a MA-PD plan. The remaining 16% were enrolled in employer sponsored Retiree plans (KFF 2021).

medical coverage, which obscures the relationship between premiums and prescription drug costs.

B. Pharmacy Benefit Managers

PBMs provide a multitude of services for insurers including processing of claims, clinical and utilization management, designing the drug formulary, contracting with pharmacies, and negotiating rebates with drug manufacturers. While Part D has regionally defined markets, PBMs typically contract with insurers at a national level. For instance, an insurer offering plans in multiple Part D regions will typically contract with the same PBM in all of those regions. Although PBM-insurer relationships are generally national, we will conduct our analysis at the plan-region-year level to account for competitive dynamics in regional insurance markets.

II. Conceptual Framework of Potential Effects of Insurer-PBM Integration

We outline a simple conceptual framework to understand how vertical integration of an insurer and PBM affects market outcomes post-merger. In this framework we consider two potential cases of insurer-PBM vertical integration.

A. Purely Vertical Merger (Case 1)

First, we consider the case of a purely vertical merger, i.e., a merger between an insurer without PBM capabilities and a standalone PBM. To illustrate, we consider a market with a single PBM that contracts with 2 prescription drug insurers: Plan A and Plan B (see Panel A of Appendix Figure B.1). Suppose there is a vertical merger between one of the plans (Plan B) and the PBM. We describe the main predicted harms and efficiency gains from the vertical merger relative to the baseline case with no vertical integration.

The main predicted harms are input foreclosure and customer foreclosure. Input foreclosure occurs when a PBM owned by an insurer disadvantages rival insurers by increasing

the costs or reducing the quality of the PBM services it provides to them.[2] For example, the PBM could pass through a larger share of manufacturer rebates to its parent insurer (Plan B) than it passes through to a rival insurer (Plan A). It could also charge higher administrative fees, cover higher rebate but higher cost drugs in the formulary, or foreclose certain services that were previously offered. All of these actions could raise costs for the rival insurer (Plan A), which could in turn lead to higher premiums.

The degree of input foreclosure will depend on several factors that affect the merged firm's incentive and ability to raise costs for their rival. First, it will depend on the level of competition in the PBM market. In this simple case with a monopolist PBM, input foreclosure is highly likely since the rival insurer (Plan A) cannot switch to another PBM if their contract becomes unfavorable. However, if there are many standalone PBM competitors, then input foreclosure is less likely since the rival plan can switch to a substitute PBM. Second, input foreclosure may depend on insurer size. Smaller insurers are more likely to experience input foreclosure because they cannot credibly threaten to manage their own pharmacy benefit. Third, the degree of input foreclosure could depend on insurer inertia. The merged firm is less likely to engage in input foreclosure for rival plans that are new clients compared to existing clients, as new clients might scrutinize the behavior of the merged firm more than existing clients who could become inertial and inattentive to worsening services.

Customer foreclosure, on the other hand, occurs because the parent insurer will always use services from its own PBM once they consolidate, thus reducing the potential number of clients for PBMs. This reduction in the number of insurer clients available to PBMs could either

[2] While vertically integrated firms could also refuse to supply services altogether (i.e., complete foreclosure), this is not the primary concern in our context. We use the term "input foreclosure" to encompass both conduct that raises rivals' costs and complete foreclosure (e.g., DOJ and FTC Vertical Merger Guidelines (2020)).

deter entry of new PBMs or lead to exit of existing PBMs thereby reducing competition in the PBM market.

The potential benefits of the merger are efficiencies gained from the elimination of double marginalization, alignment of incentives, and better coordination between insurer and PBM. The merged firm maximizes a joint profit function rather than separate profit functions, which eliminates double marginalization. In our context, double marginalization could occur when a PBM engages in practices such as "spread pricing", not completely passing through rebates to the insurer, or charging a mark-up on administrative fees for services provided. Following the merger, rebates and discounts are fully passed through to the insurer and the PBM provides services at cost since it is part of the same firm. Vertical integration also aligns the incentives of the PBM with the insurer. For example, a standalone PBM could prefer drugs with higher rebates even if it increases costs for the plan as higher rebate drugs imply higher profits for the PBM. Post vertical integration, the incentives of insurer and PBM are the same and thus can potentially lead to efficiencies in formulary and benefit design. Finally, better coordination between the insurer and PBM could lead to efficiencies in clinical management. For example, they could integrate their IT systems and share information more seamlessly.

B. **Vertical and Horizontal Merger (Case 2)**

In the second case, we consider a merger between a vertically integrated insurer and a standalone PBM. This is the case represented in our empirical analysis: UnitedHealthcare already had its own PBM OptumRx and it acquired the standalone PBM Catamaran. In this type of merger, there will be both vertical and horizontal effects. Panel B of Appendix Figure B.1 shows this type of merger. Suppose vertically integrated Plan B merges with standalone PBM B. Plan B already owned PBM A, so it combines both PBM A and PBM B after the merger.

This type of merger shares similar vertical effects as a purely vertical merger (Case 1). Similar to a purely vertical merger, the main predicted harm is input foreclosure.[3] Former clients of PBM B (Plans C and D) could experience input foreclosure since they switch from using a standalone PBM to using a PBM owned by a rival insurer. Additionally, Plan A, which had already been using a PBM owned by a rival insurer, also faces an increased risk of input foreclosure.[4] Plan A lost the remaining outside option for standalone PBM services, so they can no longer threaten to switch to another PBM. This makes it more likely that they will receive unfavorable terms or lower quality services from their existing, rival-owned PBM.

This type of merger differs from the purely vertical merger with respect to the efficiency gains. Unlike the first case, this merger is unlikely to lead to substantial efficiencies from eliminating double marginalization or by aligning incentives because these benefits were previously realized by the parent insurer (Plan B) when they merged with the initial PBM (PBM A). However, the integration of PBM A and PBM B could lead to efficiencies from its enhanced bargaining power in negotiations with the drug manufacturers which could increase rebates collected. Logistical efficiency gains are also possible due to economies of scale. This would reduce costs and could lower premiums primarily for the merged firm.

Based on this framework, we predict that non-vertically integrated insurers will experience an increased risk of input foreclosure post-merger which could raise their costs and

[3] Unlike the case of the purely vertical merger, this merger will not lead to customer foreclosure because the number of potential customers for standalone PBMs (i.e., non-vertically integrated insurers) is unchanged after the merger.
[4] In addition to the vertical input foreclosure effects of the UnitedHealth-Catamaran merger, the combination of OptumRx and Catamaran could also, in principle, generate horizontal market power effects by increasing concentration in the PBM market. These horizontal effects would, in theory, raise prices for all PBMs. However, since Catamaran was the last standalone PBM in the Part D market and the remaining PBMs were all vertically integrated, we do not expect to observe market-wide increases in PBM prices, as would typically result from standard market power effects. This is because the vertically integrated PBMs would raise prices for their rival insurer clients but not for their own parent insurers–a differential effect that constitutes input foreclosure. In other words, the increasing horizontal concentration resulting from this merger exacerbates input foreclosure effects since it eliminated the outside option for standalone PBM services.

lead them to increase their premiums. Insurers who use their own PBM will not experience any input foreclosure effects from the merger. This framework forms the basis of a difference-in-differences approach for estimating input foreclosure effects which is discussed in Section V.

III. Data

A. Medicare Part D Data

We use publicly available datasets from CMS that contain information on Medicare Part D plan characteristics and enrollment from 2010 through 2018. We obtain plan characteristics from the CMS PDP Landscape files (CMS 2010-2018a).[5] The files include the insurer and plan names, Part D Region of the plan, monthly premium paid by the beneficiary, and other plan characteristics. We also obtained each plan's annual enrollment from the CMS Part D Contract and Enrollment Data files (CMS 2010-2018b, CMS 2010-2018c).[6] We restrict the plans in our sample to standalone PDPs. Our full sample consists of 9,341 plan-region-year observations.

B. PBM Data

Our second data source comes from historical snapshots of the Decision Resources Group (DRG) Managed Market Surveyor (MMS) from 2010 through 2018.[7] The MMS is a proprietary dataset created by surveying all insurers offering commercial, Medicare Part D, or Medicaid plans to determine which PBM each plan utilizes for several categories of services: formulary management, rebate negotiations, claims adjudication, mail-order pharmacy, and benefit design. We match these PBM service variables from the MMS data to our sample of Medicare standalone plans to identify the PBM services used by each plan.

[5] We supplement these with additional plan information from ResDAC as well as the plan archives of Q1Medicare. See data replication package for more information (Q1Medicare 2013; ResDAC 2013).
[6] We supplement the enrollment data with social security administration to FIPS county crosswalks from NBER. See data replication package for more information (NBER 2010-2018).
[7] DRG was acquired by Clarivate after we obtained these data. Please see data replication package for more details on accessing the MMS data (Clarivate 2010-2018).

