Vertical Integration and Regulated Profits in Pharmacy Benefits Markets*

Eric Yde†

October 14, 2025; latest version available here.

Abstract

This paper studies the effects of vertical integration between insurers, pharmacy benefit managers (PBMs), and pharmacies on drug prices and insurance premiums. I construct an empirical model of pharmacy pricing, insurer premium setting, and consumer demand for insurance plans and pharmacies in Medicare Part D, a government program that provides subsidized drug insurance to older adults in the United States. I estimate the model using prescription drug claims data, which I combine with novel information on insurer-PBM relationships and pharmacy ownership. In equilibrium, vertically integrated insurers reduce premiums and increase internal prices for prescription fills, shifting profits to their pharmacies. Two institutional features motivate this profit-shifting strategy: consumer cost-sharing, which allows firms to retain profits on integrated prescription fills; and regulatory caps on insurer profits, which incentivize firms to "tunnel" excess profits to pharmacies through higher drug prices. My estimated model predicts that the divestiture of vertically integrated pharmacies would reduce drug prices by 7.3% and increase annual consumer surplus for Medicare enrollees by 8.1%.

JEL Codes: I11, I13, I18, L14.
Keywords: prescription drugs; vertical integration; pharmacy benefit managers; bargaining; health insurance.

*I am grateful to Julie Holland Mortimer, Amalia Miller, Federico Ciliberto, and Tim Layton for their unwavering support. I thank Chris Adams, Maura Coughlin, Ashvin Gandhi, Sylvia Hristakeva, Catherine Ishitani, Pragya Kakani, Alex MacKay, Luca Maini, Loren Smith, Amanda Starc, and seminar participants at ASHEcon, the Congressional Budget Office, the Southeastern Health Economics Study Group, the University of Virginia, and the Washington University in St. Louis for valuable discussions and comments. Financial support for this research was generously provided by the Bankard Fund for Political Economy and the Jefferson Scholars Foundation at the University of Virginia.

†Department of Economics, University of Virginia. Email: edy9g@virginia.edu

1 Introduction

This paper studies the effects of vertical integration between health insurers, pharmacy benefit managers (PBMs), and pharmacies on drug prices and insurance premiums. These firms play important roles in determining the cost of healthcare: insurers provide prescription drug coverage in exchange for premium payments, and rely on PBMs to negotiate drug prices with pharmacies, which dispense drugs to consumers. Four healthcare conglomerates — CVS Health, Express Scripts, Humana, and UnitedHealthcare — perform all three functions through subsidiary businesses that are prominent in their respective levels of the pharmacy benefits market. For patients covered by Medicare Part D in 2017, these four firms filled 25% of prescriptions as pharmacies, processed over 90% of prescription drug claims as PBMs, and covered over 60% of prescription drug claims as insurers.

Policymakers and market participants have voiced concerns about the incentives faced by integrated payers and pharmacies, leading to increased scrutiny by state and federal regulators. One common concern pertains to how vertical integration aligns incentives within integrated firms. Anecdotal evidence from an investigation of PBMs by the Federal Trade Commission suggests that vertically integrated pharmacies may charge high prices to their integrated PBMs and insurers (Federal Trade Commission 2025). This finding runs counter to the usual theoretical assumption that vertical integration induces firms to eliminate markups on internal transfers, suggesting that pharmacy benefits markets may function differently than standard vertical supply chains. Another concern pertains to how vertical integration affects interactions between integrated firms and their competitors. Insurers may "steer" consumers away from rival pharmacies to their integrated options through advertising to enrollees (Kakani et al. 2025); they may also leverage their ownership of pharmacies to negotiate lower prices with non-integrated pharmacies. Similarly, pharmacies that are integrated with an insurer may be incentivized to raise prices for rival insurers. Despite increasing calls for regulatory interventions, there is scarce empirical evidence on the effects of vertical integration between payers and pharmacies.

The goal of this paper is to identify and quantify the mechanisms by which vertical integration between payers and pharmacies affects drug prices, insurance premiums, and welfare. To do so, I formulate an empirical model of the Medicare Part D pharmacy benefits market. In the model, vertically integrated firms set prices for integrated prescription fills while PBMs bargain with non-integrated pharmacies. Simultaneously, insurers set subsidized premiums for insurance plans according to Nash-Bertrand competition. Consumers then select a plan and fill prescriptions at pharmacies of their choice. To estimate the parameters of the model, I construct a dataset on the Medicare Part D pharmacy benefits market by combining prescription drug claims data with novel information on insurer-PBM contractual relationships and pharmacy ownership. The combined data allow me to observe how negotiated drug prices depend on the degree of integration between the pharmacy, PBM, and insurer involved in each prescription drug claim.

When choosing an insurance plan, consumers consider both the premium charged by the plan and their expected utility from filling prescriptions through the plan's pharmacy network.[1] Their valuation of the plan's pharmacy network depends on the prices that they face at in-network pharmacies. As a result, changes

[1] Economists refer to these types of markets as "option demand" markets (Capps et al. 2003).

in drug prices affect consumer demand for both pharmacy services and insurance plans; likewise, changes in insurance premiums affect consumers' plan choices and thereby alter their utilization of pharmacies. Vertical integration provides firms with two levers (premiums and drug prices) that they can use to maximize their overall profits. I find that integrated firms use these levers to shift rents from their insurance division to their pharmacy division by setting lower premiums that subsidize higher prices on prescription fills at their integrated pharmacies. Two institutional features motivate this profit-shifting strategy: consumer cost-sharing (which reduces insurers' exposure to drug prices) and regulatory caps on insurer profits (which incentivize firms to shift excess profits to pharmacies through higher drug prices).

Cost-sharing creates a trade-off for vertically integrated firms that is unique to insurance markets. Consumers in Medicare Part D pay roughly 30% of total drug costs out-of-pocket; as a result, insurers do not bear the full financial impact of price changes at integrated pharmacies. Thus, while prescription fills at non-integrated pharmacies are purely a cost to insurers, cost-sharing payments at integrated pharmacies create a source of potential profits. While higher prices at integrated pharmacies may increase profits for an integrated firm's pharmacy division, they also reduce the value of the integrated plan's pharmacy network. This may cause consumers to substitute to different plans, reducing profits for the integrated firm's insurance division. Likewise, higher insurance premiums may increase profits for an integrated firm's insurance division but may also ultimately reduce demand for an integrated firm's pharmacies. This creates a strategic trade-off between insurance and pharmacy margins that does not arise in standard vertical supply chains in which consumers typically make only one demand decision.

The relative elasticities of demand with respect to premiums and drug prices incentivize integrated firms to shift profits from their insurance division to their pharmacy division. My estimated demand model reveals that consumers are much more sensitive to insurance premiums than they are to their expected value of a plan's pharmacy network. As a result, integrated firms can offset large increases in drug prices at their integrated pharmacies with relatively small reductions in premiums. Higher drug prices may cause some consumers to substitute to competing pharmacies, but integrated insurers limit this substitution by "steering" consumers towards their integrated pharmacies. My estimated pharmacy demand model shows that consumers are more likely to use pharmacies that are integrated with their insurer, consistent with insurers exerting influence over consumer pharmacy utilization through non-price measures.[2] This inelastic insurance demand with respect to pharmacy networks, combined with the ability to steer consumers towards integrated pharmacies, induces integrated firms to subsidize their pharmacy division through lower insurance premiums.

Government regulations on insurer markups further strengthen incentives for vertically integrated firms to shift profits to their integrated pharmacies. These regulations, known as minimum medical loss ratio (MLR) requirements, mandate that insurers pay out 85% of premium revenues in healthcare. However, profits retained by an integrated pharmacy do not count towards an insurer's MLR; thus, minimum MLR requirements create an incentive for insurers to increase internal transfers in order to minimize the cost of complying with the regulations. I leverage the introduction of minimum MLR requirements in Medicare

[2]I am unable to observe the exact non-price mechanisms by which insurers and PBMs steer consumers to their pharmacies. Government investigations have found that these firms send letters to enrollees to encourage them to switch to integrated pharmacies (House Committee on Oversight and Accountability 2024).

Part D as a natural experiment to study whether vertically integrated firms "tunnel" profits into their pharmacy division (Johnson et al. 2000). Following the implementation of MLR requirements in 2014, insurers increased internal reimbursement rates for generic drugs at integrated pharmacies by 5% relative to non-integrated pharmacies. I use the estimated model to assess how minimum MLR requirements shape firm incentives. In equilibrium, they cause firms to place a greater value on profits earned through prescription fills relative to profits earned from selling insurance, leading to lower premiums and higher drug prices.

My estimated model of bargaining between PBMs and pharmacies allows me to quantify the competitive effects of vertical integration on rival pharmacies and plans, which I ultimately find to be small relative to the internal effects. I find that the scale and bargaining ability of PBMs enable them to negotiate reimbursement rates with non-integrated pharmacies that are close to pharmacy marginal costs. High concentration in the PBM segment of the pharmacy benefits market weakens the bargaining position of non-integrated pharmacies: they stand to lose significant profits if they fail to reach an agreement with a PBM because there are few outside options for patient volume. Conversely, PBMs can easily redirect consumers to rival pharmacies with relatively limited losses in overall plan enrollment. Consequently, vertical integration between PBMs and pharmacies has a negligible effect on the prices paid to non-integrated pharmacies: the marginal bargaining leverage generated by the ownership of a rival pharmacy is insignificant because PBMs are already able to negotiate prices close to marginal costs. I also find that the foreclosure of rival PBMs by vertically integrated pharmacies is unprofitable, because foreclosure does not generate enough new insurance profits to offset the losses in pharmacy profits from exiting rival PBMs' pharmacy networks. While PBMs are effective at reducing prescription drug prices at non-integrated pharmacies, consumer cost-sharing and minimum MLR requirements weaken incentives for them to eliminate markups on prescription fills at their integrated pharmacies. Through these combined factors, vertical integration *increases* drug prices in equilibrium.

I use the estimated model to predict the effects of divesting vertically integrated pharmacies from insurers and PBMs on drug prices, insurance premiums, and consumer welfare. This is a policy-relevant counterfactual exercise: Arkansas recently required insurers and PBMs to divest their ownership stakes in pharmacies in order to operate in the state (Office of the Governor of Arkansas 2025), and at the federal level, a bipartisan Senate bill proposes to expand that policy nationwide (Breslin 2024). I estimate that forcing the divestiture of vertically integrated pharmacies would reduce average Medicare drug prices by 7.3%, directly benefiting consumers through reduced cost-sharing payments. This is driven primarily by reductions in drug prices charged by pharmacies to their integrated PBMs and insurers, which fall by over 50% on average as they shift from unilaterally setting internal prices to negotiating with a PBM. Although the divestiture increases the value of non-integrated pharmacies to PBMs, the bargaining ability of PBMs prevents pharmacies from raising prices: prices negotiated by non-integrated pharmacies increase by less than 1%. I find that formerly integrated insurers increase premiums by 4.4% after being forced to divest their pharmacies. Despite these premium increases, non-integrated insurers decrease premiums by 1% because they now face stronger competition from formerly integrated plans that offer consumers much lower out-of-pocket prices, which increases the value of their plan offerings to consumers. Overall, plans increase premiums by 1.1% on average following the divestiture of vertically integrated pharmacies.

My model predicts that the divestiture of vertically integrated pharmacies would increase annual con-

sumer surplus in Medicare Part D by $44 per enrollee (8.1%), implying aggregate gains in consumer surplus of $2.6 billion per year. The largest gains occur in geographic regions where consumers have limited options for filling prescriptions outside of their insurer's integrated pharmacies. In these regions, the premium reductions needed to subsidize integrated pharmacies are smallest, weakening the procompetitive benefits of vertical integration. As such, the largest benefits from the divestiture accrue to rural consumers whose non-integrated pharmacy options are limited. The divestiture also generates larger increases in consumer surplus for sicker consumers, who have higher prescription drug demand and thus enjoy larger reductions in expected cost-sharing payments.[3] The model predicts that the divestiture would ultimately reduce healthcare costs, causing annual government spending on subsidies and reinsurance in Medicare Part D to decline by $5.3 billion.

In sum, the pricing decisions of vertically integrated firms depend critically on two consumer preferences: their willingness to pay for pharmacy networks and their price sensitivity with respect to plan premiums. My estimated demand model reveals that consumers are more sensitive to insurance premiums than to their expected value of a plan's pharmacy network. As a result, integrated firms can offset large increases in drug prices at their integrated pharmacies with relatively small reductions in premiums. These consumer preferences, coupled with minimum MLR regulations that reduce the profitability of selling insurance, incentivize firms to shift profits from their insurance division to their pharmacy division by reducing premiums and increasing prices charged by their own pharmacies, leading to higher consumer cost-sharing payments. The consumer harm generated by higher drug prices outweighs the gains from lower insurance premiums, causing vertical integration to harm consumers on average.

This paper contributes to our understanding of the effects of vertical integration in the healthcare sector by providing the first analysis of integration between payers and pharmacies. There is an extensive literature on the effects of non-horizontal mergers between hospitals and healthcare providers[4] but considerably less research on vertical integration between insurers and providers (Ho 2009; Cho 2025). The closest paper is Cuesta et al. 2024, who find that vertical integration between insurers and hospitals in Chile results in higher hospital prices, higher premiums, and lower welfare. While I identify similar theoretical trade-offs for vertically integrated firms as Cuesta et al. 2024, the mechanisms by which vertical integration reduces welfare differ across our empirical settings due to differences in intermediary bargaining leverage and government regulations. Cuesta et al. 2024 find that vertical integration eliminates the markups charged by hospitals to integrated insurers but also incentivizes hospitals to raise prices for rival insurers, resulting in higher prices on net. There is minimal scope for either effect in my setting due to the strong bargaining leverage of PBMs; instead, vertical integration results in higher prices due to the profit-shifting incentives created by cost-sharing and minimum MLR regulations. Overall, the findings of our respective analyses highlight

[3] One possibility is that vertical integration may mitigate adverse selection by making it more profitable for insurers to cover high-cost enrollees. This may affect the magnitude of the effects of vertical integration on drug prices and premiums but should not change the direction of the effects. Additionally, my model estimates reveal that plans with more generous pharmacy networks attract lower-cost enrollees on average, suggesting that selection on this margin of plan generosity may be advantageous rather than adverse.

[4] Some examples include Baker et al. 2014, Baker et al. 2016, Brot-Goldberg and de Vaan 2018, Carlin et al. 2015, Ciliberto and Dranove 2006, Cooper et al. 2025, Cutler et al. 2020, Encinosa et al. 2021, Koch et al. 2017, Lin et al. 2021, Song et al. 2020, Venkatesh 2024, and Whaley and Zhao 2024.

that the effects of vertical integration between payers and providers are likely to vary across geographic and provider markets, requiring an empirical analysis of supply and demand to measure their costs and benefits.

The welfare analysis of vertical integration in non-insurance markets, including business-to-business (Hortaçsu and Syverson 2007; Atalay et al. 2014; Luco and Marshall 2020) and retail settings (Hastings and Gilbert 2005; Houde 2012; Luco and Marshall 2021; Farronato et al. 2025), typically involves weighing the benefits from the elimination of double marginalization against the costs of anticompetitive behavior. I show that the effects of vertical integration in insurance markets are fundamentally different from standard vertical supply chains because consumers face prices on two interconnected demand curves. The relative elasticities of these demand curves and the profitability of different business divisions dictate how integrated firms determine prices. My modeling approach draws from Crawford et al. 2018's study of vertical integration in the pay-TV market, an "option demand" market in which consumers choose a cable package based on its assortment of channels.[5] The authors find incomplete elimination of the markups charged by channels to their integrated cable provider, which they attribute to managerial failures within integrated firms. In my setting, vertical integration increases internal markups not because of managerial frictions but because of regulations, cost-sharing, and consumer preferences. Combined, these factors generate strong incentives for firms to shift profits from their insurance segment to their pharmacy segment through higher drug prices.