Most plans in our sample (about 74% of plan-region-year observations) utilize only one PBM per year or act as their own PBM. The remainder use two or more PBMs for different services (e.g., one PBM for rebate negotiations/formulary design and another for mail-order pharmacy) (26%). When there are multiple PBMs recorded, we assign the PBM that is responsible for rebate negotiations and formulary management which is most relevant for our analysis. For about 1.7% of plan-region-year observations, a plan uses a different PBM for rebate negotiations and formulary management. In these cases, we research the insurer and PBMs by reading 10Ks, annual reports, and other publications to determine the primary PBM serving each plan (see Appendix A for details on the assignment algorithm).

C. Defining Insurer-PBM Relationships

Our analysis will study insurer-PBM relationships in the Part D PDP market. We categorize insurer-PBM relationships into four distinct groups: (a) insurers that are vertically integrated with a PBM (e.g., CVS Caremark plans using CVS Caremark as their PBM); (b) insurers without PBM capabilities that use a PBM which is vertically integrated with a rival insurer (e.g., Wellcare using CVS Caremark as its PBM); (c) insurers without PBM capabilities that use standalone PBMs—that is, PBMs that sell their services to Part D insurers, but do not offer prescription drug plans themselves (e.g., Wellcare using Catamaran as its PBM); (d) insurers who possess PBM capabilities that they use for their own plans, but do not sell those PBM services to rival insurers (e.g., Humana). We consider group (d) outside the PBM market. Table 1 provides summary statistics for each category.

IV. Trends in Insurer-PBM Vertical Integration and Premiums in Medicare Part D

Using these definitions, we first compute market shares for the three insurer-PBM types that participate in the PBM market ((a) through (c)) by summing enrollment for each insurer-

PBM type and dividing by total enrollment across the three types.[8] Figure 1 shows that about 30% of Medicare Part D PDP enrollees in our sample were enrolled in an insurance plan vertically integrated with a PBM (type (a)). By 2018, more than 80% were enrolled in a vertically integrated plan. Over the same time period, the market shares of non-vertically integrated plans using a rival insurer's PBM or a standalone PBM plummeted. The market share of plans using a rival's PBM was only 19% by 2018. The market share of plans utilizing standalone PBMs never exceeded 25%. However, their collective market share fell close to zero after Catamaran, the last significant standalone PBM, was acquired in 2015.[9] Rising market share of vertically integrated plans indicates rising customer foreclosure in the PBM market, as members of these plans are locked out from the PBM market and are unable to use standalone PBMs. This could have precipitated the collapse of the standalone PBM market in Part D. Furthermore, this trend could indicate the potential for input foreclosure since plans will be less able to threaten a switch to a standalone PBM as vertical integration increases.

Next, we show trends in mean monthly Part D premiums paid by Medicare beneficiaries in Figure 2. If input foreclosure is increasing in this market, then we would expect that premiums would rise faster for non-vertically integrated plans using PBMs owned by rival insurers (type (b)), who would face higher input costs for PBM services due to input foreclosure, relative to vertically integrated plans (type (a)). These differences would be more pronounced as competition from standalone PBMs weakens.

[8] The descriptive analysis of the PBM market focuses on the first three insurer-PBM relationships, which account for three-fifths of the PDP market, and excludes group (d) because those PBMs do not compete with other PBMs. For example, a non-Humana insurer cannot purchase PBM services from Humana's PBM. However, the difference-in-differences analysis includes group (d) plans in the control group since they are unaffected by input foreclosure; our results do not change whether or not they are included in our analysis.

[9] Two small standalone PBMs, DST Pharmacy Solutions and MedImpact, remained after Catamaran's exit with a combined market share of 0.37% in 2016. DST exited the PDP market in 2018 and MedImpact retained only one client in one Part D region.

Part D premiums were initially similar across plan types, but began to diverge as the market share of vertically integrated plans increased such that by 2018, the average premiums of non-vertically integrated insurers using a rival's PBM were almost 63% higher than premiums of vertically integrated plans.[10] Overall, premiums grew by 74% from 2010 to 2018 for non-vertically integrated plans using a rival's PBM compared to a slight reduction of approximately 5% for vertically integrated plans. These trend lines are raw means that do not account for differences in plan or geographic characteristics. However, these trends are consistent with the possibility that there was increasing input foreclosure. The trend of decreasing premiums for vertically integrated insurers is consistent with possible efficiency gains.

V. Empirical Strategy: Leveraging the Exit of the Last Standalone PBM

To assess whether input foreclosure can explain the increase in premiums observed in the previous descriptive analysis, we conduct a difference-in-differences and event study analysis to study UnitedHealth/OptumRx's acquisition of Catamaran, the last significant standalone PBM, which occurred in July 2015.[11] When Catamaran became part of the vertically integrated UnitedHealth/OptumRx, insurers previously using this standalone PBM transitioned largely to contracts with vertically integrated PBMs. This merger provides an opportunity to test two hypotheses outlined in the conceptual framework. First, we predict that insurers switching from a standalone PBM to a rival's vertically integrated PBM could experience input foreclosure which could raise their costs and lead them to increase their premiums relative to vertically integrated insurers. Second, the exit of Catamaran could also affect other non-vertically integrated insurers which had already been utilizing a PBM owned by a rival insurer prior to Catamaran's exit.

[10] We exclude from Figure 2 plans using standalone PBMs (type (c)) since there were very few enrollees in these plans in the later years of our study period, so the premium data are noisy. Appendix Table B.1 shows premium trends for these plans.

[11] UnitedHealth is the insurance arm while OptumRx is the PBM arm of the same company.

These insurers could also be exposed to an increased risk of input foreclosure as they no longer have the outside option of switching to a standalone PBM. To test this, we compare premium changes after the UnitedHealth-Catamaran merger for non-vertically integrated insurers who were exposed to an increased risk of input foreclosure relative to a control group of vertically integrated insurers that use their own PBM and thus do not face input foreclosure. This isolates the input foreclosure effects of the merger, which should only affect non-vertically integrated insurers. It is possible that the merger could result in efficiency gains for the merged firm, which could contribute to our estimates of input foreclosure. However, we will show that premiums do not change for UnitedHealth relative to other vertically integrated PBMs, making this less likely.[12]

To conduct our difference-in-differences analysis, we estimate the following regression:

$$(1)\ Premium_{ijrt} = \gamma_j + \tau_t + \alpha_r + \boldsymbol{X'}_{ijrt}\boldsymbol{\beta} + \delta\left(1(Treated_j) \times 1(Year_t \geq 2015)\right) + \varepsilon_{ijrt}$$

Where $Premium_{ijrt}$ is the monthly premium of plan i offered by insurer j in Part D region r in year t.[13] Premiums represent the monthly amount that beneficiaries pay during the calendar year.[14] $1(Treated_j)$ is an indicator equal to one if the insurer is not vertically integrated with a PBM and thus must purchase PBM services from a rival firm. The control group are insurers who are vertically integrated with a PBM (group (a)) or insurers who use their own PBM but do not sell those services to other plans (group (d)). We define both groups based on the insurer's

[12] The merger could also lead to market-wide effects due to lessened downstream competition after some insurers face increased costs. Our paper does not estimate market-wide effects and instead focuses on identifying the differential effects of the merger on non-vertically integrated insurers. We difference out market-wide effects that are the same across insurers with time and region fixed effects. To the extent that vertically integrated insurers raise premiums more than others because of increased market power, this would likely attenuate our results. However, finding no premium changes for UnitedHealth lessens this concern.

[13] We do not adjust Part D premiums for inflation since we include year fixed effects in our analyses which will account for national inflationary effects.

[14] Premiums can change on January 1 and changes are typically announced at the end of the previous year.

status just prior to the merger. $1(Year_t \geq 2015)$ is an indicator equal to 1 in all years on or after 2015, when Catamaran was acquired. We include insurer fixed effects γ_j to account for fixed, unobservable characteristics of the insurers that may influence their premiums, year fixed effects τ_t to account for national trends in premiums, and Part D region fixed effects α_r to control for regional characteristics that are constant over time. We also control for a full set of plan characteristics: annual deductible, an indicator for enhanced benefits, an indicator for gap coverage, and an indicator for whether the plan is eligible to enroll low-income beneficiaries. Standard errors are clustered at the insurer level. We also estimate an event-study version of Equation (1) where we interact $1(Treated_j)$ with year fixed effects to evaluate the parallel trends assumption and show how the merger effects evolve over time.

We assess heterogeneity in the effects of Catamaran's exit across two groups of non-vertically integrated plans (see Appendix A for insurers in these groups). First, we examine 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. Second, we examine plans that had already been using a vertically integrated PBM owned by a rival insurer in 2015. These plans lost their remaining outside option of a standalone PBM when Catamaran exited.

Finally, we assess the merger's effects for UnitedHealth's own plans compared to other insurers that use their own PBM. UnitedHealth plans may realize efficiency gains from the enhanced bargaining power of adding additional lives to its PBM.

VI. Results

A. Effects of UnitedHealth-Catamaran Merger on Premiums

We begin by estimating an event study of premium changes in Figure 3. Prior to the merger, between 2010 and 2014, the premium trends for non-vertically integrated plans were not

statistically distinguishable from vertically integrated plans that used their own PBM. However, following Catamaran's exit in 2015, we observe a statistically significant divergence in these trends. Non-vertically integrated plans' premiums begin to grow relative to vertically integrated plans.[15] The small effect in 2015 likely reflects that this is a partially treated year.[16] Using our difference-in-differences model in equation (1), Figure 4 shows that non-vertically integrated plans experienced premium growth of approximately $22 per month after Catamaran's exit relative to the control group of vertically integrated plans (Column (1)); this represents an approximately 42% increase from the mean monthly premium of $53. The large magnitude of this effect may indicate that PBMs are raising costs for rivals along multiple dimensions.[17]

B. Heterogeneity by Insurer Type

Next, we decompose this effect separately for the two groups of non-vertically integrated insurers: (1) plans using Catamaran in the quarter before its exit who switched to a rival's vertically integrated PBM, and (2) plans that were already using a rival's vertically integrated PBM before the exit (Columns (2) and (3) of Figure 4). The insurers that shifted to a rival's vertically integrated PBM after using Catamaran experienced a premium increase of approximately $15 relative to the control group of vertically integrated plans (29% increase). For

[15] We expect that the effects would grow over time, since pre-existing contracts between PBMs and insurers–which typically last three years (McEacherm and Cambel 2020)— might protect some insurers from facing the full effects of input foreclosure until those contracts expire.

[16] There is often a long period of negotiation and due diligence before a merger announcement which could lead to anticipatory effects on premiums. For example, vertically integrated PBMs who anticipate that Catamaran will be bought could raise costs for rival insurers in anticipation of the merger, which could affect premiums in 2015.

[17] PBMs could raise costs to rivals through multiple channels including rebates, administrative fees, formulary design, and clinical management. Moreover, the opaqueness of PBM contracts increases the likelihood that these changes can be made without input or awareness from the insurers, potentially leading to large cost increases. To further assess the plausibility of these estimates, we estimate the change in enrollment resulting from the premium increase (see Appendix Table B.2). We estimate a premium elasticity of demand of -0.723 in the log specification (-0.746 in levels) which is within the range of other studies of Part D (e.g., Abaluck & Gruber (2011), Lucarelli, Prince, and Simon (2012), Brown & Jeon (2024)).

insurers already using a rival's vertically integrated PBM in 2015, the relative premium increase was approximately $31 (58% increase).

We investigate two possible explanations for the result that the plans most directly affected by Catamaran's exit had a smaller premium increase than plans indirectly affected because they lost their outside option for standalone PBM services. First, we explore the extent to which an insurer's size predicts the magnitude of the premium effect. We hypothesized that smaller insurers are more likely to experience input foreclosure. Since plans that previously used Catamaran tended to be larger insurers, the premium effects of the merger for these plans could be smaller. To test this explanation, we estimate the premium effect separately for insurers who had been using a rival's PBM in 2015 based on quartiles of their size. Indeed, the largest increase in premiums occurs for the smallest insurers (quartile 1). For the remaining quartiles there is no relationship between insurer size and the premium increase (Appendix Figure B.2). Thus, this may explain some, but not likely all, of the differences in effects between the two groups of plans.

The second explanation we consider is insurer inertia. Insurers who had Catamaran as their PBM were forced to switch to a new PBM. PBMs might offer better deal terms to new clients and then gradually increase input foreclosure over time as insurers become more inattentive (i.e., in the spirit of the "invest-then-harvest" strategy (Ericson 2014)). We re-estimate our main regression, but split the plans already using a rival's PBM in 2015 into two subgroups: (1) those that stayed with the same PBM for all years after Catamaran's exit and (2) those that switched to a different PBM at any point after Catamaran's exit.[18] We find that insurers that switch to a new PBM increase their premiums by approximately $18 (Column (4) of Figure 4).

[18] Five out of the fifteen insurers switched to a new PBM and the remaining ten stayed with the same PBM.

In contrast, the inertial insurers that did not change PBMs increased premiums by nearly $32 (Column (5)). These results are consistent with PBMs raising input costs more for inattentive insurers.

C. Effects of Merger on UnitedHealth's Own Plans

It is possible that the integration of Catamaran and OptumRx could enhance the PBM's bargaining power in negotiations with drug manufacturers resulting in greater cost savings. Additionally, acquiring Catamaran could have improved the operations of UnitedHealth's PBM, which enabled reduced premiums. To test this, we estimate an event study comparing how the premiums of UnitedHealth's plans change after the merger relative to the premiums of other insurers that use their own PBMs. The point estimates from this event study are near zero and not statistically significant suggesting that UnitedHealth did not experience meaningful efficiency gains to lower its premiums relative to other vertically integrated competitors or that any cost savings were not passed through to consumers (see Figure 5).[19]

D. Robustness Tests

We conducted numerous robustness tests that are discussed in detail in Appendix C. First, we test whether plan characteristics change endogenously as a result of the merger. We directly estimate the impact of the merger on plan characteristics, but the estimates are not statistically significant. Additionally, our main results are unchanged whether or not we include plan characteristic controls. 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). Our results are also robust to weighting by insurer

[19] As an additional robustness check, we also re-estimate our primary regression excluding UnitedHealth's own plans and rival plans using UnitedHealth's PBM. Our results are effectively unchanged (columns (6) through (8) of Appendix Table B.3).

enrollment or market share or using an alternative control group. Finally, we implement a "leave-one-out" analysis where we exclude each Part D region in turn. The effects of the merger on premiums are not driven by a single market.

VII. Conclusion

We document that the market share of vertically integrated Part D prescription drug plans grew significantly from approximately 30% to 80% between 2010 and 2018. As integrated insurer-PBM enrollment expanded, the potential market size for standalone PBMs shrunk (i.e., customer foreclosure). This is one force that may have contributed to Catamaran's exit and the end of the standalone PBM market in Medicare Part D.

We show that both customer foreclosure and input foreclosure can occur and are potentially linked. As the market share of vertically integrated insurers grew, premiums increased rapidly for non-vertically integrated plans using a rival insurer's PBM. This premium increase was particularly pronounced following Catamaran's exit, the last significant standalone PBM. The growth in premiums of non-vertically integrated plans is consistent with input foreclosure. That is, when non-vertically integrated insurers lost an outside option for standalone PBM services, vertically integrated PBMs had a greater incentive to raise costs for its rivals which led to premium increases. These premium increases provide evidence of direct harm to consumers. We do not rule out the possibility that insurers vertically integrated with a PBM experience efficiency gains that might enable them to lower their own premiums. However, for the merger we analyzed, our results do not show any benefit to consumers because premiums did not change for UnitedHealth plans relative to other insurers that use their own PBM.[20]

[20] The efficiency gains could differ for a purely vertical merger as discussed in Section II.A This type of merger does not exist during our study period and thus we leave it as an important area for future research.

In the long run, vertical mergers might also have market-wide effects. Regulators should consider the extent to which a vertical merger could potentially concentrate market power in both the insurer and PBM markets. The merger we studied increased concentration in the PBM market which increased the incentive for input foreclosure (the focus of this study). Input foreclosure might ultimately lead to reduced enrollment in and exit of non-vertically integrated insurers, consequently increasing concentration in the insurer market. Vertical integration might also deter entry in both the PBM and insurer markets. These long run market-wide effects may lead to oligopolistic competition between vertically integrated firms with important consequences for consumer welfare. Our analysis did not estimate these long run market-wide effects, but they are an important direction for future research.

The results of our study should be viewed in light of its limitations. First, we study input foreclosure in a context where insurers lost the remaining outside option to get services from a standalone PBM. This scenario resembles the commercial health insurance market where the three largest PBMs have integrated with large insurers, leaving limited options for standalone PBM services. However, the results might not generalize to other markets where firms have many options to obtain inputs from non-vertically integrated firms—these markets could experience smaller input foreclosure effects. Our paper highlights a key lesson for policymakers that the likelihood of input foreclosure increases with less competition in the input market. Second, although the data classifies the services provided by each PBM to insurers, we do not have detailed information on the specific contract terms. Therefore, we are unable to observe how contracts change after the merger. Third, although we show that the exit of Catamaran is associated with changes in insurers' premiums, these changes may not be solely attributable to this event. We control for observable plan characteristics, but there may be unobservable factors

that could also influence plan premiums. For instance, to the extent that vertically integrated PBMs improve *unobserved* dimensions of plan quality, this will not be captured in our study. Fourth, our analysis focuses on how the UnitedHealth-Catamaran merger affected non-vertically integrated insurers relative to vertically integrated insurers and does not estimate the market-wide effects of the merger.

That said, our results have important implications for antitrust regulators. Regulators should carefully weigh the potential benefits of vertical integration with the potential for foreclosure. Increasing vertical integration caused by rising concentration of these firms, or even the removal of a non-integrated competitor, could increase the incentive for foreclosure which may offset potential efficiency gains.