Prior literature has identified similar disparities in consumer sensitivity to premiums and out-of-pocket prices in insurance markets (Abaluck and Gruber 2011, 2016, 2023; Starc and Town 2020). In my empirical analysis of consumer plan choice, these elasticities are identified using variation in premiums and pharmacy network generosity across plans: the observed choice behavior of consumers indicates that they are more responsive to changes in premiums than they are to changes in their expected value of the plan's pharmacy network, which is a function of out-of-pocket prices. The positive implications of my model are insensitive to the source of this consumer behavior: these differences in elasticities could reflect legitimate differences in preferences for plan characteristics, or they could indicate that consumers make mistakes when choosing an insurance plan. My findings reveal a novel consequence of this well-documented consumer choice behavior: vertically integrated insurers respond strategically to the elasticities on these two interrelated demand curves by reducing premiums and shifting higher drug costs onto consumers through their integrated pharmacies.

This paper also contributes to our understanding of the role played by PBMs in determining drug prices. Prior work has focused mostly on the role played by PBMs in securing rebates from drug manufacturers (Conti et al. 2021; Brot-Goldberg et al. 2022; Feng and Maini 2024; Gray et al. 2023; Ho and Lee 2024; Olssen and Demirer 2021). By incorporating novel data on the use of PBMs in Medicare Part D, I am able to provide the first empirical analysis of contracting between PBMs and pharmacies. Starc and Swanson 2021 and Fleitas et al. 2025 show that selective pharmacy contracting by insurers reduces drug costs both by steering patients towards lower cost pharmacies and by providing additional bargaining leverage. My analysis complements these papers by examining the role played by PBMs in determining prices through bargaining with pharmacies. I find that bargaining by PBMs is effective in reducing the prices paid to pharmacies. However, vertical integration with pharmacies weakens incentives for PBMs to reduce markups

[5] Chipty 2001 and Lee 2013 also study the effects of vertical integration in the pay-TV and video game industries on assortment decisions but they do not model the process by which firms set prices.

on internal prescription fills, leading to higher drug prices in equilibrium.

Finally, my analysis provides new insights on the effects of regulations on markups in the healthcare industry. Past research has shown that policies that restrict profits weaken incentives for firms to control costs, which, in turn, drives up prices, undoing the intent of policies (Cicala 2015; Cicala et al. 2019; Zhao 2021). I show that regulated markups may also increase prices by encouraging profit tunneling by vertically integrated firms. This is consistent with findings by Geruso and Layton 2020 and Gandhi and Olenski 2024, who show that regulations can alter internal transactions between business units of healthcare conglomerates in a way that raises costs for governments. In my setting, MLRs affect how firms set prices and directly result in higher costs for consumers of integrated pharmacies due to cost-sharing.

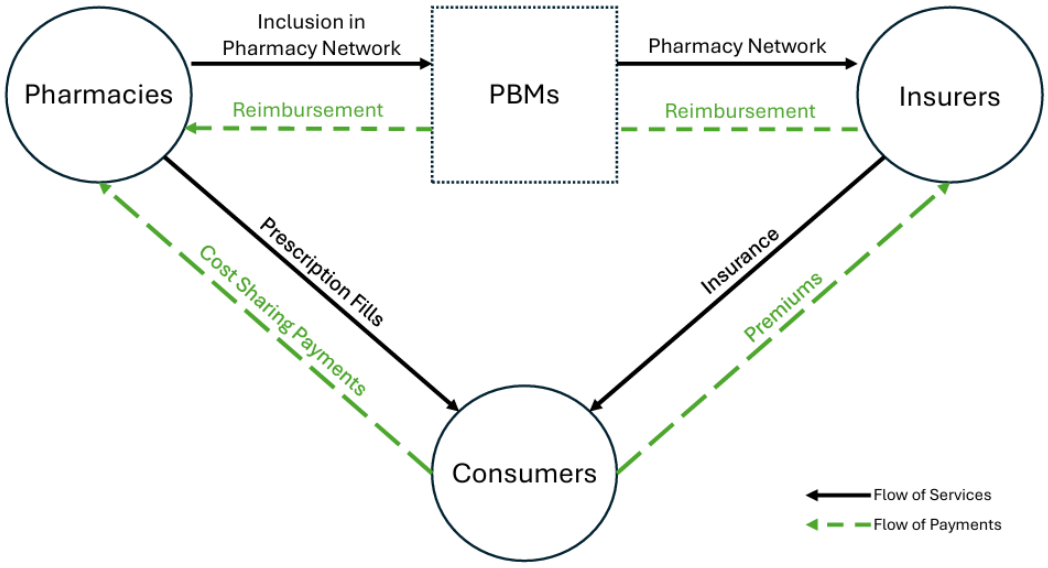
This paper proceeds as follows. Section 2 provides an overview of the empirical setting and data. Section 3 presents evidence on the effects of minimum MLR regulations on drug prices. Section 4 outlines the model. Section 5 presents my estimation method and identification strategy, and Section 6 presents the results. Section 7 presents the results of my counterfactual exercises, and Section 8 concludes.

2 Setting and Data

2.1 The Medicare Part D Pharmacy Benefits Market

Figure 1 depicts the flow of services and payments in the pharmacy benefits market. The market is composed of three types of firms: insurers, pharmacy benefit managers (PBMs), and pharmacies. Insurers sell insurance plans to consumers that cover the majority of their prescription drug expenditures in exchange for premium payments. PBMs establish pharmacy networks on behalf of insurers and negotiate reimbursement rates for prescription fills with pharmacies. Consumers can fill prescriptions at pharmacies in their insurer's pharmacy network but may need to pay some of the drug price out of their own pocket.

Figure 1: **Flow of Services and Payments in the Pharmacy Benefits Market**



The setting for my empirical analysis is Medicare Part D, a social insurance program that provides prescription drug benefits to older adults in the United States. It is a major component of the US prescription drug market, accounting for $144 billion in drug spending (or 32% of total US drug spending) in 2023 (Centers for Medicare and Medicaid Services). The program is regulated by the Centers for Medicare and Medicaid Services (CMS) but the benefits are administered by private insurers who sell subsidized plans to consumers.

Consumers may select one of potentially dozens of Medicare Part D plans available in their county. There are two types of Medicare plans available to consumers: standalone prescription drug plans (PDP) offer drug insurance, while Medicare Advantage plans (MA-PD) offer bundled drug and medical insurance.[6] To determine subsidy payments and consumer premiums, CMS collects "bids" from insurers for each plan that stipulate the price at which they are willing to provide prescription drug insurance. CMS pays a share of premiums for consumers who qualify for low-income subsidies (LIS). Since 2014, insurers in both the PDP and MA-PD segments have been required to have a medical loss ratio (MLR) of 85% or greater, meaning that they must spend at least 85% of all revenues (including premium revenue and government payments for both drug and medical insurance) on medical and drug claims. Insurers who have an MLR of less than 85% must rebate any excess revenues to consumers, and insurers that repeatedly violate the minimum MLR requirement may be prohibited from enrolling new members or expelled from Medicare.

Insurers outsource many of the administrative functions of providing prescription drug insurance to PBMs. These tasks include designing a formulary of covered drugs, negotiating rebates with drug manufacturers, monitoring consumer prescription drug utilization, establishing a pharmacy network, processing prescription drug claims, and negotiating reimbursement rates with pharmacies. This paper focuses on the last task and abstracts away from the other functions performed by PBMs. PBMs offer value to insurers through specialization and scale. In particular, many insurers may be drawn to work with the same PBM because the combined scale may allow the PBM to secure larger discounts from pharmacies and drug manufacturers than the insurers could achieve if they handled those negotiations themselves (Conti et al. 2021).

The reimbursement rates negotiated between PBMs and pharmacies consist of two payments: a payment to cover the "ingredient cost" (which is typically a percentage of a drug price benchmark such as the average wholesale price) and a dispensing fee. While I do not observe the full contracts negotiated between PBMs and pharmacies, they are typically annual contracts that begin in the fourth calendar quarter of each year and that prices are negotiated separately for Medicare Part D and for commercial payers. CMS sets minimum pharmacy network adequacy standards for plans. Specifically, at least 90 percent of the plan's urban enrollees must have an in-network pharmacy within two miles of their home. For suburban (rural) enrollees, CMS requires plans to have an in-network pharmacy within five (15) miles of the homes of 90 (70) percent of enrollees. Outright exclusion of large pharmacy chains from pharmacy networks is rare as a result of these network adequacy standards; instead, some PBMs and insurers design "preferred pharmacy networks," in which they set differential cost-sharing rates across pharmacies to steer consumer demand towards particular pharmacies (Starc and Swanson 2021; Fleitas et al. 2025).

CMS sets a minimum level of plan generosity in terms of actuarial value and sets minimum coverage

[6]PDP enrollees receive government-administered medical insurance through "Traditional" Medicare.

standards on other plan dimensions (e.g., formulary coverage of drugs). The typical benefit design of a Medicare Part D plan is non-linear and features a deductible phase (in which consumers pay 100% of costs), an initial coverage range (ICR) (in which they pay no more than 25%), a coverage gap phase known as the "donut hole," and a final "catastrophic" phase (in which they pay no more than 5% of costs).[7] The benefit design of Medicare Part D plans causes consumers to pay roughly 30% of the total cost of drugs out-of-pocket, even with insurance. LIS consumers receive additional subsidies that cover almost all of their out-of-pocket expenses. When filling a prescription, the out-of-pocket requirements for a patient depend on the drug (through its placement on the plan's formulary), the patient's current phase in the plan's benefit schedule, the patient's low-income subsidy status, and the pharmacy.

2.2 Data

The primary data for my analysis are prescription drug claims and plan enrollment data for a random 20% sample of Medicare enrollees from 2012-2017. For each prescription drug claim, these data list the date of the fill, a unique identifier for the enrollee, the plan that covered the fill, the national provider identifier (NPI) of the pharmacy, the drug (as identified by the National Drug Code (NDC)), and the total amount paid to the pharmacy by the plan and by the patient, separately.[8] For each enrollee in my sample, I observe their demographics (including their zip code of residence and indicators for the receipt of low-income subsidies) and history of plan choices. I link the claims and enrollment data to three sources that provide additional information on Medicare Part D plans. The first source is a collection of data maintained by CMS on the benefit design of Medicare Part D plans, including their premiums, formularies, cost-sharing schedules, and pharmacy networks. The second source is the CMS Medicare Part D MLR Public Use File, which reports the annual MLR and other accounting data for each Medicare contract. Finally, I collect data on the bids placed by MA-PD plans and their expected annual medical costs from the bid documents that insurers submit to CMS in order to receive their subsidy payments.

I combine the claims data with two supplemental datasets that allow me to observe the relationships between insurers, PBMs, and pharmacies. The first dataset contains information on insurer-PBM contractual relationships in Medicare Part D from CMS's Health Plan Management System (HPMS). I obtained these data for all years from 2010 through 2021 through a Freedom of Information Act (FOIA) request of CMS. For each Medicare contract, CMS requires the insurer to report the use of subcontractors for specific plan functions via the HPMS. These include a variety of functions traditionally handled by PBMs, such as pharmacy network management and negotiations with drug manufacturers. For each function, the insurer must list all firms that performed the function. These data allow me to identify the PBM(s) for each plan in the data. I identify insurers that are vertically integrated with a PBM based on the names reported in the HPMS data and the CMS plan data. To identify the ownership of each pharmacy in the data, I merge on a proprietary dataset on pharmacy characteristics from the National Council of Prescription Drug Plans (NCPDP)

[7] Figure A.1 provides a graphical depiction of the typical Medicare Part D benefit schedule. This figure was repurposed from Starc and Town 2020.

[8] I observe only the total payment made by each insurer to each pharmacy at the time of the claim. PBMs negotiate rebates with drug manufacturers and may also charge pharmacies additional fees (known as "direct and indirect remuneration" or DIR fees) for participating in their pharmacy networks. I do not observe these payments and focus only on the gross price paid to the pharmacy.

DataQ database (National Council for Prescription Drug Programs, Inc.). These data report snapshots of the name(s), address, pharmacy type, and parent company of each pharmacy at different points in time. I manually identified pharmacies that are owned by PBMs or insurers using the name and parent company information provided in the DataQ. I provide more details on the datasets used in this paper in Appendix C.

The combined dataset provides visibility into the functioning of pharmacy benefits markets at a level of granularity that has been previously unavailable to researchers on two key dimensions. First, I am able to observe the PBM that processed each claim in the data, which had been previously impossible due to a lack of data on PBM-insurer contracts. Second, the information on pharmacy ownership (combined with the data on PBM-insurer relationships) allows me to identify the degree of vertical integration between the insurer, PBM, and pharmacy for each claim in my sample.

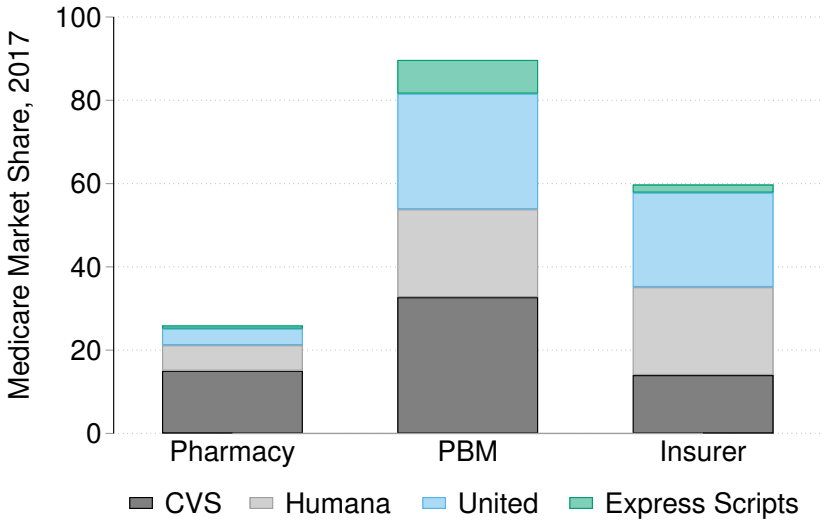
2.3 Summary Statistics

I use the combined dataset to establish three stylized facts about the Medicare Part D pharmacy benefits market that are crucial for understanding the effects of vertical integration. First, vertically integrated firms are prominent at all levels of the pharmacy benefits market. I focus on four vertically integrated firms in my analysis: CVS, Express Scripts, UnitedHealthcare, and Humana.[9] Figure 2 presents their market shares in 2017 separately as insurers, as PBMs, and as pharmacies. These firms combined to fill 25% of prescriptions as pharmacies, process over 90% of prescription claims as PBMs, and cover over 60% of claims as insurers. Figure 2 also illustrates that the relative presence of these firms varies across segments. This may cause firms to balance priorities differently when making strategic decisions. The second stylized fact is that PBMs often work for both their integrated insurers and competing insurers. As illustrated by Figure 2, the four main vertically integrated firms insure 60% of claims but process 90%. The difference between these two totals is due to non-integrated insurers who contract with integrated PBMs.[10]

[9] Four other insurers (Aetna, Centene, Emblem Health, and Kaiser Permanente) and two PBMs (Catamaran and Envision) operate pharmacies at times during my sample. I include them in the descriptive analyses but do not model their behavior, either because they were not vertically integrated for the whole panel of my analysis, because their pharmacy businesses were small during this time, or, in the case of Kaiser, because of data quality concerns. I am able to more cleanly identify the effects of vertical integration by focusing on the four "mature" integrated firms in this market.

[10] As an example, Optum RX is United Healthcare's vertically integrated PBM, but Optum RX provided PBM services to Cigna in 2017.