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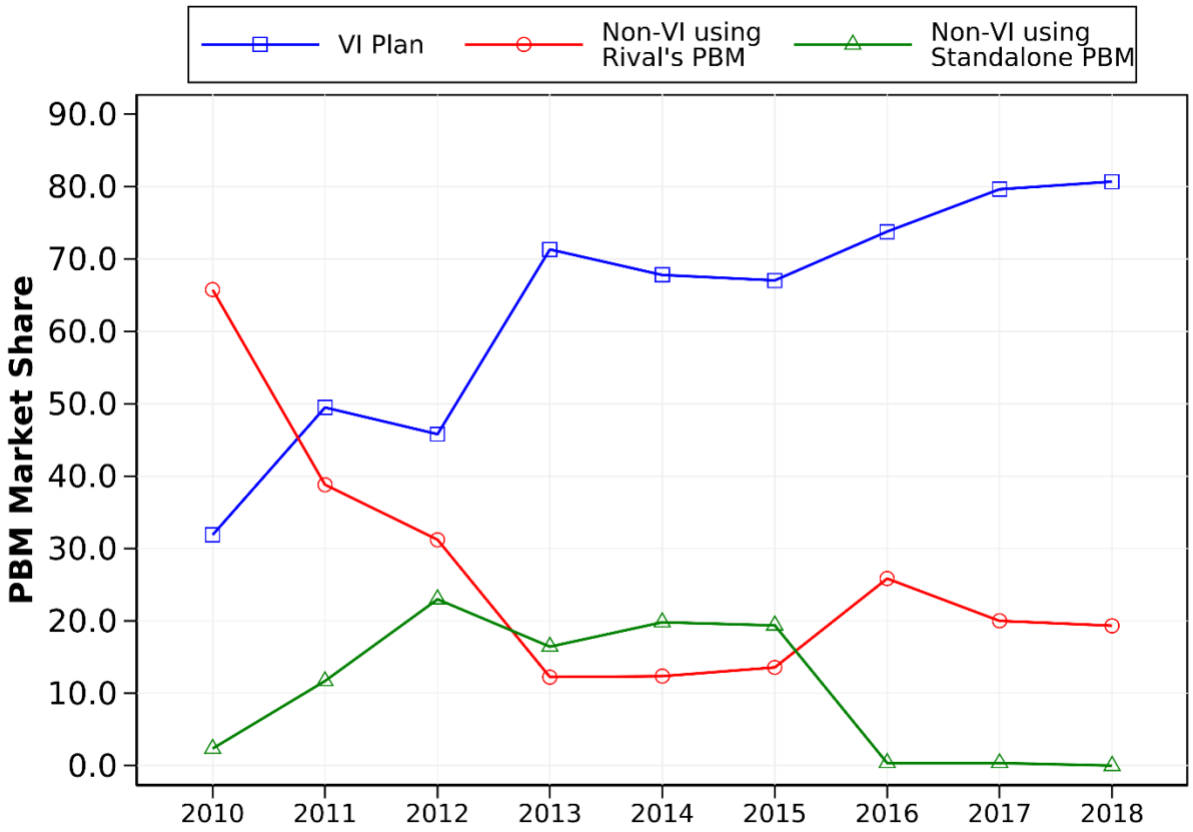
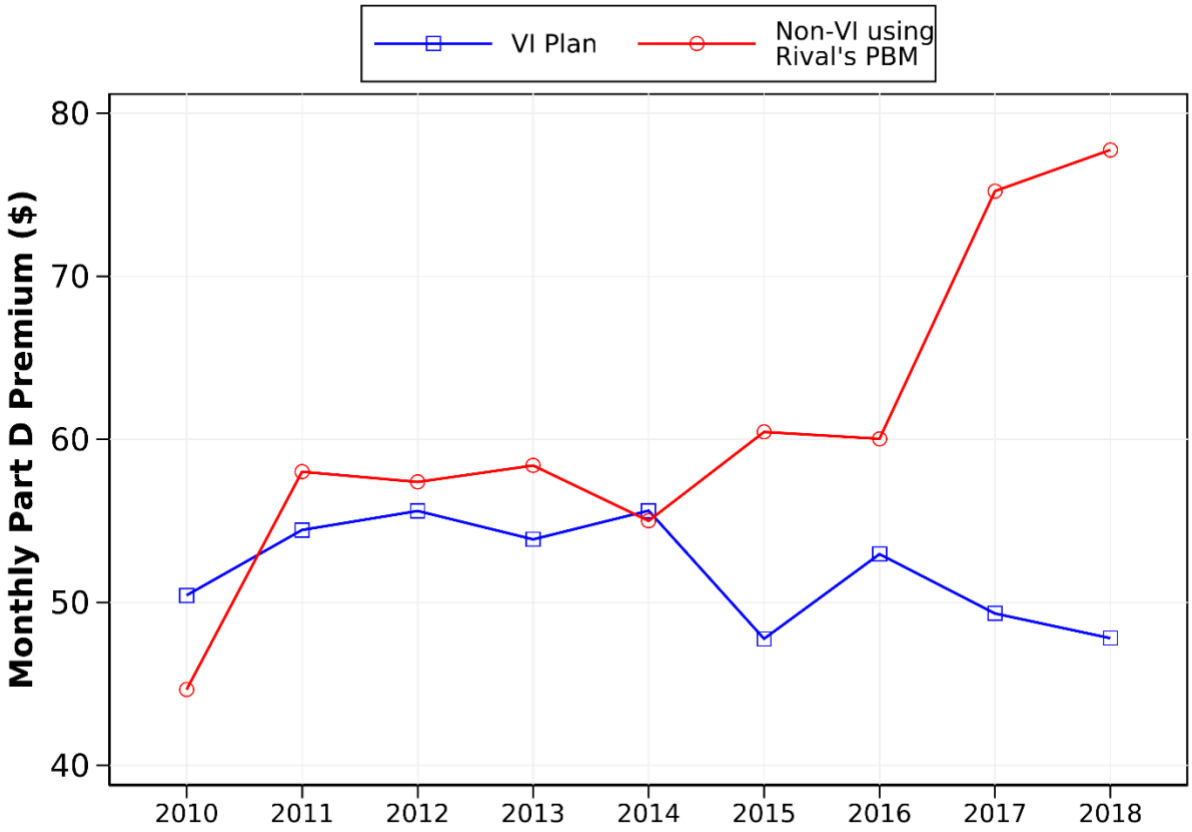
Figures and Tables

FIGURE 1: Trends in Part D Plan Market Shares by Insurer-PBM Relationship Type



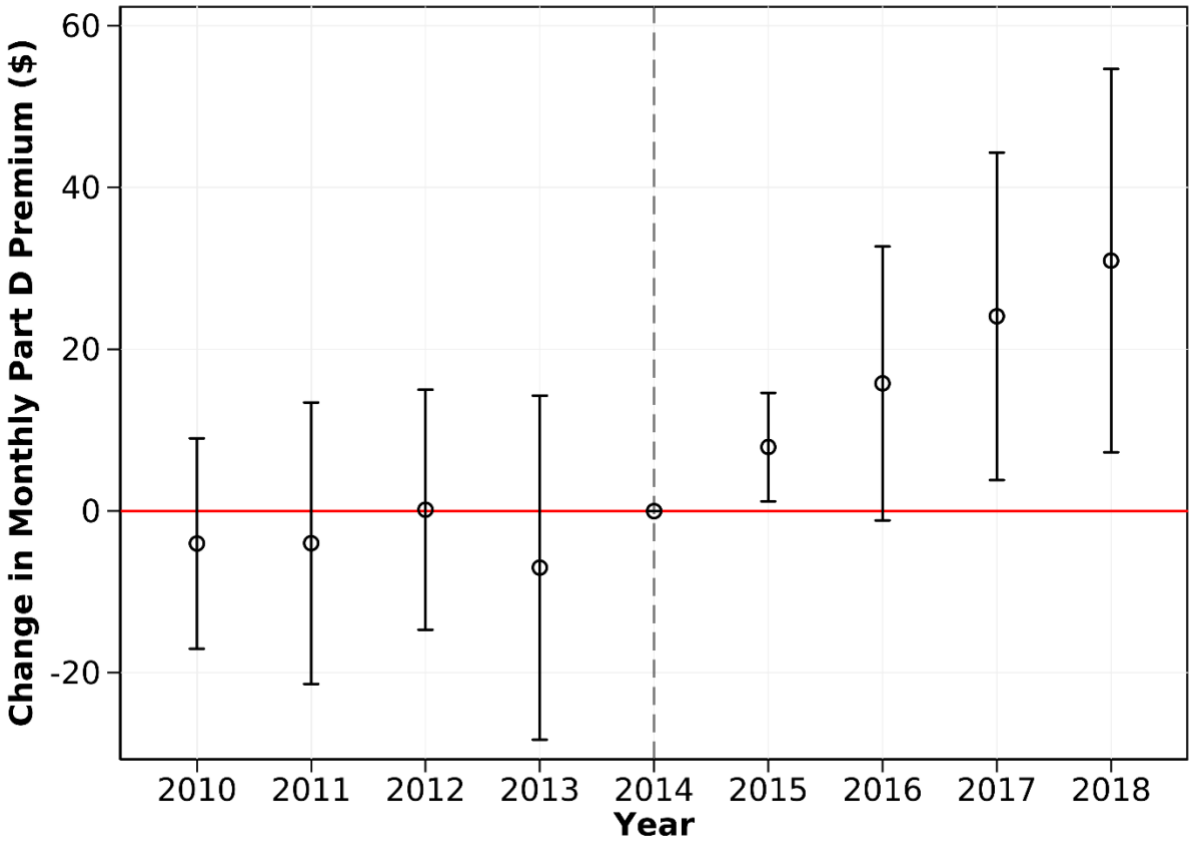
NOTES: The graph displays trends in national market shares of Part D PDP enrollment for the three categories of insurer-PBM relationships. The blue line displays the market share of plans which are operated by an insurer that is vertically integrated (VI) with a PBM. The red line displays the market share of non-vertically integrated (Non-VI) insurers that utilize a PBM that is vertically integrated with a rival insurer. The green line displays the market share of non-vertically integrated plans that utilize a standalone PBM. Market share is calculated as the enrollment for insurers in each category divided by the total enrollment for the calendar year. We do not include enrollment for insurers who are outside of the PBM market— i.e., those that possess PBM capabilities that they use for their own plans, but do not sell those PBM services to rival insurers (e.g., Humana).