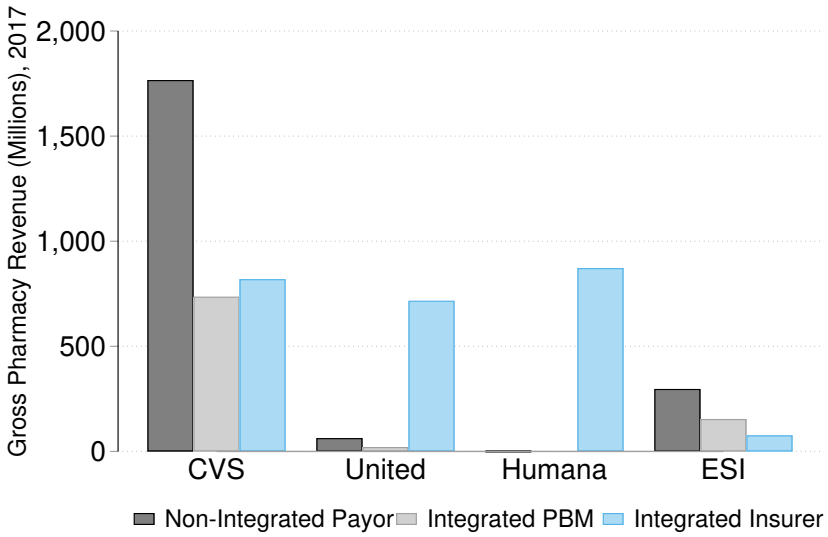
Figure 2: **Market Shares of Vertically Integrated Firms, 2017**



Notes: Market shares are calculated based on the total days supply in the pharmacy claims data.

The third stylized fact is that pharmacies may fill prescriptions for three different types of customers: fully integrated (meaning the plan, pharmacy, and PBM are all part of the same parent company), PBM-integrated (meaning the PBM and pharmacy are part of the same parent company but not the plan), and non-integrated. Figure 3 shows gross pharmacy revenue by segment at the four vertically integrated pharmacies in 2017. The relative size of these customer segments varies across firms. Most of CVS's prescription revenue comes from non-integrated plans; conversely, nearly all of the prescription revenue for Humana and United is generated by integrated plans. This heterogeneity stems primarily from differences in the operational structure of vertically integrated pharmacies: CVS is a brick-and-mortar pharmacy chain, whereas Humana, United, and Express Scripts operate mail-order pharmacies that ship drugs directly to consumers.

Figure 3: **Gross Pharmacy Revenue by Payor Type at Vertically Integrated Pharmacies, 2017**



Notes: Revenues are calculated based on the total drug cost field in the pharmacy claims data, which consists of a random 20% sample of Medicare Part D enrollees.

3 The Effect of Minimum MLR Requirements on Pharmacy Prices

In this section, I provide evidence that the pricing incentives of vertically integrated firms are shaped by a specific regulatory constraint: minimum MLR requirements. In 2014, the Affordable Care Act required all insurers participating in Medicare Part D to have an MLR of at least 85%. The stated intention of this policy was to incentivize insurers to reduce administrative costs, which policymakers hoped would ultimately lead to lower premiums. Cicala et al. 2019 and Zhao 2021 show that minimum MLR requirements typically weaken incentives for insurers to secure lower prices with providers, leading to increased healthcare spending and ultimately higher premiums. Vertical integration between insurers and providers presents another channel through which minimum MLR requirements may increase healthcare costs. Payments made to integrated pharmacies for prescription fills count as costs towards an insurer's MLR, but the profits retained by integrated pharmacies are not included in the MLR calculation; thus, by increasing internal reimbursement rates and transferring profits to their pharmacy division, insurers can reduce the costs of complying with the minimum MLR requirements (Frank and Milhaupt 2023).[11]

To test this prediction, I leverage the introduction of minimum MLR requirements in Medicare Part D as a natural experiment. I use a two-way fixed effects approach to study how the introduction of minimum MLR requirements changed the pricing incentives of vertically integrated firms. I compare how reimbursement rates changed at vertically integrated pharmacies relative to reimbursement rates at non-integrated pharmacies for the same drug-plan combination following the policy change. Formally, my estimating equation

[11] One may wonder whether integration between PBMs and insurers offers any additional avenues for strategic responses to minimum MLR requirements on another, non-pharmacy dimension. While pharmacy claims count as a cost in the MLR calculation, CMS excludes manufacturer rebates and administrative costs (such as PBM fees) from the calculation; thus, other internal transfers are unlikely to assist insurers in circumventing minimum MLR requirements.

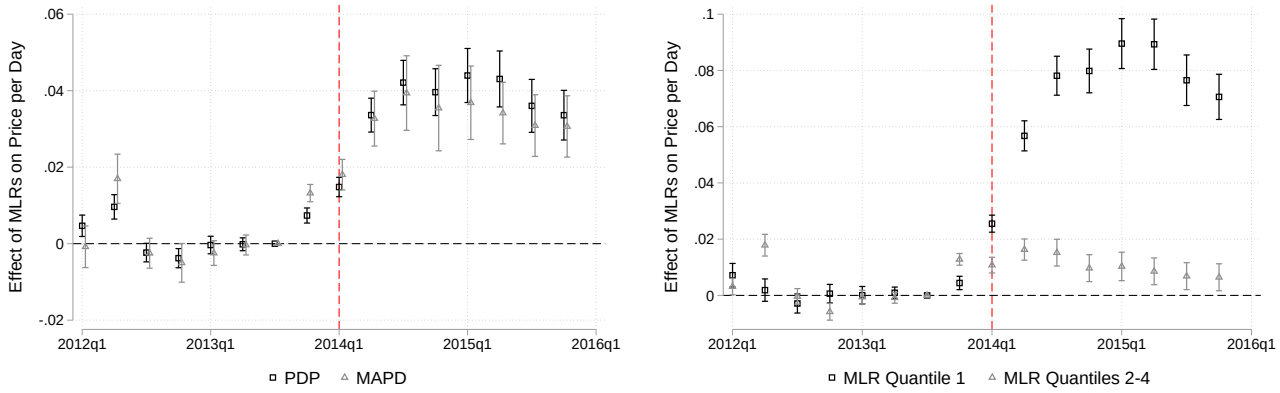
is:

$$Price_{fhdt} = \sum_{t=-8}^{8} \beta_t 1(VI_{fh}) * 1(MLR_{t+1}) + \alpha_{fh} + \alpha_{fdt} + \varepsilon_{fhdt}, \quad (1)$$

where $1(VI_{fh})$ is an indicator equal to one if plan f and pharmacy h are vertically integrated, $1(MLR_{t+1})$ is an indicator equal to one if the minimum MLR requirements will apply in quarter $t+1$, α_{fh} is a plan-pharmacy NPI fixed effect, and α_{fdt} is an plan-NDC-quarter fixed effect. I allow for a one-quarter lead in the effects of the MLR policies to account for the fact that, based on the CMS pharmacy network data, PBM-pharmacy contracts seem to renew in the fourth quarter of every calendar year.[12]

Figure 4 presents the main results. The left panel presents the estimates for generic drug prices, separately for MA-PD and PDP plans. Insurers increase internal reimbursement rates by \$0.03 per days supply relative to non-integrated reimbursement rates for generic drugs, a 5% increase over the sample mean. The right panel presents the estimates separately for plans based on their MLRs in 2014. Plans in the bottom quartile of 2014 MLR increased internal reimbursement rates by roughly five times more than plans in the upper three quartiles. This finding is intuitive: insurers face stronger incentives to "tunnel" profits to pharmacies when the minimum MLR requirements are binding.

Figure 4: **Event Study of the Implementation of Minimum MLR Requirements on Prices for Vertically Integrated Generic Drug Prescriptions**



(a) By Plan Segment

(b) By 2014 Medical Loss Ratio Quartile

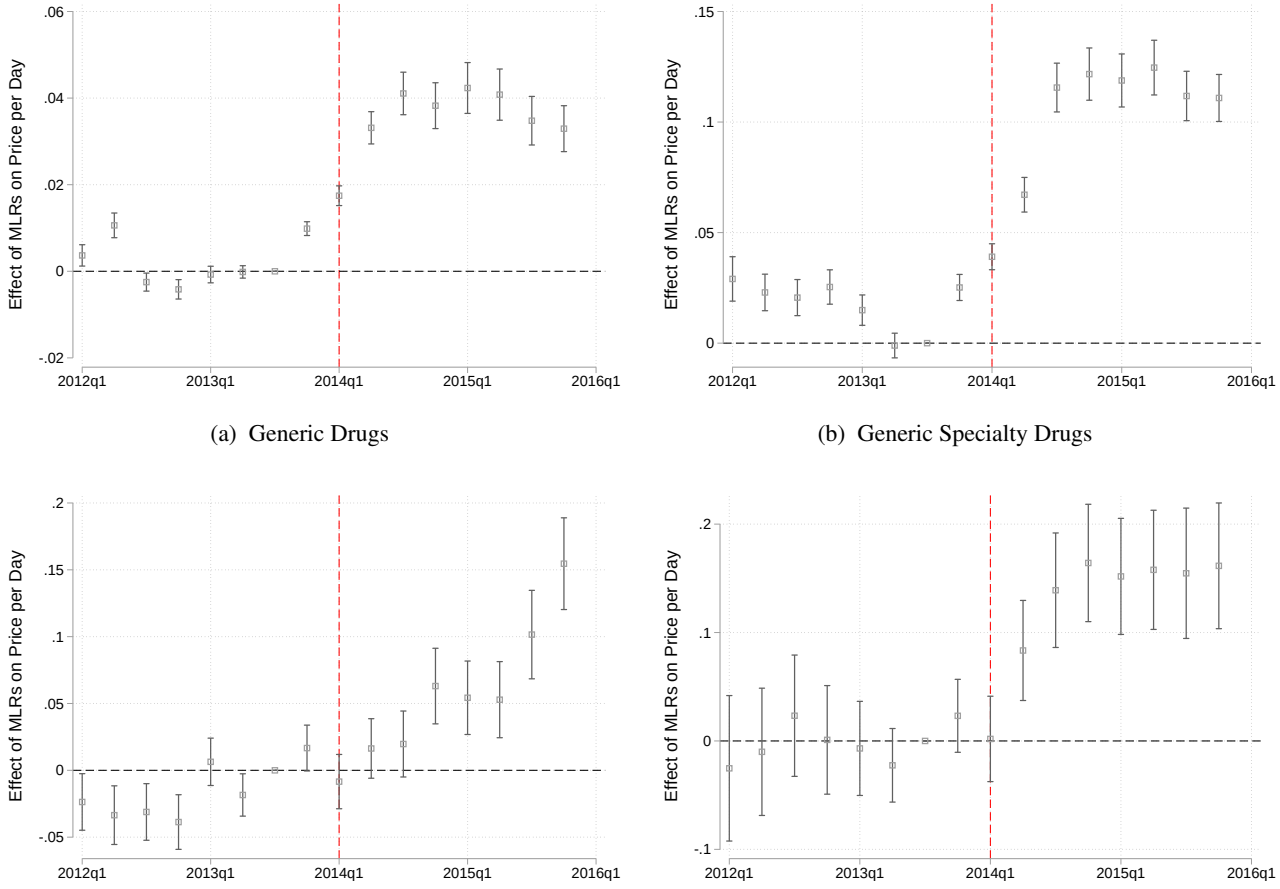
Notes: The bars represent 95% confidence intervals. Standard errors are clustered by insurer-pharmacy combination. The unit of observation is a combination of Medicare contract ID, Medicare plan ID, pharmacy National Provider Identifier (NPI), 11-digit National Drug Code (NDC), and quarter-year. I sum the total drug costs and days supply across claims for each combination before computing prices. I assign branded or generic status to each NDC based on the most frequent branded/generic code associated with that NDC in the data. The underlying data are limited to 2012-2015. I exclude NPI-plan combinations for which vertical integration status is not constant for the entire panel. I also exclude NPI-plan combinations and 11-digit NDCs that are not present in the data for the entire panel. The regressions are weighted by days supply.

Efforts to tunnel profits to vertically integrated pharmacies through higher prices may be unsuccessful if consumers substitute to different pharmacies in response to price changes. To explore how insurers execute their tunneling strategy, Figure 5 shows the event studies separately for different groups of drugs. I observe larger increases in absolute terms for "specialty" drugs, for which internal reimbursement rates increased

[12] One potential confounder is the emergence of a large price-fixing scheme among generic drug manufacturers around the same time as the implementation of the minimum MLR regulations. In unreported specifications, I confirm that the results are robust to excluding drugs that were identified as being cartelized in Starc and Wollmann 2022.

by $0.12 per days supply (1%), and for generic specialty drugs, for which they increased by $0.09 per days supply (8%). Consumer demand may be less elastic for specialty drugs, which typically treat rare diseases. Furthermore, Kakani et al. 2025 find that vertically integrated insurers may exert greater control over pharmacy choice for specialty drugs. By steering consumer demand towards integrated pharmacies, insurers may be able to ensure that consumers do not substitute to different pharmacies in response to higher prices. The effects are muted for branded drugs, for which prices are more closely tied to the list prices set by drug manufacturers.[13]

Figure 5: **Event Study of the Implementation of Minimum MLR Requirements on Prices for Vertically Integrated Prescriptions, by Drug Type**



(a) Generic Drugs

(b) Generic Specialty Drugs

(c) Branded Drugs

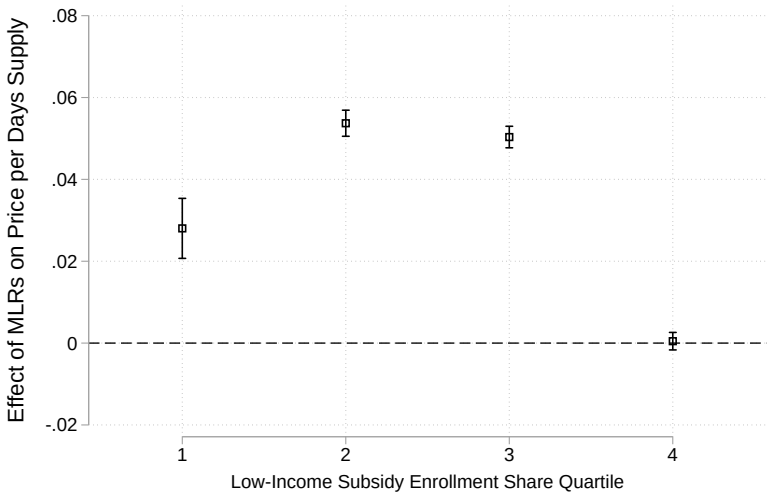
(d) Specialty Drugs

Notes: The bars represent 95% confidence intervals. Standard errors are clustered by insurer-pharmacy combination. The unit of observation is a combination of Medicare contract ID, Medicare plan ID, pharmacy National Provider Identifier (NPI), 11-digit National Drug Code (NDC), and quarter-year. I sum the total drug costs and days supply across claims for each combination before computing prices. I assign branded or generic status to each NDC based on the most frequent branded/generic code associated with that NDC in the data. I assign specialty status to drugs if they are placed on a specialty formulary tier for any plan. The underlying data are limited to 2012-2015. I exclude NPI-plan combinations for which vertical integration status is not constant for the entire panel. I also exclude NPI-plan combinations and 11-digit NDCs that are not present in the data for the entire panel. The regressions are weighted by days supply.

[13]Drug manufacturers negotiate rebates with insurers for branded drugs in exchange for favorable placement on drug formularies. As a result of this pricing convention, there may be minimal scope for price variation in branded drugs across pharmacies. Conversely, generic drug manufacturers compete for shelf space at pharmacies, leading to price variation across pharmacies for these drugs. Starc and Swanson 2021 document larger price variation across pharmacies for generic drugs than for branded drugs.

Figure 6 explores heterogeneity in the effects for generic drugs across plans based on the percentage of their enrollees who receive low-income subsidies. I observe roughly similar increases in prices for the bottom three quartiles of LIS enrollment share but no change in prices for the top quartile. Starc and Swanson 2021 find that LIS consumers are more sensitive to out-of-pocket drug prices than non-LIS consumers. Therefore, these heterogeneous price effects suggest that insurers concentrated tunneling efforts towards plans with relatively inelastic demand for pharmacy services.[14]

Figure 6: **Heterogeneous Effects of Minimum MLR Requirements on Generic Drug Prices for Vertically Integrated Prescriptions by Low-Income Subsidy Enrollment Share**



Notes: The bars represent 95% confidence intervals. Standard errors are clustered by insurer-pharmacy combination. The unit of observation is a combination of Medicare contract ID, Medicare plan ID, pharmacy National Provider Identifier (NPI), 11-digit National Drug Code (NDC), and quarter-year. I sum the total drug costs and days supply across claims for each combination before computing prices. I assign branded or generic status to each NDC based on the most frequent branded/generic code associated with that NDC in the data. The underlying data are limited to 2012-2015. I exclude NPI-plan combinations for which vertical integration status is not constant for the entire panel. I also exclude NPI-plan combinations and 11-digit NDCs that are not present in the data for the entire panel. The regressions are weighted by days supply. These graphs depict the average treatment effect from separate regressions of Equation (1) for each listed quartile. The LIS quartiles are calculated based on enrollment in 2014.

In sum, vertically integrated insurers responded strategically to minimum MLR regulations by increasing reimbursement rates at integrated pharmacies, enabling compliance with the regulations without reducing overall profits. The incentive to tunnel profits to integrated pharmacies was strongest for plans for which the minimum MLR threshold was most likely to bind. This strategic response is more feasible when consumers are less likely to substitute to other pharmacies in response to price changes. Thus, integrated firms targeted their price increases towards less elastic demand segments: specialty drugs, for which insurers have better control over consumer choices of pharmacies, and plans with a larger share of non-LIS enrollees, who are less sensitive to price.

[14] Another explanation could be that plans with high LIS enrollment also have higher MLRs and thus do not face an incentive to tunnel profits. However, Figure A.2 illustrates that LIS enrollment share and MLRs are uncorrelated.

4 Model

4.1 Overview

To understand the effects of vertical integration, I formulate an empirical model of the Medicare Part D pharmacy benefits market as a game in three stages that accounts for the regulatory complexities created by minimum MLR requirements. I follow the approach developed in other papers and model the behavior of consumers and firms while taking the horizontal and vertical market structure as predetermined (Crawford et al. 2018; Cuesta et al. 2024). In the first stage of the game, three supply decisions are made simultaneously: pharmacies set prices for prescription fills made by enrollees of their integrated PBMs and insurers; pharmacies bargain over prices with non-integrated PBMs; and insurers set premiums. In the second stage, consumers choose an insurance plan. Finally, consumers face stochastic illnesses and use pharmacies to fill prescriptions. In this section, I first describe the set-up of the model in reverse order. I then use the model to illustrate the theoretical effects of vertical integration.

4.2 Demand

4.2.1 Pharmacy Demand

I take demand for specific drugs as given and model only the process by which consumers choose a pharmacy at which to fill prescriptions. At the beginning of year t, consumer i of low-income subsidy status ℓ in state s expects to require $\gamma_{\ell(i)dst}$ days supply of drugs in formulary tier $d \in \{1,2,3\}$.[15] The consumer must fill prescriptions at a pharmacy in their plan's pharmacy network. Consumers consider the out-of-pocket price that they face at each pharmacy when choosing where to fill a prescription. I model prices for drugs in formulary tier d as the product of: (1) a "base" price p_{njt} negotiated between plan j and pharmacy n; and (2) a scalar "resource intensity" weight ω_{dt} that is common to all plans and pharmacies and scales up base prices based on the average costs of drugs within formulary tier d.[16] The out-of-pocket price for consumers is the product of the base price, the resource intensity weight, and an "effective" coinsurance rate r that varies by plan, formulary tier, low-income subsidy status, and pharmacy.[17]

Formally, for fills of drugs in formulary tier d at pharmacy location n, consumer i enrolled in plan j

[15] Following Starc and Swanson 2021, I group any higher formulary tiers into formulary tier 3. Some plans offer higher formulary tiers for specialty drugs, which have few prescriptions in the data.

[16] Drug prices vary substantially across the more than 200 thousand unique NDCs that are sold in the United States. This approach allows me to construct a single endogenous scalar price for each pharmacy-plan combination, which simplifies the estimation of the pricing and bargaining game while still capturing important price variation across drugs. The resource intensity weight ω is analogous to the Diagnosis Related Group (DRG) weight that is used to standardize the prices paid by insurers to hospitals (which varies based on the patient's diagnosis) into a single scalar price.

[17] I choose to represent the effective cost-sharing for each patient as a coinsurance rate because consumers face varying exposure to drug prices over the course of a plan year due to the non-linearity of Medicare Part D benefit schedules. Many consumers face linear co-pays for drugs while in the plan's initial coverage range but must pay the full negotiated reimbursement rate before hitting their deductible and, in some cases, in the coverage gap. The effective coinsurance rate captures the average share of drug prices borne by consumers over the course of the plan year. Figure A.1 provides an illustration of a typical Medicare Part D benefit schedule.

receives utility according to:

$$u^H_{idnjt} = \beta^{OOP}_{\ell(i)d} r_{\ell(i)dnjt} p_{dnjt} + \beta^{Mail}_{\ell(i)d} Mail_n + \beta^{Dist}_{\ell(i)d} Dist_{in} + \beta^{Dist^2}_{\ell(i)d} Dist^2_{in} + \beta^{VI}_{\ell(i)d} VI_{njt} + \xi^H_{\ell(i)dnjt} + \varepsilon^H_{idnjt}, \quad (2)$$

where $r_{\ell(i)dnjt}$ is the effective coinsurance rate, $Mail_n$ is an indicator equal to one if pharmacy n is a mail-order pharmacy, $Dist_{in}$ is the distance in miles from consumers i's zipcode centroid to pharmacy location n,[18] VI_{njt} is an indicator equal to one if pharmacy n is integrated with plan j (or plan j's PBM), $\xi^H_{\ell(i)dnjt}$ is a pharmacy-plan-formulary tier-year specific fixed effect that captures unobserved quality, and ε^H_{idnjt} is an iid error term that is distributed type 1 extreme value (T1EV).

4.2.2 Plan Demand

Before filling prescriptions, consumers must enroll in an insurance plan. Their preferences for a given plan depend on the plan's characteristics, including its premium and the consumer's expected value of its pharmacy network. Each consumer in county c has three options: enroll in an MA-PD plan, enroll in a PDP plan, or choose the outside option (e.g., no Part D insurance or remain on an employer-sponsored plan). I follow Starc and Town 2020 and model consumer plan choice using a nested logit utility specification.

I follow the standard approach from the hospital demand literature to calculate a consumer's expected value for each plan's pharmacy network (Capps et al. 2003). Conditional on the T1EV distribution of ε^H_{idnjt}, the expected value of filling drugs d by consumers of type $\ell(i)$ in zipcode z at pharmacies within the pharmacy network $\mathcal{G}_j$ offered by plan j of nest $g \in \{MAPD, PDP\}$ can be written as $EU_{\ell(i)zdjt}(\mathcal{G}_j) = \frac{1}{-\beta_{1\ell(i)d}} log(\sum_{n \in \mathcal{G}_j} exp(\tilde{u}^H_{idnjt}))$. To construct the willingness-to-pay (WTP) of enrollee i of LIS status $\ell(i)$ for plan j's pharmacy network in county c, I sum the expected utilities of prescriptions for each formulary tier d and zip-code z, and then take the population-weighted average across zip-codes within each county:

$$WTP_{\ell(i)zjt}(\mathcal{G}_j) = \sum_d \gamma_{\ell(i)dt} EU_{\ell(i)zdjt}(\mathcal{G}_j) \quad (3)$$

Formally, consumer i in county c receives utility from plan j according to:

$$u^F_{icjt} = \alpha^b_{\ell(i)} b^{Drug}_{\ell(i)jt} + \alpha^{WTP}_{\ell(i)} WTP_{\ell(i)cjt} + \alpha^{Ded}_{\ell(i)} Deductible_{cjt} + \xi^F_{\ell(i)cjt} + \zeta^F_{\ell(i)cgt} + (1-\sigma_{\ell(i)})\varepsilon^F_{icjt}, \quad (4)$$

where $b_{\ell(i)jt}$ is the consumer-facing drug premium for plan j (scaled to account for low-income subsidies), $Deductible_{cjt}$ is the plan's annual deductible, and $WTP_{\ell(i)cjt}$ is the plan's average zip-level pharmacy network surplus (weighted by zipcode Medicare enrollment). There are two mean-zero preference shocks: $\xi^F_{\ell(i)cjt}$ is common to all plans, while $\zeta^F_{\ell(i)cgt}$ is an error term common to all products in nest g and has a distribution function that depends on $\sigma_{\ell(i)} \in (0,1)$. I assume that ε^F_{icjt} is distributed type 1 extreme value.

[18] $Dist_{in}$ is set to zero for mail-order pharmacies.

4.3 Supply

There are three types of firms in each county c in each year t: pharmacies $h \in \mathcal{H}$, PBMs $k \in \mathcal{K}$, and insurers $f \in \mathcal{F}$. Each insurer f offers a set of plans $j \in \mathcal{J}_f$, while each pharmacy chain h has a set of locations $n \in \mathcal{N}_h$. The profits for each firm depend on three objects: pharmacy networks $\mathcal{G}$ (which map pharmacies onto coinsurance rates r), premiums b, and pharmacy prices p.

Each pharmacy chain $h \in \mathcal{H}$ receives profits according to

$$\Pi^H_{ht}(\underbrace{\mathcal{G}}_{\substack{\text{Pharmacy}\\\text{Networks}}}, \underbrace{\boldsymbol{b}}_{\text{Premiums}}, \underbrace{\boldsymbol{p}}_{\text{Prices}}) = \sum_d \sum_{f\in\mathcal{F}} \sum_{j\in\mathcal{J}_f} \sum_{n\in\mathcal{N}_h} \underbrace{D^H_{dnjt}}_{\substack{\text{Demand for}\\\text{Pharmacy } h}} (\underbrace{p_{dnjt}}_{\substack{\text{Pharmacy}\\\text{Price}}} - \underbrace{c_{dnt}}_{\substack{\text{Marginal}\\\text{Cost}}}), \tag{5}$$

where D^H_{dnjt} is the unconditional demand for pharmacy location n from plan j, p_{dnjt} is the price received by pharmacy n for formulary tier d prescription fills made by enrollees of plan j, and c_{dnt} are pharmacy marginal costs. The economic marginal costs of pharmacies include the costs of filling prescriptions (e.g., drug acquisition costs, pharmacist wages) but also any additional profits generated by the pharmacy's retail segment from selling consumer goods, which would enter as a negative cost. Like prices, I assume that pharmacy marginal costs for formulary tier d are scaled by the resource weight such that $c_{dnt} = \omega_{dt} c_{nt}$.

Insurers $f \in \mathcal{F}$ receive profits according to:

$$\Pi^F_{ft}(\mathcal{G}, \boldsymbol{b}, \boldsymbol{p}) = \sum_{j\in\mathcal{J}_f} [D^F_{jt}(b^{Drug}_{jt} + \underbrace{z_t}_{\text{Subsidies}} + \underbrace{b^{Medical}_{jt}}_{\substack{\text{Medical}\\\text{Payments}}} - \underbrace{\eta_{jt}}_{\substack{\text{Other}\\\text{Costs}}}) - \underbrace{\sum_d \sum_{h\in\mathcal{H}} \sum_{n\in\mathcal{N}_h} D^H_{dnjt}(1 - r_{dnjt}) p_{dnjt}]}_{\text{Net Payments to Pharmacies}}, \tag{6}$$

where D^F_{jt} is the demand for plan j, b^{Drug}_{jt} are the drug premiums paid by consumers, z_t are the subsidies received from the government for providing drug insurance (which are common across all Part D plans), $b^{Medical}_{jt}$ are the payments received by MA-PD plans for providing medical insurance, and η_{jt} are all non-pharmacy insurance costs. The second term of insurer profits captures payments to pharmacies for filling prescriptions, net of cost-sharing by consumers.

PBMs bargain over prices with non-integrated pharmacies on behalf of insurers. I take as given that each PBM k has a set of insurer clients $\mathcal{F}_k$. When working for insurer f, I assume that PBM k's objective is to maximize a scaled version of insurer f's profits: $\Pi^K_{kft}(\mathcal{G}, \boldsymbol{b}, \boldsymbol{p}) = \underbrace{\lambda_{kft}}_{\substack{\text{Profit}\\\text{Weight}}} \underbrace{\Pi^F_{ft}}_{\substack{\text{Insurer } f\\\text{Profits}}}$, where λ_{kft} is the weight placed by PBM k on its client insurer's profits.[19] If $\lambda_{kft} = 1$, then the PBM fully internalizes how its actions affect the profits of its client insurers. I allow λ_{kft} to be different from one to capture potential variation in PBM effort for non-integrated insurers.

I follow Cuesta et al. 2024 and Crawford et al. 2018 and assume that the objective function for vertically

[19] I do not observe the compensation received by PBMs. My understanding is that PBMs receive volume-based fees from Medicare Part D insurers and may also retain a share of manufacturer rebates. In other non-Medicare market segments, PBMs are paid on "spread": they agree to fill prescriptions at a set price with insurers, and then negotiate prices with pharmacies, keeping the difference as profit. Spread pricing is prohibited in Medicare.

integrated firm a is the weighted sum of its insurance profits and its pharmacy profits:

$$\Pi_{at}(\mathcal{G}, \boldsymbol{b}, \boldsymbol{p}) = \Pi^{F}_{a(f)t} + \mu_{at}\Pi^{H}_{a(h)t}, \tag{7}$$

where μ_{at} is the weight placed by firm a on their pharmacy profits relative to insurance profits. I allow for μ_{at} to be different from one, as minimum MLR requirements may induce firms to place a greater value on a dollar of pharmacy profits than a dollar of insurance profits. μ_{at} will pick up the constraints placed on a firm by minimum MLRs, which could cause μ_{at} to exceed one.[20]

4.3.1 Pharmacy Pricing

I assume that pharmacy prices are determined simultaneously with insurer premium competition. Figure A.3 provides a diagram that explains how prices are determined in the model based on the degree of integration between the pharmacy, PBM, and insurer. Pharmacies do not bargain with their integrated PBMs; rather, they set prices to maximize weighted joint profits. I assume that pharmacies set separate prices for each plan offered by an insurer that is either integrated with or a client of the pharmacy's integrated PBM. The price charged by pharmacy n of chain h to plan j offered by integrated insurer f is determined by taking the first-order condition of the weighted sum of insurer f and pharmacy chain h profits:

$$\frac{d\Pi_{at}}{dp_{jnt}} = \frac{d\Pi^{F}_{a(f)t}}{dp_{jnt}} + \mu_{at}\frac{d\Pi^{H}_{a(h)t}}{dp_{jnt}} = 0. \tag{8}$$

Likewise, the price charged by pharmacy n through integrated PBM k to plan j for non-integrated insurer f is

$$\frac{d\Pi_{kt}}{dp_{jnt}} = \lambda_{kft}\frac{d\Pi^{F}_{ft}}{dp_{jnt}} + \mu_{kt}\frac{d\Pi^{H}_{h(k)t}}{dp_{jnt}} = 0. \tag{9}$$

Chain pharmacies bargain with non-integrated PBMs over prices. For a given pharmacy, I assume that PBMs secure one price for all insurers that they work for such that $p_{jnt} = p_{knt} \forall j \in \mathcal{F}_k$. The price p_{knt} negotiated between PBM k and pharmacy chain h solves their Nash bargaining problem:

$$p_{knt} = argmax_{p_{kht}}[\underbrace{\sum_{f\in\mathcal{F}_k}(\Pi^{K}_{kft}(\mathcal{G},\mathbf{b},\mathbf{p}) - \Pi^{K}_{kft}(\mathcal{G}/kh,\mathbf{b},\mathbf{p}))}_{\substack{\text{Change in PBM k's profits}\\ \text{upon disagreement with chain h}}} + \underbrace{\kappa WTP_{kht}}_{\substack{\text{Disagreement}\\ \text{Penalty}}}]^{\tau_k}[\underbrace{\Pi^{H}_{ht}(\mathcal{G},\mathbf{b},\mathbf{p}) - \Pi^{H}_{ht}(\mathcal{G}/kh,\mathbf{b},\mathbf{p})}_{\substack{\text{Change in chain h's profits}\\ \text{upon disagreement with PBM K}}}]^{1-\tau_k}, \tag{10}$$

where $\Pi^{K}_{kft}(\mathcal{G}/kh,\mathbf{b},\mathbf{p})$ represents the payoff for insurer f (as internalized by PBM k) upon disagreement with pharmacy chain h, and $\Pi^{H}_{ht}(\mathcal{G}/kh,\mathbf{b},\mathbf{p})$ represents the payoff for pharmacy chain h upon disagreement with PBM k. If chain h and PBM k fail to come to an agreement, I assume that chain h is "out-of-network" for all of PBM k's insurer clients, meaning that their enrollees cannot access chain h's pharmacies.[21] In

[20] An alternative approach would be to add a constraint to the insurer's profit function that their MLR must not exceed 85%. Such a constraint would make the best response function of the insurer discontinuous, which may create issues with equilibrium existence.