FIGURE 2: Trends in Average Monthly Part D Premiums by Plan Type



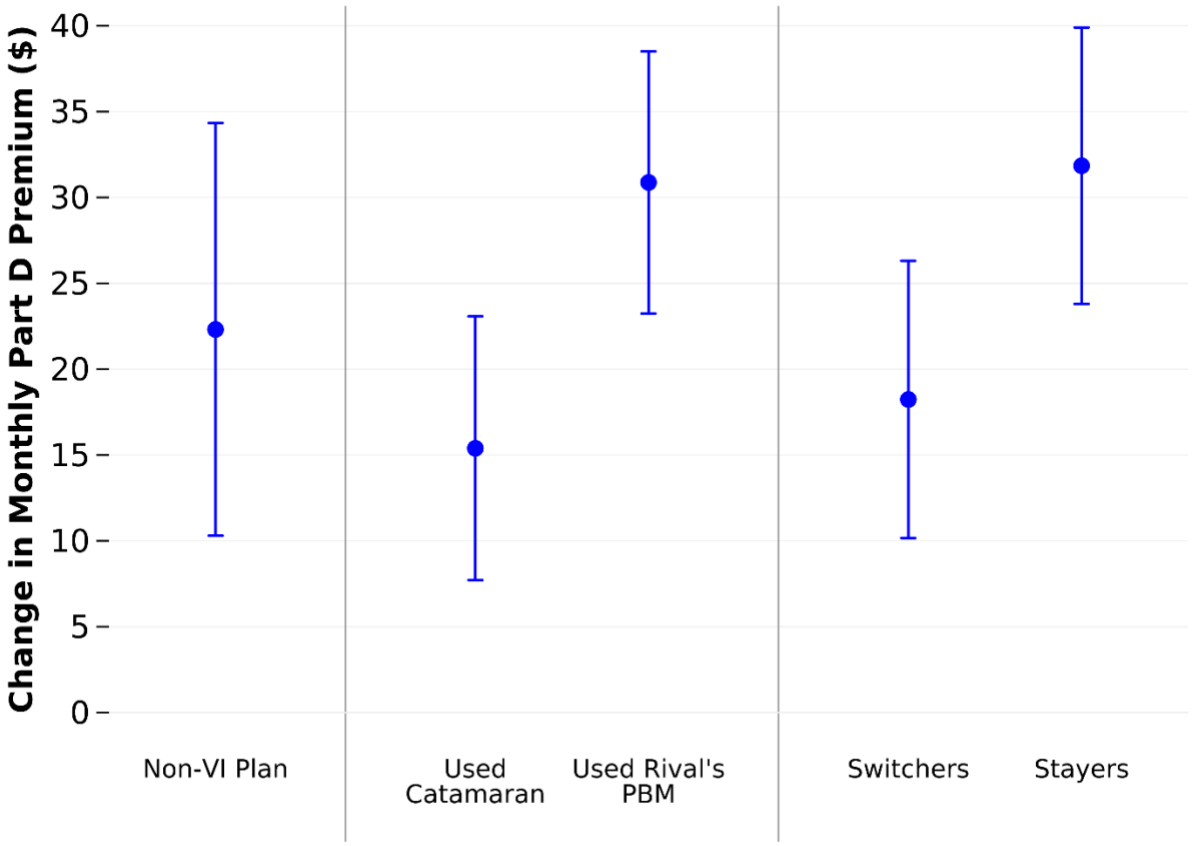
NOTES: The graph displays trends in average monthly Part D premiums across plans. Premiums represent the monthly amount that beneficiaries pay during the calendar year. Premiums can change on January 1 of each year. The blue line displays the average premium of plans which are operated by an insurer that is vertically integrated with a PBM. The red line displays the average premium of non-vertically integrated insurers that utilize a PBM that is vertically integrated with a rival insurer.

FIGURE 3: Event Study Estimates of Premium Changes for Non-Vertically Integrated Plans After UnitedHealth-Catamaran Merger



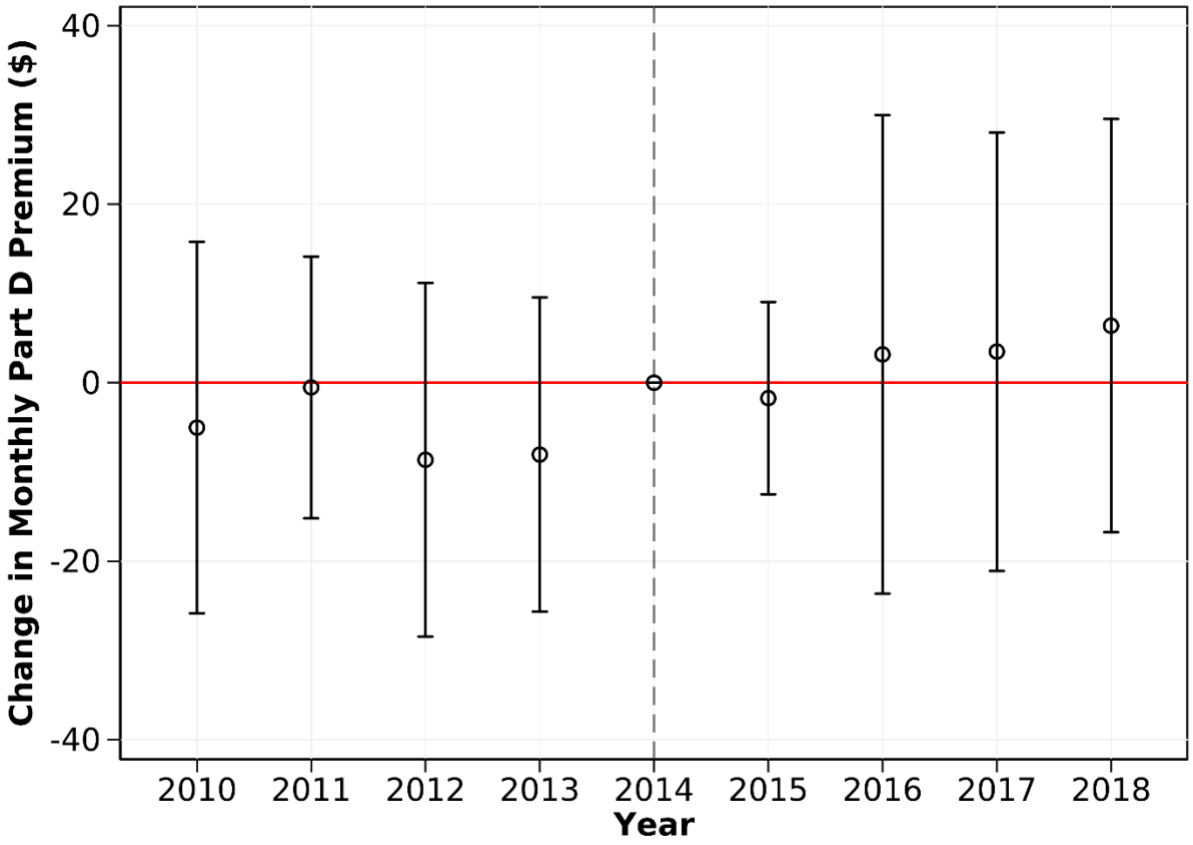
NOTES: This graph displays the treatment effect point estimates (and their 95% confidence intervals) from our event study analysis. The outcome is the monthly Part D premium for each plan. The treatment group includes non-vertically integrated plans and the control group consists of plans that use their own PBM (i.e., types (a) and (d)). 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.

FIGURE 4: Difference-in-Differences Estimates of Premium Changes for Non-Vertically Integrated Plans After UnitedHealth-Catamaran Merger, by Plan Subgroup



NOTES: The outcome is the monthly Part D premium for each plan. 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. Columns (2) and (3) separate out these two groups to allow for group specific estimates. Columns (4) and (5) split the insurers who used a rival's PBM (Column (3)) into two groups: those that switched PBMs in any year after Catamaran's exit and those that stayed with the same PBM for all years after Catamaran's exit. In all columns, the control group is plans that use their own PBM (i.e., types (a) and (d)). Standard errors are clustered at the insurer level. The error bars indicate 95% confidence intervals. 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.