[21] In reality, a consumer may choose to fill prescriptions at out-of-network pharmacies and pay the cash price for the drug, perhaps through a discount card program like GoodRx. This is unlikely in the Medicare context. Out-of-network pharmacy claims are rare

the case of pharmacy contract terminations, PBM k faces financial penalties if their new pharmacy network does not satisfy CMS's pharmacy network adequacy standards. I account for these penalties in the model by assuming that PBM k faces a financial penalty equal to the additional network surplus added by pharmacy chain h (WTP_{kht}), scaled by a parameter κ, if it excludes chain h from its networks.

I make the "passive beliefs" assumption that is common in Nash-in-Nash bargaining models: when PBM k and pharmacy chain h bargain over prices, they take as given all other PBM-pharmacy contracts, the design of their cost-sharing schedules, and insurer premiums. Further, they assume that these outcomes would remain fixed even if the two parties failed to come to an agreement. One may be concerned that PBM k may adjust either their pharmacy networks or cost-sharing schedules in response to changes in bargaining outcomes. In the data, I observe contracts between each major PBM and all large pharmacy chains, meaning that the pharmacy networks are "complete." Thus, I assume that PBM k cannot replace pharmacy chain h in their networks with a different, large pharmacy chain. I assume that PBMs take the cost-sharing assigned by each plan to each pharmacy as given when bargaining, as plan design decisions are typically made on a local level while bargaining occurs nationally.

The simultaneity of prices and premiums implies that pharmacies believe that premiums do not adjust in response to changes in reimbursement rates or pharmacy network structure. This assumption provides significant computational benefits, as I do not have to compute the pass-through of prices to premiums when solving the bargaining model. However, other research has shown that this simultaneity assumption may lead researchers to predict unrealistically large distortions from double marginalization when applying Nash-in-Nash solution concepts to consumer goods markets since upstream firms fail to internalize that price increases reduce demand (Panhans 2024). In my case, pharmacies internalize that higher prices reduce demand for two reasons. First, consumers are directly exposed to prices through cost-sharing, and may substitute across pharmacies in response to price changes. Second, pharmacies internalize that increases in prices reduce consumer plan demand by reducing the quality of the plan's pharmacy network, which ultimately reduces demand for the pharmacy. As such, I view this assumption as providing a realistic approximation of the trade-offs faced by firms in their negotiations while providing substantial computational benefits.

4.3.2 Insurer Premium Competition

Simultaneously with pharmacy pricing, insurers engage in Nash-Bertrand competition over drug premiums. The premium charged by plan j is determined by taking the first-order condition of its weighted insurance and pharmacy profits, such that $\frac{d\Pi_{at}}{db_{jt}^{Drug}} = \frac{d\Pi_{a(f)t}^{F}}{db_{jt}^{Drug}} + \mu_{at}\frac{d\Pi_{a(h)t}^{H}}{db_{jt}^{Drug}} = 0$. The consumer drug premium for plan j is the difference between its bid and a baseline subsidy amount, which is set by statute at 74.5% of the national average bid. I follow the standard assumption in the literature that plans know the baseline subsidy before bidding, which allows me take the subsidy as given.[22] Insurers place bids for PDP plans that apply

in the data, and industry reports suggest that Medicare enrollees almost always fill prescriptions through insurance at in-network pharmacies (Adolph et al. 2022).

[22] Since the subsidies are determined based on the average bid placed by Medicare Part D plans, this assumption implies that insurers take the national average bid as given when submitting their bid. This assumption is plausible, as dozens of different insurers place bids for dozens of plans in a given year.

for plan's entire service region, and thus all consumers within the same PDP service region face the same premium for the plan; insurers can design separate MA-PD plans for each county, and thus the MA-PD bid and consumer premium can vary by county. I take as given the bids placed by MA-PD plans for providing medical insurance.

4.4 Theoretical Effects of Vertical Integration

In this subsection, I use the theoretical model to describe how vertical integration affects the incentives of insurers, pharmacies, and PBMs. First, I model how vertically integrated firms set prices for integrated prescription fills and premiums to illustrate the trade-offs they face in making these strategic choices. Then, I use the bargaining model to illustrate the competitive effects of vertical integration on rival insurers and pharmacies.

4.4.1 Alignment of Internal Incentives

Without loss of generality, I assume that there is only one formulary tier d, that each insurer f only offers one plan j, and that each pharmacy h only has one location n. Thus, I suppress the d subscript and use f and h in place of the j and n subscripts, respectively. By re-arranging terms in the first-order condition for profits with respect to integrated prices, I show the trade-offs faced by vertically integrated firms when determining the prices for drugs at integrated pharmacies:

$$\underbrace{\frac{dD^F_{a(f)}}{dp_{a(h)a(f)}}(b^{Drug}_{a(f)}+z^{Drug}+b^{Medical}_{a(f)}-\eta_{a(f)})}_{\text{Change in Premium Revenue}}-\underbrace{\sum_{h'\in\mathcal{H}}(1-r_{h'a(f)})\frac{dD^H_{h'a(f)}}{dp_{a(h)a(f)}}p_{h'a(f)}}_{\text{Change in Insurer Outlays to Rival Pharmacies}}+\underbrace{\mu_a(\sum_{f'\in\mathcal{F}}\frac{dD^H_{a(h)f'}}{dp_{a(h)a(f)}}(p_{a(h)f'}-c_{a(h)}))}_{\text{Change in Pharmacy Profits From Rival Insurers}}$$

$$+\underbrace{(\mu_a-(1-r_{a(h)a(f)}))(D^H_{a(h)a(f)}+\frac{dD^H_{a(h)a(f)}}{dp_{a(h)a(f)}}p_{a(h)a(f)})-\mu_a\frac{dD^H_{a(h)a(f)}}{dp_{a(h)a(f)}}c_{a(h)}}_{\text{Change in Effective Profits from Integrated Prescriptions}}=0. \quad (11)$$

The first two terms of Equation (11) represent changes to the integrated insurer's profits due to price increase by integrated pharmacies. Higher pharmacy prices decrease the value of the plan's pharmacy network (as measured by WTP), causing some consumers to switch plans and reducing premium revenue. Consumers who remain enrolled in the plan may substitute to other pharmacies, which affects insurer costs due to variation in negotiated rates across pharmacies. The third term represents the changes in pharmacy profits from rival insurers who absorb consumers who switch from the integrated plan.

The last term is crucial for understanding the incentives of vertically integrated firms: it represents the marginal profits earned from integrated prescription fills. Two factors create a wedge between the pharmacy's marginal revenue and the insurer's marginal outlays for these transactions. The first factor underlying this wedge is the coinsurance rate (r_{hf}). Consumers are responsible for paying a fraction of drug costs. As such, insurers do not bear the full cost of a price increase. Thus, vertically integrated firms may desire to charge above marginal cost to earn additional profits from partially-insured consumers. The second factor

underlying the wedge is the pharmacy profit weight μ. Markups increase as firms place a greater weight on pharmacy profits relative to insurer profits. Minimum MLR requirements may induce firms to view a dollar of pharmacy profits as "more valuable" than insurance profits, which would materialize as a higher μ value in my model. Together, these factors explain why vertically integrated firms may maintain markups on prescription fills at their integrated pharmacies.

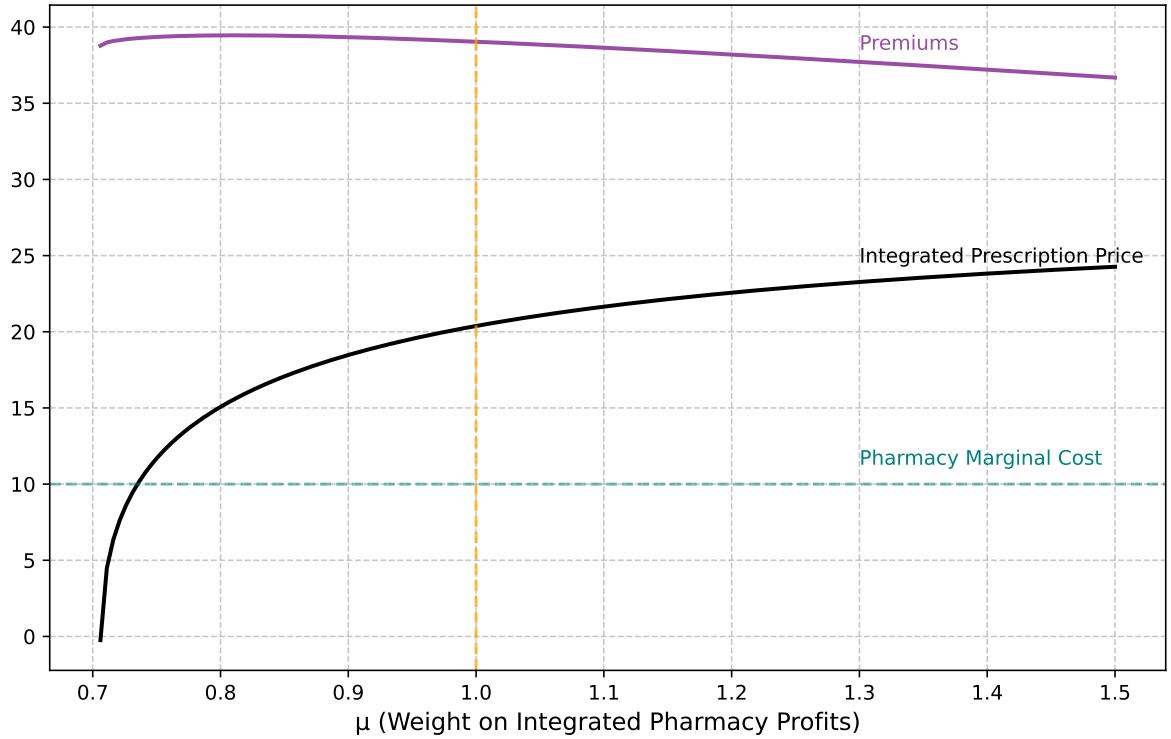
I now examine how vertical integration affects insurance premiums. Re-arranging the terms in the first order condition of profits with respect to premiums allows me to write the equilibrium premium as:

$$b_{a(f)} = \eta_{a(f)} - z^{Drug} - b^{Medical}_{a(f)} + \underbrace{\sum_{h \in \mathcal{H}} D^{H}_{ha(f)}(1 - r_{hf}) p_{ha(f)}}_{\text{Payments to Pharmacies}}$$
$$\underbrace{- D^{F}_{a(f)} (\frac{dD^{F}_{a(f)}}{db_{a(f)}})^{-1}}_{\text{Standard N-B Markup}} \underbrace{- \mu_a (\sum_{f' \in \mathcal{F}} \frac{dD^{H}_{a(h)f}}{db_{a(f)}} (p_{a(h)f} - c_{a(h)}))}_{\text{Change in VI Pharmacy Profits}} (\frac{dD^{F}_{a(f)}}{db_{a(f)}})^{-1}. \quad (12)$$

The last term of the FOC captures how vertical integration shapes insurer premium competition. When setting premiums, insurers internalize that higher premiums not only reduce demand for their plan but also reduce demand for their integrated pharmacies. This incentivizes insurers to reduce premiums, which serves to subsidize demand for their integrated pharmacies. The degree to which insurers reduce premiums to subsidize their pharmacies depends on the profit weight μ.

In equilibrium, higher premiums reduce demand for integrated pharmacies, and higher drug prices reduce demand for integrated insurers. This mutual dependence causes vertically integrated firms to view drug prices and premiums as strategic substitutes. Figure 7 demonstrates this in a simple simulation where I predict how premiums and integrated drug prices change as I vary the pharmacy profit weight μ. The simulation illustrates the strategic substitutability of premiums and prices: as pharmacies increase prices for integrated prescription fills, integrated insurers counteract the negative demand effect by reducing premiums. It also shows how consumer cost-sharing and internal firm objectives drive a wedge between pharmacy marginal revenue and insurer marginal outlays. Integrated firms charge higher markups on prescription fills when they place greater weight on pharmacy profits, perhaps in response to minimum MLR requirements. However, even if μ equals one, the integrated firm still charges prices above marginal costs in order to generate profits from partially-insured consumers.

Figure 7: **Simulated Prices and Premiums for a Vertically Integrated Firm**



4.4.2 Competitive Effects

I now illustrate how vertical integration affects bargaining between PBMs and pharmacies over reimbursement rates. Vertical integration changes the gains from trade for both PBMs and pharmacies: PBMs bargain with pharmacies that compete with their integrated pharmacies, and pharmacies bargain with PBMs that represent plans that compete with its integrated insurer. For ease of exposition in this subsection, assume for the moment that there is no coinsurance ($r = 0$), such that insurers pay the full reimbursement rate to pharmacies, and no network disagreement penalty ($\kappa = 0$). I consider a vertically integrated PBM a that bargains with a rival, vertically integrated pharmacy chain b. In the spirit of Ho and Lee 2017, in which there is no consumer cost-sharing, I can take the first order condition of Equation (10) and re-arrange terms to illustrate the determinants of the payment from PBM a to pharmacy chain b.

$$\underbrace{p^*_{ab}\sum_{f\in\mathcal{F}_a}\lambda_{af}D^H_{fb}}_{\substack{\text{Total payments}\\ \text{from PBM } a\\ \text{to pharmacy } b}} =$$

$$(1-\tau_a)\Bigg[\underbrace{\sum_{f\in\mathcal{F}_a}\lambda_{af}\Delta_{ab}D^F_f\left(b^{\text{Drug}}_f+z+b^{\text{Medical}}_f-\eta_f\right)}_{\text{(i) Premium and enrollment effect}}-\underbrace{\sum_{f\in\mathcal{F}_a}\lambda_{af}\sum_{h\in\mathcal{G}_f\setminus\{b\}}\Delta_{ab}D^H_{fh}p^*_{ah}}_{\text{(ii) Price reinforcement effect}}+\underbrace{\mu_a\sum_{f\in\mathcal{F}}\Delta_{ab}D^H_{fh(a)}\left(p_{fh(a)}-c_{h(a)}\right)}_{\text{(iii) Pharmacy conversion effect}}\Bigg]$$

$$+\tau_a\Bigg[\underbrace{\mu_b\sum_{f\in\mathcal{F}_a}D^H_{fb}c_b}_{\substack{\text{(iv) Pharmacy}\\ \text{cost effect}}}-\underbrace{\mu_b\sum_{f\notin\mathcal{F}_a}\Delta_{ab}D^H_{fb}\left(p^*_{fb}-c_b\right)}_{\text{(v) Recapture effect}}+\underbrace{\Delta_{ab}D^F_{f(b)}\left(b^{\text{Drug}}_{f(b)}+z+b^{\text{Medical}}_{f(b)}-\eta_{f(b)}\right)-\sum_{h\in\mathcal{G}_{f(b)}}\Delta_{ab}D^H_{f(b)h}p_{f(b)h}}_{\text{(vi) Insurer conversion effect}}\Bigg]. \tag{13}$$

where $\Delta_{ab}D^F_f = D^F_f(\mathcal{G}) - D^F_f(\mathcal{G}\setminus ab)$ is the change in demand for insurer f in the case of disagreement between PBM a and pharmacy chain b and $\Delta_{ab}D^H_{fh} = D^H_{fh}(\mathcal{G}_f) - D^H_{fh}(\mathcal{G}_f\setminus ab)$ is the change in demand for pharmacy chain h from insurer f in the case of disagreement between PBM a and pharmacy chain b. I borrow terminology from Ho and Lee 2017 to describe the determinants of the total payment from PBM a to pharmacy b:

(i) *Premium and enrollment effect*: when PBM a fails to contract with pharmacy b, consumer willingness-to-pay for PBM a's client plans decreases, causing some consumers to switch plans. The more premium revenue that PBM a's plans lose due to disagreement with pharmacy b, the more pharmacy b is paid in equilibrium.

(ii) *Price reinforcement effect*: some consumers remain enrolled in PBM a's plans but change their utilization of pharmacies. Excluding chain b is costlier for PBM a if consumers substitute to more expensive pharmacy chains. The more expensive other pharmacies in PBM a's network are, the more pharmacy b will be paid by PBM a in equilibrium.

(iii) *Pharmacy conversion effect*: the contract between PBM a and pharmacy b affects demand for a's integrated pharmacy, as pharmacy b and PBM a's pharmacy compete for patient volume. This term represents the opportunity cost for PBM a's pharmacy unit of working with rival pharmacy b. The more consumers would substitute to PBM a's pharmacy as a result of a network exclusion of pharmacy b, the costlier it is for PBM a to include pharmacy b in its networks, and the less PBM a pays pharmacy b in equilibrium.

(iv) *Pharmacy cost effect*: pharmacy b's marginal costs are passed through to the price paid by PBM a.

(v) *Recapture effect*: this term represents the opportunity cost for pharmacy b of being in PBM a's network. If pharmacy b exits PBM a's networks, some consumers will switch plans. The more of these

prescriptions that pharmacy b is able to "recapture" through other plans, the more it can charge PBM a in equilibrium.

(vi) *Insurer conversion effect*: the contract between PBM a and pharmacy b affects demand for b's integrated plans, as PBM a's insurer clients compete with pharmacy b's integrated plans. This term represents the opportunity cost for pharmacy b's insurance unit of working with rival PBM a. The more consumers would substitute to pharmacy b's integrated plans as a result of pharmacy b exiting PBM a's networks, the more PBM a pays pharmacy b in equilibrium.

Vertical integration increases the opportunity costs for integrated plans and pharmacies in dealing with rivals, which are captured by the pharmacy and insurer conversion effects. This can result in lower prices through the pharmacy conversion effect, as PBMs effectively leverage integrated pharmacies to improve their outside option in negotiations with other pharmacy chains. It can also result in higher prices through the insurer conversion effect, as integration with a plan improves the outside option for pharmacies. As such, the insurer conversion effect and pharmacy conversion effect mirror the classic "input foreclosure" and "customer foreclosure" theories that are associated with vertical integration.

Three factors are crucial in determining the direction and magnitudes of the competitive effects: PBM bargaining ability (τ), firm incentives (as measured by the profit weight μ), and consumer preferences. Equation (13) illustrates that the degree to which these competitive effects pass through to prices depends on the bargaining ability of PBMs. As the bargaining ability of a PBM increases, it can secure prices closer to the pharmacy's reservation price. Thus, when PBMs are in a strong bargaining position ($\tau_a = 1$), ownership of pharmacies does not affect the prices paid to rival pharmacies, as those pharmacies are paid their reservation prices. Conversely, when PBMs are in a weak bargaining position ($\tau_a = 0$), ownership of pharmacies provides important leverage in negotiations by reducing the value of contracts with non-integrated pharmacies. The correlation is reversed for pharmacies: integration with plans provides meaningful leverage for pharmacies only when they have little pre-existing bargaining ability. Figure A.4 illustrates how bargaining ability shapes the competitive effects of vertical integration in a toy model.

Holding τ fixed, the competitive effects are amplified when firms place a greater weight on the profits of their pharmacies, such that μ increases. As such, minimum MLR requirements may affect not only internal firm decisions but also their interactions with rivals. Finally, the extent to which these foreclosure effects are economically significant depend on the elasticities of demand and consumer substitution patterns. Integrated firms will find input foreclosure profitable only if it induces enough substitution to integrated plans to offset potential losses in profits at integrated pharmacies; likewise, they will find customer foreclosure profitable only if it induces enough substitution to integrated pharmacies to offset potential losses in profits for integrated plans.[23] As such, measuring the competitive effects of vertical integration requires an empirical analysis of supply and demand.

[23] One possibility is that integrated pharmacies may raise prices for non-integrated PBMs in efforts to raise the premiums of rivals, thus inducing greater substitution and also allowing integrated plans to raise premiums in response. This possibility is ruled out in the model by the simultaneity of prices and premiums. Instead, pharmacies face foreclosure incentives that degrade the quality of rival plan's by diminishing consumer WTP for rival plan networks.

5 Estimation and Identification

I estimate my model in four steps. First, I estimate my model of pharmacy demand to recover preferences for pharmacies. Second, I estimate my model of plan demand to recover preferences for insurance plans. Third, I infer pharmacy marginal costs c, internal profit weights μ, and external profit weights λ for integrated firms using the first-order conditions for premiums and integrated prescription pricing. Finally, I use the first-order condition of the Nash bargaining equation to estimate PBM bargaining parameters τ, non-integrated pharmacy marginal costs c, and the network disagreement penalty κ.

5.1 Inputs for Estimation

I need to construct several inputs based on the data in order to estimate the model.

1. **Prices (p)** and **resource weights (ω)**: As described in Section 2, pharmacies typically receive a payment for the ingredient cost of the dispensed drug and a dispensing fee. I observe the total payment received by the pharmacy for each claim but not the separate components. Prices vary substantially across drugs within the same pharmacy. I follow a similar procedure as Gowrisankaran et al. 2015 and Cuesta et al. 2024 to recover a single negotiated rate and a measure of resource intensity that allows reimbursement rates to vary by formulary tier.

   I assume that pharmacy chains set a linear price for each integrated plan at the start of the calendar year; as described above, PBMs and non-integrated pharmacies contract over a single linear price for all of the PBM's plans. To calculate these prices, I first regress logged observed average prices on contracting pair-year fixed effects and drug-quarter-year fixed effects. Then, I recenter the pair-year fixed effects around the average price of tier 1 drugs to recover the "base" reimbursement rate. Finally, I use the drug-quarter-year fixed effects to calculate resource weights ω_{dt} for each formulary tier $d \in \{1,2,3\}$ in each year t. I assume that these resource weights are common across all PBMs and pharmacies and that they scale up reimbursement rates and pharmacy marginal costs equivalently. I provide more details on the exact procedure to recover prices and resource weights in Appendix C.3.

   The price that I measure is the point-of-sale price paid to the pharmacy for drugs in a given formulary tier. PBMs secure rebates from branded drug manufacturers and from pharmacies that lower the costs for insurers ex post. I do not have data on these rebates and assume they are determined independently of the strategic decisions that I model in this paper.

2. **Non-Drug Insurer Costs (η)**: I observe pre-rebate drug costs in the data but not other sources of costs, including administrative costs or medical costs. I use insurer accounting data and the bid documents submitted by plans to CMS to back out the non-drug insurer costs for each plan. For MA-PD plans, I calculate non-drug insurer costs using data on plan-reported expected medical costs, which plans submit in their bids to CMS. For PDP plans (and for MA-PD plans for which the medical costs data are not available in the bid documents), I infer non-drug insurer costs using plan-reported MLR data (Zahn 2025). I calculate the non-drug insurer costs that would make the MLR observed in

the data equal to the plan's reported MLR. I assign the average cost across other plans to plans with small enrollments for which CMS censors the public use data.

3. **Pharmacy networks ($\mathcal{G}$)** and **effective coinsurance rates (r)**: consumer cost-sharing requirements vary across pharmacies within a plan due to the use of preferred pharmacy networks, which offer consumers reduced cost-sharing at specific pharmacies. To identify the structure of each plan's network, I follow Starc and Swanson 2021 and assign preferred status to pharmacies by comparing observed out-of-pocket payments with the cost-sharing amounts for preferred pharmacies as reported by plans. I cross-validate these empirical networks against plan-reported network data.

   Consumer cost-sharing varies across plans, pharmacies, formulary tiers, coverage phases, and low-income subsidy status. I use the following procedure to calculate a single expected coinsurance rate for each plan, pharmacy, formulary tier, and low-income subsidy status combination. After constructing the pharmacy networks, I calculate coinsurance rates separately for each coverage phase of a given plan, formulary tier, and preferred pharmacy status combination based on plan-reported benefit schedules. I take the weighted average of these coinsurance rates across coverage phases, weighted by expected days supply in each phase. I scale down the coinsurance rate for LIS consumers in each benefit phase based on the observed LIS cost-sharing subsidies in the claims data.

4. **Expected drug utilization (γ)**: for each state, year, formulary tier, and LIS status combination, I calculate γ as the average days supply per enrollee observed in the data.

I provide more details on how I prepared the data for analysis in Appendix C.

5.2 Pharmacy Demand Estimation

I follow Starc and Swanson 2021 in estimating demand for pharmacies. Consumers may fill many prescriptions over the course of a year and often use multiple pharmacies. To account for this, I aggregate prescription fills with in a year for each combination of formulary tier, pharmacy, plan, zip code, and low-income subsidy status. I exclude prescriptions filled at pharmacies more than 50 miles away from the centroid of each zip code as well as prescriptions filled by long-term care pharmacies, hospitals, and government-owned providers. I treat independently-owned pharmacies as a non-strategic option and normalize their utility to zero.

I estimate separate multinomial logit models for each combination of formulary tier and low-income subsidy status. The estimating equation is therefore:

$$ln(\frac{s_{z\ell(i)dnjt}}{s_{z\ell(i)d0jt}}) = \beta^{OOP}_{\ell(i)d} r_{dnjt} p_{dnjt} + \beta^{Mail}_{\ell(i)d} Mail_n + \beta^{Dist}_{\ell(i)d} Dist_{zn} + \beta^{Dist^2}_{\ell(i)d} Dist^2_{zn} + \beta^{VI}_{\ell(i)d} VI_{njt} + \underbrace{\delta^H_{\ell(i)djt}}_{\substack{\text{Plan x} \\ \text{Year FE}}} + \underbrace{\delta^H_{\ell(i)dh(n)t}}_{\substack{\text{Chain x} \\ \text{Year FE}}} + \xi^H_{z\ell(i)dnjt}, \quad (14)$$

where $\delta^H_{\ell(i)djt}$ is a LIS-by-tier-by-plan-by-year fixed effect and $\delta^H_{\ell(i)dh(n)t}$ is a LIS-by-tier-by-pharmacy chain-by-year fixed effect.

I face two key threats to identification that I address by constructing a set of instrumental variables for pharmacy out-of-pocket prices. The first is the simultaneity of prices: unobserved demand shocks may increase both pharmacy demand and reimbursement rates. The second threat to identification is the salience of consumer-facing prices: consumers may not be fully informed about either the negotiated reimbursement rates at each pharmacy or their expected out-of-pocket cost-sharing.

To address the endogeneity of prices, I include the average price charged by the same pharmacy to other PBMs in the prior year in my instrument set. Pharmacy marginal costs and bargaining leverage are likely imperfectly persistent over time, meaning that bargaining outcomes for the same pharmacy will be correlated over time; furthermore, a pharmacy's bargaining outcomes should be correlated across PBMs through common cost structures and/or pharmacy-specific bargaining leverage. Thus, the price negotiated by pharmacy h with PBM k in year t should be correlated with the prices negotiated by pharmacy h with other PBMs $k' \neq k$ in year $t-1$. This instrumental variable is analogous to using pharmacy marginal costs and/or bargaining ability as cost-shifter instruments (Grennan 2013).

I assume that this instrumental variable does not affect current pharmacy demand except through its correlation with current prices.[24] A potential threat to this exclusion restriction is that consumer insurance plan choice depends on out-of-pocket prices at all pharmacy/plan combinations through WTP, meaning that reimbursement rates charged to other PBMs may affect pharmacy demand through their effect on plan enrollment. I address this by lagging average prices by one year, such that the instrument reflects prices that predate the plan choice decisions made during the annual open enrollment period and is thus uncorrelated with contemporaneous demand shocks at either the pharmacy or plan level.

To address concerns about the salience of out-of-pocket prices, I also include the average co-pay for prescription fills at pharmacy h in the initial coverage range for plan j enrollees in my instrument set. While consumers may not be perfectly informed of their expected cost-sharing at all points in their benefit schedule, they may have better information on the expected co-pays at each pharmacy during the initial coverage range. This information is commonly available to consumers during open enrollment. Thus, this instrument provides an alternative source of price variation that is likely more salient to consumers.

I assume that there is no correlation between unobservable consumer preferences and observable pharmacy characteristics, which is a standard assumption in the hospital demand literature. This assumption would be violated if sicker consumers have unobservable tastes for certain pharmacies, especially if they view certain pharmacies as providing higher quality service (Shepard 2022). While quality differentials across hospitals can be important determinants of consumer choice, I am not aware of evidence on healthcare quality differentials across pharmacies and thus assume they are not important determinants of consumer choice. I also assume that consumer choice of pharmacy is frictionless. In reality, consumers may face ordeals in switching prescriptions from one pharmacy to another. Another concern is that consumer demand for pharmacies may be inertial, especially if they have automatic refills set up at a given pharmacy. However, I observe that many consumers use multiple pharmacies (including pharmacies in different chains) within the same year. By aggregating across prescription fills within a year, I effectively account for within-year

[24] In other words, I assume that the price charged by Walgreens to United Healthcare in year $t-1$ does not affect the demand decisions of consumers who are enrolled in a Humana plan in year t, but that this price depends on Walgreens' marginal costs and bargaining leverage, which in turn affect the price that Walgreens negotiates with Humana.

state-dependence in pharmacy demand.

In this paper, I model only the choice of pharmacy and not the extensive margin decision of whether to fill a prescription. I assume that firms consider how drug prices and premiums affect choices of pharmacies and plans but not how they affect treatment decisions. Past work has shown that increases in prices may induce consumers to delay filling a prescription or stop treatment altogether (Einav et al. 2018; Gross et al. 2022). I discuss how to interpret my counterfactual exercise in light of the assumed exogeneity of prescription drug utilization in Section 7.

5.3 Plan Demand Estimation

The set of plans available to consumers varies by county and year and consists of two types of plans: (1) all PDP plans available in the county's service region, where each PDP plan is identified as a unique combination of Medicare contract and plan identifiers; and (2) all MA-PD plans that are available in the county, where each MA-PD plan is identified as the lowest-number plan identifier for each Medicare contract in the county (Starc and Town 2020). The estimating equation for plan demand can be written as:

$$ln(\frac{s_{\ell(i)cjt}}{s_{\ell(i)c0t}}) = \alpha^{b}_{\ell(i)} b_{\ell(i)cjt} + \alpha^{WTP}_{\ell(i)} WTP_{cjt} + \alpha^{Ded}_{\ell(i)} Deductible_{cjt} + \sigma_{\ell(i)} log(s_{\ell(i)cjt|g}) + \bar{\xi}^{F}_{\ell(i)f(j)t} + \xi^{F}_{cjt}, \quad (15)$$

where $log(s_{\ell(i)cjt|g})$ is the logged share of plan j within its nest g, and $\bar{\xi}_{\ell(i)f(j)t}$ is an insurer-year fixed effect. The outside option for consumers is to either not purchase a Part D plan or to purchase a Medicare plan through their employer (referred to as an employer group waiver or 800-series plan). I exclude consumers who did not make an active plan choice and were automatically enrolled in a random plan by CMS.