FIGURE 5: UnitedHealth's Relative Premium Changes vs. Other Vertically Integrated Insurers' Premiums Changes



Notes: This graph displays the treatment effect point estimates (and their 95% confidence intervals) from an event study analysis similar to that presented in Figure 3. However, in this figure, the "treatment" group is all plans offered by UnitedHealth and the control group consists of all other plans that use their own PBM (i.e., group (a) and group (d)) excluding UnitedHealth. 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.

TABLE 1: Summary Statistics by Insurer-PBM Relationship, Pre-Merger (2010-2014)

	Group (a) VI Insurers	*Group (b) Non-VI Insurers using VI PBM*	*Group (c) Non-VI Insurers using Standalone PBM*	*Group (d) VI Insurers using Own Exclusive PBM*
# of Insurers (per year)	3	21	8	10
# of Plans (per year)†	273	287	145	481
Share of PBM Market Enrollment (%)	53.3	32.1	14.7	-
Monthly Premium ($)	54.0	53.5	48.3	51.4
	(26.7)	(24.9)	(23.5)	(28.1)
Annual Deductible ($)	156.5	135.8	169.8	154.6
	(150.6)	(137.3)	(156.5)	(148.1)
Prop. Enhanced Plans	0.5	0.5	0.4	0.5
Prop. Gap Covered Plans	0.3	0.3	0.2	0.3
Prop. LIS Eligible Plans	0.3	0.2	0.4	0.3

NOTES: Sample averages and standard deviations (in parentheses) are taken across the five years of data prior to the UnitedHealth-Catamaran merger. Insurers in group (a) are vertically integrated with a PBM that sells its services to rival insurers in Part D (the vertically integrated insurers in Part D are Express Scripts/Medco, UnitedHealth[a], CVS/Caremark[b]). Insurers in group (b) do not have PBM capabilities but use a PBM which is vertically integrated with a rival insurer. Insurers in group (c) do not have PBM capabilities but use standalone PBMs. Insurers in group (d) have their own PBM that they utilize for PBM services, but they do not sell those PBM services to competing insurers during our time period (these insurers account for two-fifths of the PDP market). We consider group (d) outside the PBM market. When computing market shares and average premiums, we allow insurers to change classifications over time as they switch from one Insurer-PBM type to another. Thus, some insurers appear in more than one group across the sample period.

[a] Prior to 2013, UnitedHealth operated a PBM, called Prescription Solutions. In 2013, it renamed its PBM OptumRx and began selling PBM services to rival insurers in Part D. Thus, for our average premium and market share calculations, we follow the categorization of the MMS data and treat UnitedHealth as a group (d) insurer from 2010 to 2012 and then a group (a) insurer from 2013 onwards. Medco operated as vertically integrated insurer-PBM from 2010 to 2011 while Express Scripts operated as a standalone PBM at that time. In 2012, the two merged and kept the Express Scripts name.

[b] Prime Therapeutics is also 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.

† A plan is defined at the plan-region-year level.

Supplemental Appendix

Disadvantaging Rivals: Vertical Integration in the Pharmaceutical Market

Charles Gray, Abby Alpert, Neeraj Sood

April 2025

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.

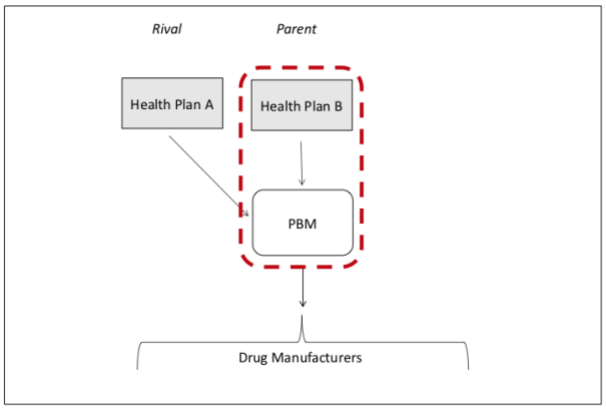
PBM owned by a rival insurer in 2015. These plans lost their remaining outside option of a standalone PBM when Catamaran exited. Fifteen insurers met this criterion.[4]

[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.

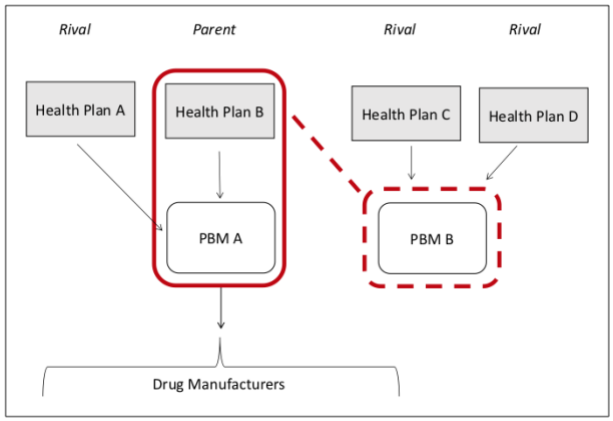
Appendix B: Supplementary Figures and Tables

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

Panel A: Purely Vertical Merger (Case 1)

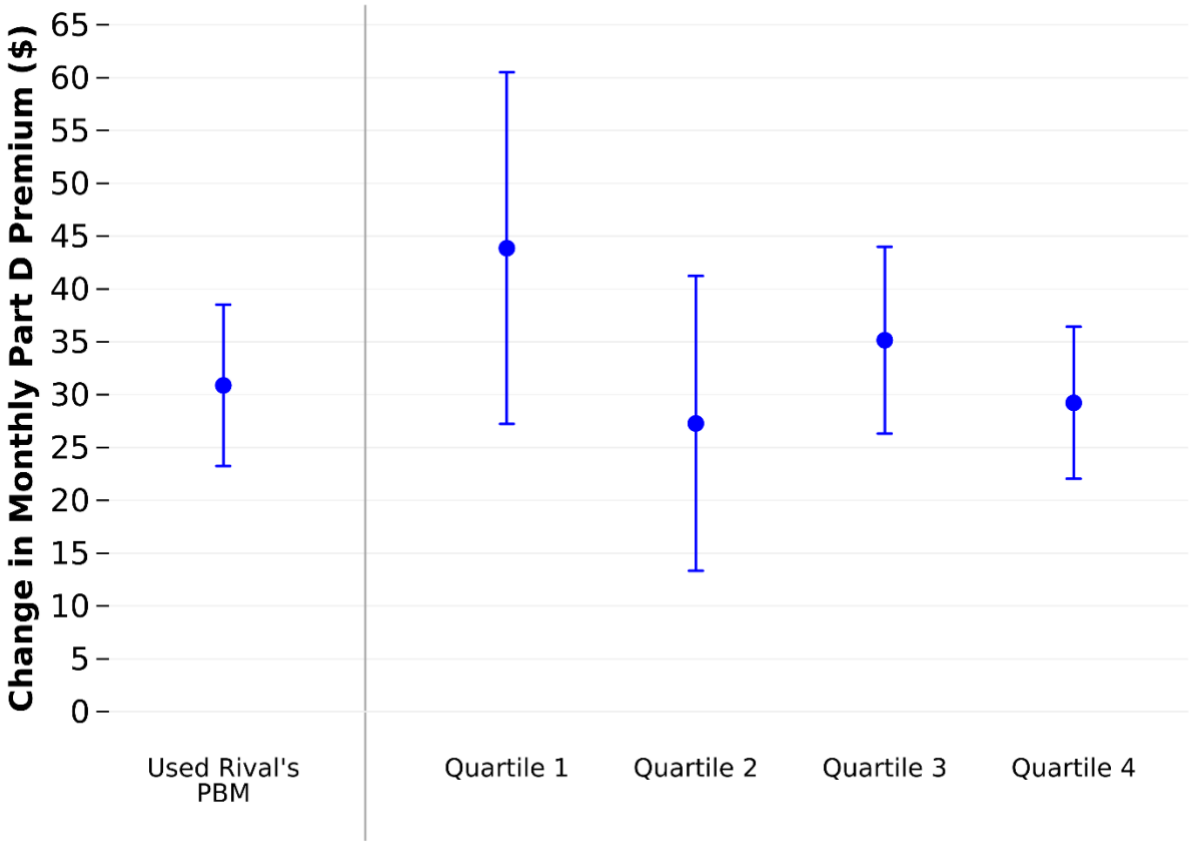


Panel B: Vertical and Horizontal Merger (Case 2)



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**
Dependent Variable in Parentheses:		
Reduced Form (Enrollment)		
1(Treated) x 1(Year ≥ 2015)	-20,495**	-0.236
	(8,990)	(0.160)
First Stage (Premium)		
1(Treated) x 1(Year ≥ 2015)	22.315***	0.326***
	(5.742)	(0.071)
2SLS (Enrollment)		
Premium ($)	-918**	-0.723
	(353)	(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 ≥ 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***	--	--	--	19.509***	23.464***	22.279***	23.428***
	(5.742)	--	--	--	(6.505)	(6.325)	(5.735)	(6.316)
1(Year ≥ 2015)*1(Used Catamaran in 2015)	--	15.395***	15.394***	15.397***	--	--	--	--
	--	(3.666)	(3.665)	(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.