There are two potentially endogenous variables in plan demand: premiums and the logged within-nest share. I follow Starc and Town 2020 in constructing a set of instrumental variables to address endogeneity concerns. First, I instrument for premiums using average premiums for the same insurer in other markets.[25] Second, I leverage a geographic discontinuity in the subsidy design of Medicare Advantage to instrument for the logged within-group share. Formally, I instrument for logged within-nest share with an indicator for whether county c is an urban county, interacted with a dummy for whether plan j is an MA-PD plan. MA-PD plans receive greater subsidies in urban counties, which incentivizes greater entry by MA-PD plans in these counties.

In my main specifications, I assume that there is no selection of consumers across insurance plans on observable variables other than LIS status and zip-code. One concern is that plans with more generous pharmacy networks may attract sicker enrollees, which could change the pricing incentives of vertically integrated firms. To test for the importance of adverse selection on pharmacy network generosity, I estimate a version of this model where I allow consumer preferences and expected pharmacy network surplus to vary by consumer health risk. I follow Decarolis et al. 2020 and predict drug spending for each consumer as a linear function of their observable demographics. Based on each consumer's predicted drug spending from

[25] Specifically, I construct the instrumental variables by averaging across premiums for the same Medicare contract ID in other counties for MA-PD plans and in other PDP service areas for PDP plans. This instrumental variable strategy has been used widely in papers that estimate demand for Medicare Part D plans (Olssen and Demirer 2021; Decarolis 2015).

this regression, I construct four risk groups for each income subsidy group, re-calculate WTP by allowing the predicted days supply (γ) to vary by risk group, and then estimate my plan choice model separately for each risk group. I provide the details on the implementation of this version of the demand estimation strategy in Appendix C.4.

5.4 Estimation of Parameters for Vertically Integrated Firms

To estimate the bargaining model, I must first recover pharmacy marginal costs (c), internal profit weights (μ), and external profit weights (λ) for vertically integrated firms, as these are necessary inputs to calculating the PBM and pharmacy gains from trade that enter the bargaining equation. For each vertically integrated firm, I infer these three terms by solving a system of three first-order conditions for premiums, fully-integrated prescription prices, and PBM-integrated prescription prices for non-integrated plans:

$$\nabla_b \Pi^F + \mu * \nabla_b \Pi^H(c) = 0 \tag{16a}$$

$$\nabla_p \Pi^F + \mu * \nabla_p \Pi^H(c) = 0 \tag{16b}$$

$$\lambda * \nabla_p \Pi^F + \mu * \nabla_p \Pi^H(c) = 0 \tag{16c}$$

I calculate the underlying terms in each FOC at the plan-county-level and then compute Medicare enrollment-weighted averages for each vertically integrated firm which I solve to infer the parameters. I make several assumptions to infer these terms. First, I assume that μ_{at} and λ_{at} are the same across all plans for firm a. Second, I assume that that c_{at} does not vary across geographies for pharmacy a. I make these first two assumptions for computational simplicity. In addition, I assume that integrated pharmacies consider only the demand of non-LIS consumers when setting prescription drug prices, because LIS consumers are highly protected from cost-sharing. Finally, I exclude "benchmark" PDP plans from Equation (16). PDP plans that set premiums below a benchmark level qualify for random assignment of LIS enrollees who do not make an active plan choice. Decarolis 2015 and Decarolis et al. 2020 show that this allocation design generates discontinuities in the profit function of insurers. I exclude benchmark plans from estimation for simplicity but include them in my counterfactual analyses.

5.5 Bargaining Model Estimation

After estimating preferences for pharmacies and plans and inferring the above terms for integrated firms, I can construct the payoffs necessary to estimate the bargaining model. I follow Gowrisankaran et al. 2015 and Cuesta et al. 2024, who show that the FOC of the Nash bargaining model can be inverted to generate an estimating equation:

$$p_{kht} = c_{ht} - (\mu_{ht} \nabla_p D^H_{ht} + \Lambda(\tau,\kappa)\, \mu_{ht} \Delta_{kh} D^H_{ht})^{-1} (\mu_{ht} D^H_{kht} + \nabla_p \Pi^F_{ht} + \Lambda(\tau,\kappa) \Delta_{kh} \Pi^F_{ht}) + \varepsilon_{kht}, \tag{17}$$

where ε_{kht} is a mean-zero error term and

$$\Lambda(\tau,\kappa) = \frac{\tau_k}{1-\tau_k} \frac{\frac{d\,\Pi_{kt}^K}{d\,p_{kh}}}{\Pi_{kt}^K(\mathcal{G},\mathbf{b},\mathbf{p}) - \Pi_{kt}^K\left(\mathcal{G}/kh,\mathbf{b},\mathbf{p}\right) + \kappa WTP_{kht}}. \tag{18}$$

I assume that PBM-pharmacy bargaining occurs nationally and that PBM k's bargaining ability is constant across pharmacies and time. As with vertically integrated prescription pricing, I assume that PBMs and pharmacies consider only the demand from non-LIS consumers when negotiating. I also assume that the disagreement penalty κ does not vary across time, PBMs, or pharmacies. I calculate the underlying terms of the bargaining FOC separately for each county and take the population-weighted average to construct the estimating equation.

I estimate τ, c, and κ with an exactly identified GMM estimator based on the assumption $E[\varepsilon_{kht}|Z_{kht}] = 0$, where Z_{kht} is a set of instrumental variables. The instrumental variables account for the fact that pharmacy markups depend on $\Lambda(\tau,\kappa)$ and Π_{ht}^F, which are functions of prices and thus endogenous. I include pharmacy-year fixed effects in Z_{kht} as well as a set of instruments that I assume to be exogenous. Following Grennan 2013 and Gowrisankaran et al. 2015, the instruments are components of the pharmacy markup in Equation (17) that I re-compute using average pharmacy prices (rather than observed prices) and, in some cases, lag by one year. I assume that these instruments are uncorrelated with the contemporaneous error term but still predictive of price. I include the following terms in Z_{kht}:

- the average consumer surplus generated by PBM k's plans, in year t and $t-1$;
- the predicted diversion from chain h to PBM k's pharmacies, lagged by one year;
- the average WTP for chain h among PBM k's enrollees, lagged by one year;
- the change in demand for PBM k's plans upon disagreement with chain h, lagged by one year; and
- the change in demand for chain h upon disagreement with PBM k, lagged by one year.

I rely on cross-sectional and panel variation in the data to identify c_{ht}, τ_k, and κ. c_{ht} is identified by within-pharmacy-year, cross-PBM variation in gains from trade: holding fixed the gains from trade and bargaining ability, costs are the only source of cross-PBM variation in prices for a given pharmacy h in year t. τ_k is identified by variation in prices across pharmacies and years for a given PBM k after controlling for costs and gains from trade. Finally, κ is identified by residual variation in WTP_{kht} for a given pharmacy-year combination after controlling for costs and bargaining ability.

I estimate the model for the four vertically integrated PBMs and the 17 largest chain pharmacies. CVS is the only vertically integrated pharmacy that bargains with rival PBMs. In the estimation procedure, I impose that the pharmacy marginal costs for CVS must be equal to the marginal costs that I infer in step three. For the purposes of this paper, I assume that small-chain pharmacies and independent pharmacies are non-strategic actors who are compensated at marginal cost.

I model PBMs and pharmacies as engaging in price negotiations for Medicare Part D prescriptions only. In reality, PBMs and pharmacies may simultaneously negotiate prices for different customer segments (i.e.,

commercial, Medicaid). I understand that the prices negotiated between these firms are typically determined separately for each customer segment. However, it is possible that PBMs could leverage their collective scale across all customer bases to secure lower prices. Unobserved variation in consumer preferences or the relative gains from trade generated by contracts between PBMs and pharmacies across consumer segments may introduce bias to my estimates of marginal costs and bargaining parameters. The direction and magnitude of the bias induced by the lack of data from other consumer segments is theoretically unclear.[26] While acknowledging the potential bias introduced by this data limitation, I proceed with estimation under the assumption that the relative gains from trade generated by contracts between PBMs and pharmacies in Medicare Part D are proportional to the gains from trade generated by the same contracts in other segments.

6 Results

6.1 Preferences for Pharmacies and Plans

Table 1 presents my estimates of consumer preferences for pharmacies, separately by formulary tier and by LIS status. The estimated coefficient on $1(VI)$ suggests that customers may be "steered" towards vertically integrated pharmacies: all else held fixed (including prices), consumers are more likely to fill prescriptions at integrated pharmacies than non-integrated pharmacies. The demand estimates help explain why the effects of minimum MLR requirements varied across drug types and consumer groups. Consumers are less sensitive to price and more likely to use pharmacies integrated with their insurer or PBM for drugs on higher formulary tiers. This supports my earlier hypothesis that insurers responded to minimum MLR requirement by increasing prices on drugs for which substitution to competing pharmacies was less likely. Likewise, LIS consumers are both more sensitive to price and less likely to use integrated pharmacies than non-LIS consumers. As such, plans with a large share of LIS consumers may be unable to tunnel profits through higher prices at integrated pharmacies without inducing consumers to substitute to other pharmacies.

[26] As an example, consider one pharmacy chain that may be very popular among older adults enrolled in Medicare Part D, and another chain that is more popular among younger adults enrolled in commercial insurance. By estimating my model using only data from Medicare, I would overstate the gains from trade for PBMs generated by contracting the former chain and understate the gains from trade generated by the latter chain. Likewise, some PBMs may have greater scale in commercial markets while others (like Humana) may be specialized in Medicare.

Table 1: **Pharmacy Demand Model Estimates**

	Non-Low Income Subsidy Consumers			**Low Income Subsidy Consumers**		
	Tier 1	Tier 2	Tier 3	Tier 1	Tier 2	Tier 3
Out-of-Pocket Price	-11.647***	-7.046***	-0.399***	-23.423***	-10.204***	-2.941***
	(0.058)	(0.054)	(0.010)	(2.632)	(1.229)	(0.176)
1(Mail Order)	-0.906***	-0.866***	-0.460***	-0.835***	-0.603***	-0.990***
	(0.009)	(0.011)	(0.011)	(0.019)	(0.022)	(0.021)
Distance	-0.191***	-0.217***	-0.191***	-0.185***	-0.178***	-0.162***
	(0.000)	(0.000)	(0.000)	(0.001)	(0.001)	(0.001)
Distance^2	0.003***	0.004***	0.003***	0.004***	0.004***	0.003***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
VI	0.286***	0.321***	0.403***	0.040***	0.033***	0.081***
	(0.007)	(0.007)	(0.008)	(0.008)	(0.010)	(0.010)
N	3,663,369	4,014,319	3,227,603	1,787,450	1,690,474	1,401,863
Plan-Year FE	Yes	Yes	Yes	Yes	Yes	Yes
Chain-Year FE	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Each column represents a separate estimation of Equation (14) based on the full panel of data (2012-2017). The unit of observation is a combination of Medicare contract ID, Medicare plan ID, pharmacy National Provider Identifier (NPI), five-digit consumer zip-code, and year.

Table 2 presents my estimates of consumer preferences for insurance plans, separately for non-LIS and LIS consumers. While consumers prefer both lower premiums and more generous pharmacy networks, the estimated marginal rate of substitution between these two plan characteristics drives the profit-shifting incentives of vertically integrated firms. Non-LIS (LIS) consumers value a $1 increase in expected pharmacy network surplus as much as a $0.36 ($0.32) decrease in premiums. Thus, vertically integrated firms can offset large increases in drug prices with small decreases in premiums, but they would need to cut pharmacy prices dramatically to offset increases in premiums. Consequently, integrated firms find it profitable to subsidize higher drug prices through lower premiums. My finding that consumers are more sensitive to insurance premiums than to drug prices is consistent with other papers that study behavioral frictions in health plan choice (Abaluck and Gruber 2011, 2016, 2023). In my case, these consumer choice tendencies can be considered consistent with rational consumer decision-making: consumers may simply value plans that offer low premiums more than plans that offer them a higher-value pharmacy network. However, my analysis reveals a new consequence of consumer behavior in insurance plan choice: by weighting premiums more heavily than drug prices, consumers incentivize vertically integrated firms to shift profits from their insurance unit to their pharmacy unit.

Table 2: **Plan Demand Model Estimates**

	Non-LIS	LIS
Premium ($100s)	-0.126***	-0.313***
	(0.003)	(0.009)
WTP ($100s)	0.046***	0.123***
	(0.001)	(0.003)
Deductible ($100s)	-0.137***	-0.083***
	(0.004)	(0.009)
σ	0.450***	0.473***
	(0.008)	(0.013)
N	293,963	194,219
Insurer-Year FE	Yes	Yes

Notes: Each column represents a separate estimation of Equation (15). The unit of observation is a combination of Medicare contract ID, Medicare plan ID, county, and year. Insurer-year fixed effects are defined as combinations of Medicare contract IDs and years. The underlying data is restricted to 2013-2017. WTP is not defined in 2012 because of the lagged instrumental variables strategy used to estimate Equation (14).

To study the importance of selection on pharmacy network generosity, Table 3 presents estimates of my plan demand model where consumer preferences and WTP are allowed to vary by low-income subsidy status and consumer health risk. Lower-risk consumers are more sensitive to both premiums and expected pharmacy network surplus than high-risk consumers, but the relative elasticities remain fairly stable across risk types. This suggests that adverse selection on pharmacy networks does not appear to be prevalent in Medicare Part D; if anything, plans with more valuable networks appear to attract lower-cost enrollees on average, consistent with findings in Starc and Swanson 2021.[27]

[27] As an alternative illustration of selection on pharmacy networks, Figure A.5 presents binned scatterplots of WTP against average consumer prescription drug spending. After controlling for county-year fixed effects, there appears to be a slight negative correlation between WTP and average prescription drug costs for non-LIS consumers and no correlation for LIS consumers.

Table 3: **Plan Demand Model Estimates, Accounting for Consumer Health Risk**

	Non-Low Income Subsidy Consumers			
Risk Quartile:	1	2	3	4
Premium ($100s)	-0.119***	-0.113***	-0.119***	-0.111***
	(0.003)	(0.003)	(0.003)	(0.003)
WTP ($100s)	0.049***	0.043***	0.035***	0.033***
	(0.001)	(0.001)	(0.001)	(0.001)
Deductible ($100s)	-0.109***	-0.101***	-0.144***	-0.132***
	(0.004)	(0.004)	(0.005)	(0.004)
σ	0.547***	0.472***	0.438***	0.453***
	(0.008)	(0.008)	(0.009)	(0.008)
N	228,574	217,787	233,357	235,177
	Low Income Subsidy Consumers			
Risk Quartile:	1	2	3	4
Premium ($100s)	-0.322***	-0.322***	-0.294***	-0.257***
	(0.015)	(0.011)	(0.013)	(0.011)
WTP ($100s)	0.132***	0.112***	0.059***	0.098***
	(0.007)	(0.003)	(0.005)	(0.004)
Deductible ($100s)	-0.075***	-0.094***	-0.101***	-0.098***
	(0.013)	(0.010)	(0.013)	(0.011)
σ	0.469***	0.491***	0.420***	0.492***
	(0.024)	(0.015)	(0.018)	(0.016)
N	92,819	141,835	107,092	132,039
Insurer-Year FE	Yes	Yes	Yes	Yes

Notes: Each column represents a separate estimation of Equation (15). The unit of observation is a combination of Medicare contract ID, Medicare plan ID, county, and year. Risk quartile 1 represents the consumers with the lowest underlying health risk while risk quartile 4 represents the consumers with the highest underlying health risk. Insurer-year fixed effects are defined as combinations of Medicare contract IDs and years. The underlying data is restricted to 2013-2017. WTP is not defined in 2012 because of the lagged instrumental variables strategy used to estimate Equation (14).