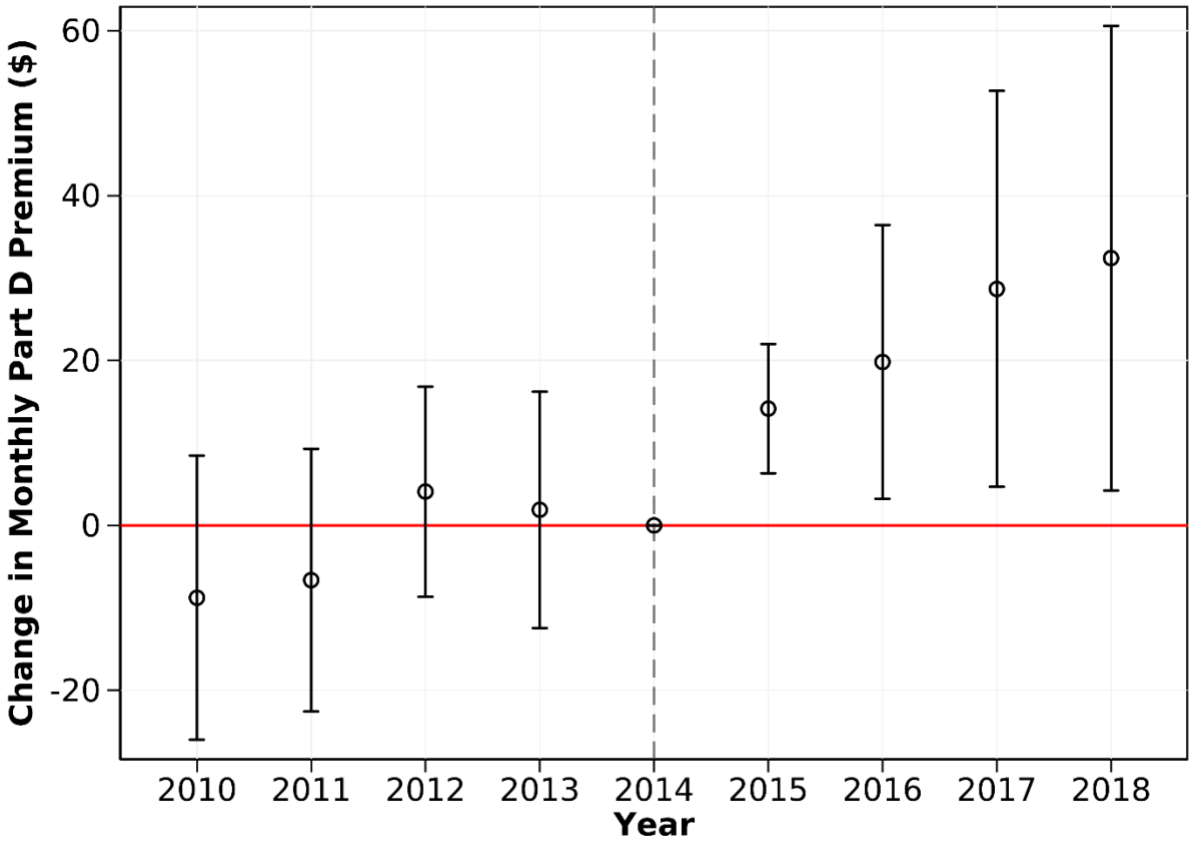
Third, we test the sensitivity of the results to an alternative control group that excludes insurers of type (d) who are outside the PBM market—i.e., those with PBM capabilities that are

[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.

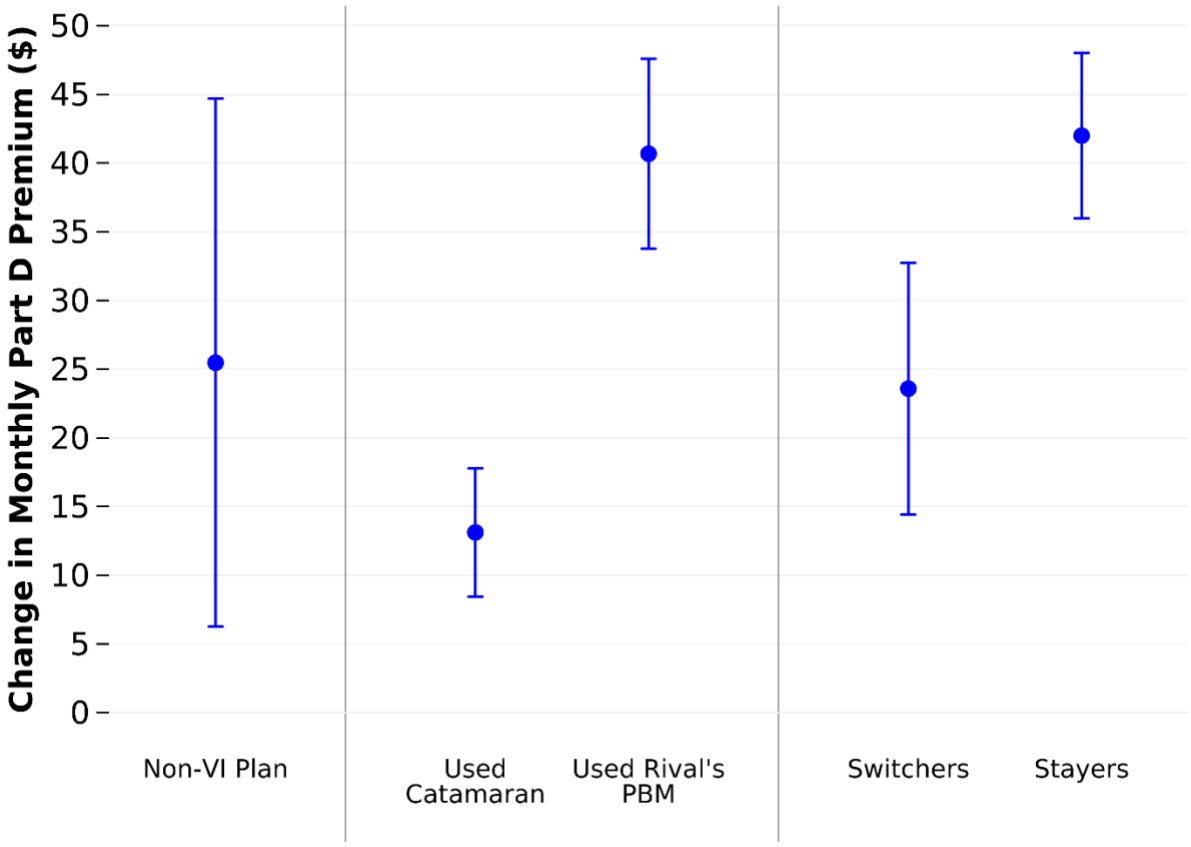
Finally, we test whether the results are driven by competitive dynamics in a particular Part D region. Appendix Figure C.5 shows the results from a leave-one-out analysis in which we estimate Equation (1) excluding each of the Part D regions in turn. The results are nearly identical across all regressions. 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)



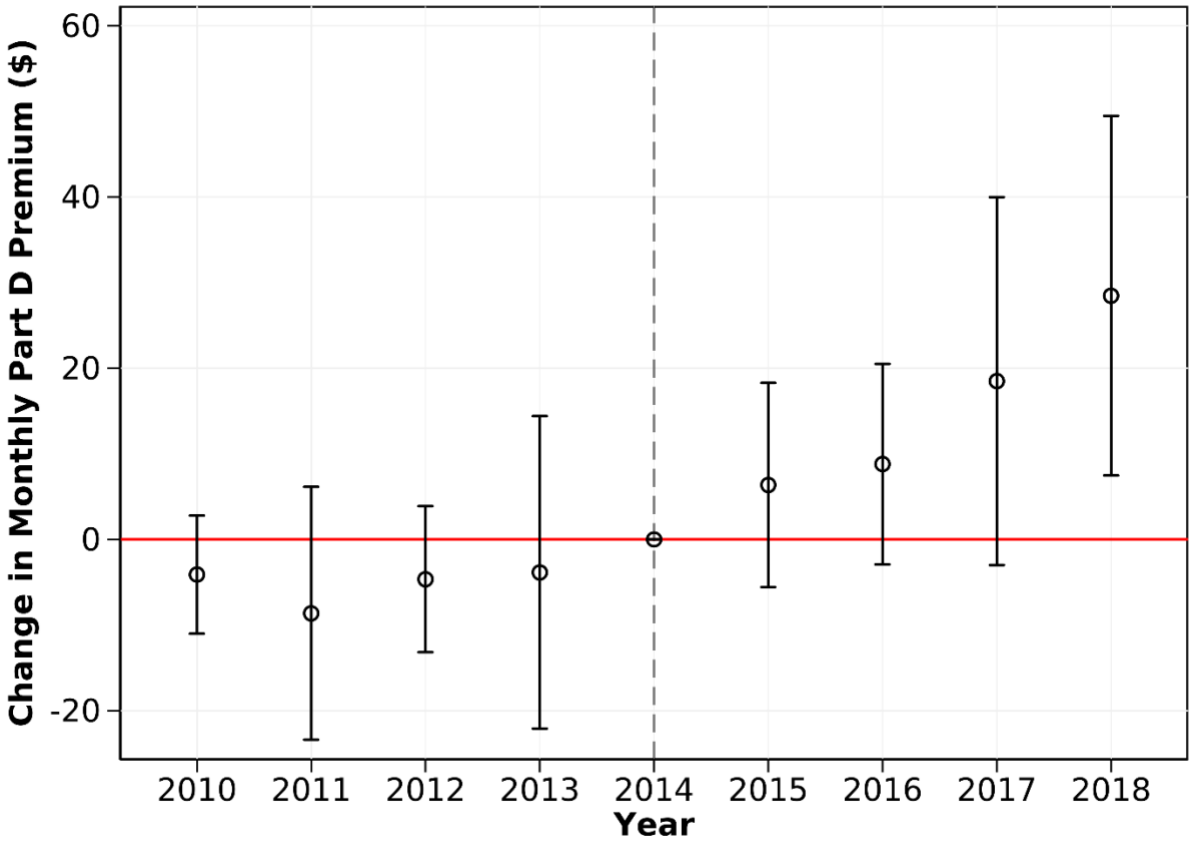
Notes: This figure replicates Figure 3 in the main paper, but excludes plan characteristic control variables. Standard errors are clustered at the insurer level. We include year fixed effects, region fixed effects, and insurer fixed effects.

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)



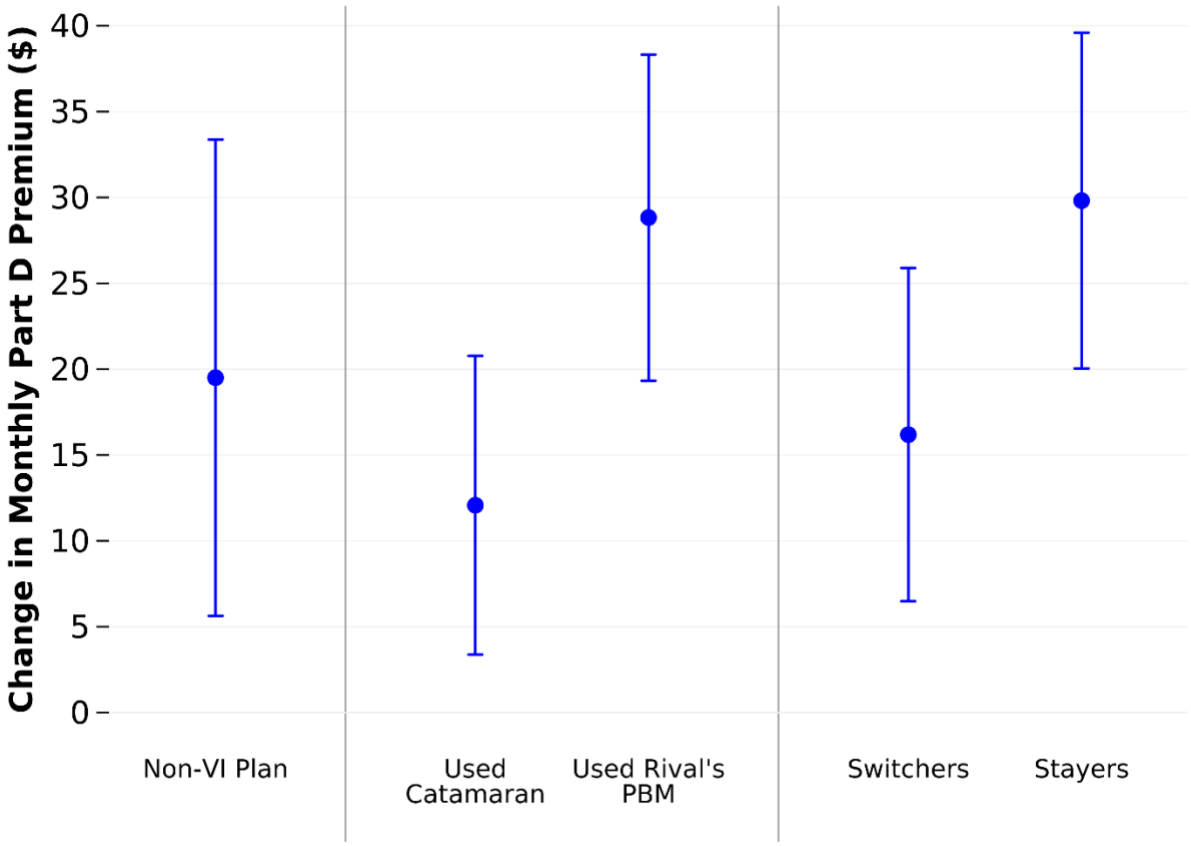
Notes: This figure replicates Figure 4 in the main paper, but excludes plan characteristic control variables. Standard errors are clustered at the insurer level. We include year fixed effects, region fixed effects, and insurer fixed effects.

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



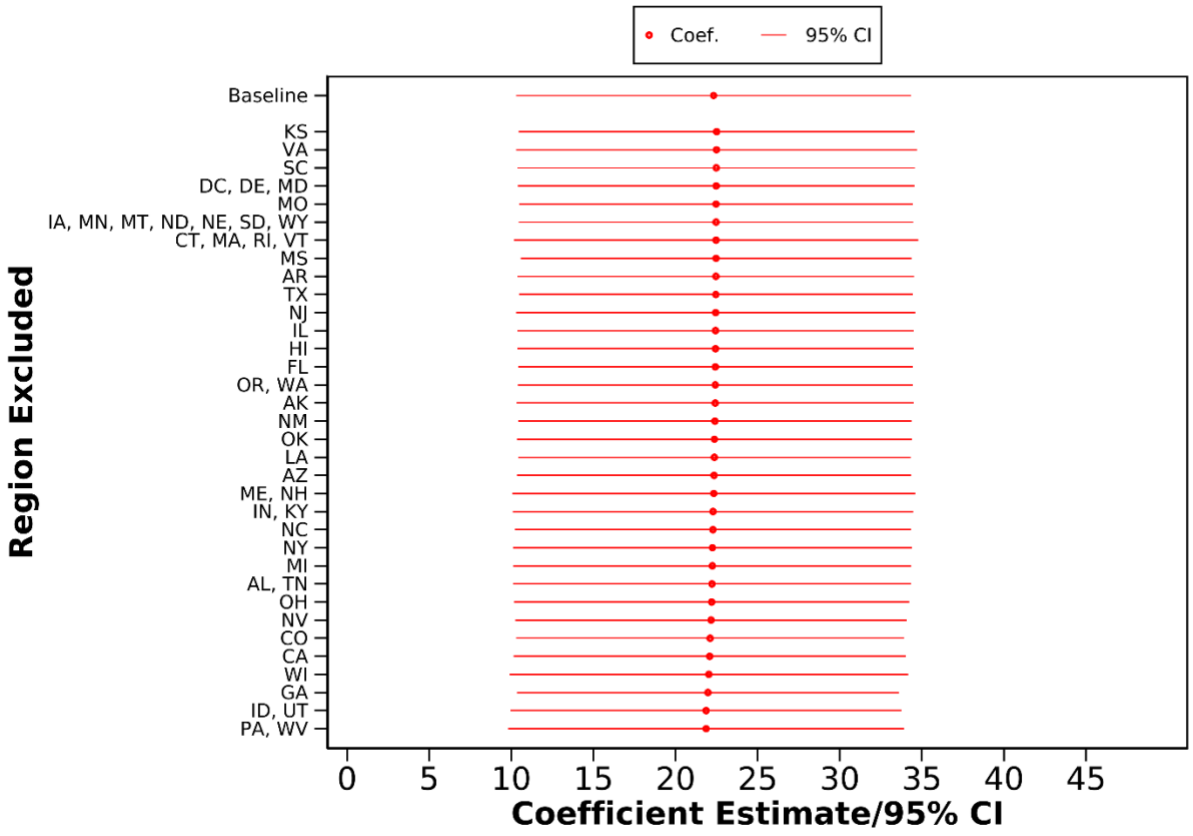
Notes: This figure replicates Figure 3 in the main paper, but uses an alternative control group. The control group is vertically integrated plans that sell their PBM services to other plans (group (a) only). Standard errors are clustered at the insurer level. We include a full set of plan characteristics 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 ≥ 2015)	-17.064	0.049	0.055	-0.067
	(53.983)	(0.059)	(0.137)	(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	Insurer's Contemporaneous Enrollment	Insurer's 2014 Enrollment	Insurer's Contemporaneous Mkt. Share	Insurer's 2014 Mkt. Share
	(1)	(2)	(3)	(4)	(5)
1(Treated)*1(Year ≥ 2015)	22.315***	23.677***	22.192***	22.278***	20.717***
	(5.742)	(4.928)	(5.280)	(4.684)	(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.