The demand estimates are useful for predicting the potential competitive effects of vertical integration, as the foreclosure incentives of vertically integrated firms depend on consumer substitution patterns. To measure these substitution patterns, the left panel of Table 4 presents a measure of substitutability between integrated pharmacies and competing pharmacies, which I refer to as the "conversion ratio." The conversion ratio is the vertical analogue to the diversion ratio commonly used to measure product substitutability in horizontal merger evaluation (Conlon and Mortimer 2021). Formally, the conversion ratio for vertically integrated PBM k and pharmacy h measures the percentage of consumers that would switch from pharmacy h to PBM k's integrated pharmacy if h were to be excluded from k's networks. The estimates reveal that PBMs can "recapture" a large share of rival pharmacy consumers at their own pharmacies through exclusion, particularly in rural areas where there are fewer pharmacy options. Consumers are relatively inelastic with

respect to expected value pharmacy network when choosing a plan and are likely to switch to integrated pharmacies in response to changes in pharmacy networks. As a result, integrated PBMs may find it profitable to foreclose rival pharmacies even though it will reduce the value of their pharmacy networks because the incremental profits generated by their pharmacy unit likely outweigh the losses incurred by their insurance unit.

The right panel of Table 4 presents the equivalent "upstream" conversion ratio for insurers, which I measure only for CVS as the other pharmacies receive negligible demand from non-integrated PBMs. This conversion ratio measures the percentage of consumers in PBM k's that would switch to pharmacy h's integrated plan if pharmacy h exited PBM k's network. The conversion ratios reveal that pharmacies are unlikely to convert consumers to their integrated plans by foreclosing rival PBMs, suggesting that the competitive effects of vertical integration on rival plans are likely negligible. As described in Section 4, whether these substitution patterns influence negotiated prices ultimately depends on the bargaining ability of PBMs.

Table 4: **Pharmacy and Plan Conversion Ratios, 2017**

	All Counties					
	Pharmacy Conversion Ratio			**Plan Conversion Ratio**		
	All	Non-LIS	LIS	All	Non-LIS	LIS
CVS	21.2%	22.3%	11.9%	11.3%	9.8%	21.1%
Express Scripts	19.1%	20.6%	3.2%	-	-	-
Humana	32.3%	34.7%	11.8%	-	-	-
United Healthcare	20.1%	22.4%	3.5%	-	-	-
	Rural Counties					
	Pharmacy Conversion Ratio			**Plan Conversion Ratio**		
	All	Non-LIS	LIS	All	Non-LIS	LIS
CVS	18.3%	19.2%	8.8%	14.5%	13.3%	28.3%
Express Scripts	24.1%	25.3%	5.2%	-	-	-
Humana	42.0%	43.9%	17.7%	-	-	-
United Healthcare	31.1%	33.3%	6.6%	-	-	-

Notes: I calculate these conversion ratios for each combination of the four vertically integrated PBMs and the 17 chain pharmacies that I include in the bargaining model estimation. The pharmacy conversion ratio for PBM k and chain h is defined as the change in demand for PBM k's integrated pharmacy when chain h is excluded from all of PBM k's network divided by the baseline demand for chain h among PBM k enrollees, holding fixed plan enrollment. The plan conversion ratio for PBM k and chain h is defined as the change in demand for chain h's integrated plans when chain h is excluded from all of PBM k's network divided by the change in demand for PBM k's enrollees when chain h is excluded from all of PBM k's networks. I calculate these conversion ratios at the county-level and present enrollment-weighted averages.

6.2 Supply Parameters

Table 5 presents my estimates of the supply parameters. The average estimate of μ implies that vertically integrated firms value pharmacy profits roughly the same as they value insurer profits, but with heterogeneity across firms. When PBMs set prices at their integrated pharmacies for non-integrated client insurers, the average estimate of λ implies that they internalize roughly 100% of the profits of those clients. However, the

average value of the λ parameter has grown from 83% in 2014 to 107% in 2017. Importantly, the tunneling incentives are only active when the insurer and pharmacy are part of the same parent company. As a result, the fact that λ and μ can both be greater than one on average points to minimum MLR requirements as causing some integrated firms to prioritize unregulated pharmacy profits over regulated insurance profits.

Consistent with anecdotal evidence, PBMs have significant bargaining ability in their negotiations with pharmacies. The average value of the PBM bargaining parameter (τ) of 0.90 indicates that PBMs capture 90% of the surplus generated by their contracts with pharmacies, resulting in reimbursement rates close to pharmacy marginal costs. Pharmacy network adequacy penalties provide pharmacies with some additional leverage by causing PBMs to internalize an additional \$0.38 per dollar of consumer surplus generated by pharmacy contracts beyond direct profits. When combined with the theoretical model in Section 4 and the conversion ratios estimated in Table 4, my supply parameter estimates suggest that the competitive effects of vertical integration on rival plans and pharmacies are limited because PBMs already extract most of the available surplus from non-integrated pharmacies.

Average pharmacy marginal costs of \$0.38 imply average prescription margins on non-integrated prescriptions of 16.2%, which is within the range of estimated margins based on academic research and industry reports (National Association of Chain Drug Stores 2018; Mattingly et al. 2023). In contrast, average markups on integrated prescription fills are over 50%. Overall, my model estimates suggest that bargaining by PBMs is a more effective means of lowering drug prices than vertical integration. Whether vertical integration ultimately benefits or harms consumers depends on its effects on both drug prices and premiums. In the next section, I estimate the consumer welfare effects of vertical integration by simulating the divestiture of pharmacies from insurers and PBMs.

Table 5: **Supply Side Estimates**

Firm	Year	μ	λ	c	τ	κ
CVS Health	2014	0.992	0.862	0.206	0.983	0.382
	2015	1.070	1.035	0.182	0.983	0.382
	2016	1.085	1.017	0.113	0.983	0.382
	2017	1.057	1.019	0.121	0.983	0.382
Express Scripts	2014	1.113	0.872	0.197	0.905	0.382
	2015	1.030	1.003	0.257	0.905	0.382
	2016	1.164	1.177	0.303	0.905	0.382
	2017	1.065	1.106	0.405	0.905	0.382
Humana	2014	0.932		0.291	0.959	0.382
	2015	0.899		0.289	0.959	0.382
	2016	0.886		0.310	0.959	0.382
	2017	0.888		0.255	0.959	0.382
United Healthcare	2014	0.983	0.759	0.241	0.753	0.382
	2015	0.945	0.942	0.271	0.753	0.382
	2016	0.942	1.080	0.303	0.753	0.382
	2017	0.963	1.111	0.221	0.753	0.382
Non-VI Pharmacies	2014			0.441		
	2015			0.402		
	2016			0.379		
	2017			0.346		

Notes: Marginal costs for non-VI pharmacies are averages across the pharmacy chains included in estimation. Table A.1 reports the full set of point estimates and standard errors for τ, κ, and c. λ is blank for Humana because it does not provide PBM services to non-integrated insurers.

7 Counterfactual Exercise

In this section, I use the estimated model to simulate the divestiture of vertically integrated pharmacies. The simulation predicts how premiums, drug prices, pharmacy demand, and plan demand would change if insurers and PBMs were required to divest their ownership stakes in pharmacies. This counterfactual exercise allows me to quantify the effects of vertical integration on prices, premiums, and welfare. Furthermore, it provides guidance to policymakers on the effects of divestiture policies, which are currently under consideration in Congress and have already been implemented in Arkansas.

7.1 Setup and Assumptions

I execute the counterfactual exercise by making three changes to the model. First, I set the pharmacy profit weights μ equal to zero. Second, I require formerly integrated pharmacies to bargain with PBMs to determine reimbursement rates instead of setting prices to maximize integrated firm profits. Finally, I set the VI steering parameter in the pharmacy demand model equal to zero. I assume that the estimated steering effects are welfare-relevant and include them in my calculations of consumer surplus. This assumption treats

steering by vertically integrated firms as creating value for consumers, potentially through improved care coordination or reduced transactions costs.

My model endogenizes drug prices, premiums, and consumer demand for insurance and pharmacies. As such, when computing equilibria, I hold fixed all other variables besides prices, premiums, and demand, including:

1. *Market structure:* I assume that the pharmacy, PBM, and insurer market structures in each county do not change in response to the divestiture. Furthermore, I assume that insurer-PBM contracts and the menu of plan offerings for each insurer in each county remain the same. Finally, I assume that pharmacy characteristics (other than the vertical integration dummy), pharmacy marginal costs, insurer non-pharmacy marginal costs, and PBM bargaining ability are exogenous.

2. *Plan design and subsidy payments:* I assume that all features of insurance plan design besides drug premiums are held fixed, including the pharmacy networks offered by each plan, the coinsurance rates at each pharmacy, and the bids placed by MA-PD plans for providing medical insurance. For computational simplicity, I also assume that the Part D direct subsidy amount and low-income premium subsidy amount remain fixed.

3. *Prices for "small" pharmacies:* I model PBM contract formation for integrated pharmacies and non-integrated large chain pharmacies. I assume that small chain pharmacies and independent pharmacies continue to receive reimbursement rates equal to their marginal costs.

I describe the nested fixed-point algorithm that I use to solve for counterfactual equilibria in Appendix C.

7.2 Counterfactual Results

Table 6 presents the results of my counterfactual exercise. The divestiture of vertically integrated pharmacies would reduce average drug prices by 7.3%. The largest price decreases are for formerly integrated prescription fills, as the bargaining power of PBMs reduces prices at formerly integrated pharmacies by over 50%. While the divestitures eliminate foreclosure incentives, the PBM segment remains relatively highly concentrated compared to the pharmacy segment. Furthermore, the large price decreases at formerly integrated pharmacies reduce the gains from trade for PBMs in dealing with chain pharmacies. As a result of these offsetting effects, the divestitures have minimal effects on the prices paid to non-integrated pharmacies, which increase by less than 1% on average. The price decreases for formerly integrated pharmacies more than offset the elimination of steering by integrated firms, attracting greater consumer volume and causing the market share of formerly integrated pharmacies to increase following the divestiture.

Decreases in drug prices benefit consumers by reducing their out-of-pocket expenditures. The counterfactual divestitures increase consumer pharmacy network surplus (WTP) for the average plan by $44 per member-year, a 4.3% increase over the baseline. This likely underestimates the surplus gains from lower drug prices for two reasons. First, I make the conservative assumption that the VI steering coefficient in the pharmacy utility function represents genuine consumer value. If the steering efforts of vertically integrated firms are not valuable to consumers, then my estimates will understate the pharmacy network surplus gains

generated by the divestiture. Second, I assume that prescription drug utilization is exogenous. These price decreases may induce some consumers to fill prescriptions that they would not have filled otherwise due to budget constraints, potentially generating additional health benefits that are not captured in these estimates.

While the divestiture reduces drug prices, it also eliminates the incentive for formerly integrated insurers to subsidize their integrated pharmacies through low premiums. As a result, formerly integrated insurers raise premiums by 4.4% for the average plan. Non-integrated plans decrease premiums by 0.9% because they experience lower drug costs (due to the reduction in prices at pharmacies previously owned by their PBM) but also face competition from higher quality plans (due to the increase in pharmacy network surplus for formerly integrated plans). The net effects of these opposing responses are small: on average, plans increase premiums by 1%. Overall, the divestiture of vertically integrated pharmacies increases average consumer surplus by $44 per Medicare enrollee per year, an 8.1% increase over the baseline.[28] When extrapolated to the total Medicare population in 2017 (58.5 million enrollees), this implies aggregate consumer surplus gains of $2.6 billion per year for Medicare consumers.

Table 6: **Effect of Vertical Integration on Prices, Premiums, and Consumer Surplus**

	Baseline	Ban VI	% Change
Pharmacy Prices ($ per days supply)			
Fully Integrated	0.58	0.30	-47.9%
Vertically Integrated with PBM, Not Plan	0.60	0.22	-63.5%
Non-Integrated	0.39	0.40	0.1%
All	0.41	0.38	-7.3%
Pharmacy Market Shares			
VI Pharmacies	32.4%	35.1%	8.4%
Non-VI Chain Pharmacies	40.7%	38.5%	-5.4%
Independent Pharmacies	26.9%	26.4%	-1.9%
Pharmacy Network Surplus ($ per member-year)			
VI Plan	1,167	1,225	5.0%
Non-VI Plan	905	937	3.5%
All	1,025	1,069	4.3%
Annual Drug Premium ($ per member-year)			
VI Plan	555	580	4.4%
Non-VI Plan	769	762	-0.9%
All	671	678	1.1%
Consumer Surplus ($ per member-year)	539	583	8.1%

Notes: Pharmacy prices represent the "base" negotiated rate between PBMs and pharmacies per unit of resources, which is benchmarked to the average formulary tier 1 drug cost. The columns display county population-weighted averages.

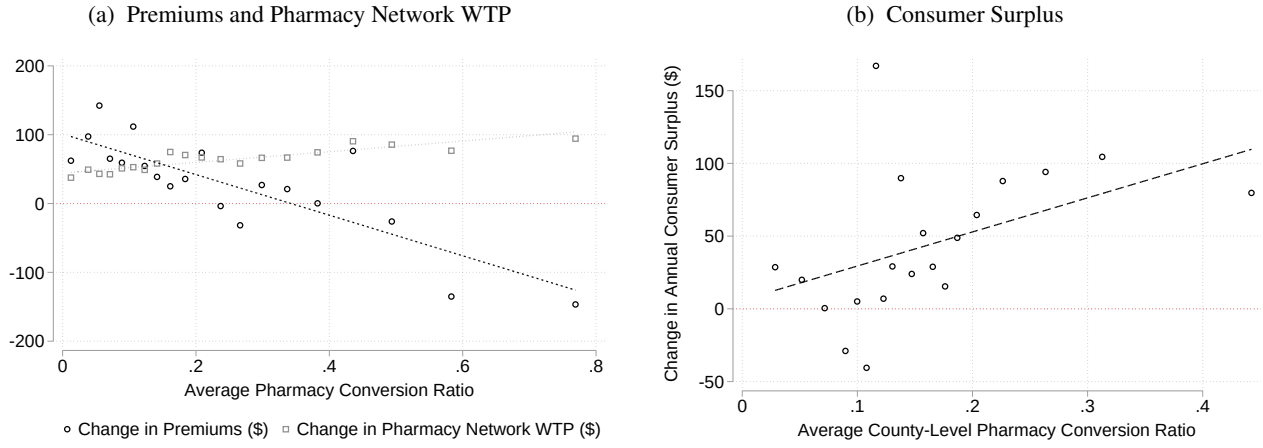
To illustrate how integrated firms balance insurance and pharmacy revenue, the left panel of Figure 8 plots plan-level changes in premiums and pharmacy network surplus against the plan's pharmacy conver-

[28] I define consumer surplus in county c as $CS_{\ell(i)ct} = \frac{1}{\alpha^b_{\ell(i)}} log(1+\sum_j exp(\frac{\bar{u}^F_{\ell(i)cjt}}{1-\sigma_{\ell(i)}}))$, where $\bar{u}^F_{\ell(i)cjt}$ is the "base" plan utility defined in Equation (4).

sion ratio. Consumers enrolled in integrated plans with high pharmacy conversion ratios experience larger increases in expected pharmacy network surplus. This is intuitive, as utilization of integrated pharmacies is more likely if consumers either view them as close substitutes for competitors or have limited alternatives for filling prescriptions. Plans that can effectively steer enrollees to integrated pharmacies need only modest premium cuts to boost pharmacy demand; as such, the divestiture causes smaller premium increases (and sometimes reductions) for these plans. Conversely, the largest increases in premiums following the divestiture are for plans with low pharmacy conversion ratios, because they previously required deeper premium cuts to compensate for their weaker ability to steer consumers to integrated pharmacies. Figure A.6 plots the change in the consumer surplus contribution of each plan against its baseline pharmacy conversion ratio to confirm that the divestiture harms consumers enrolled in plans with low conversion ratios, while consumers enrolled in plans with high conversion ratios are better off.

The right panel of Figure 8 presents the correlation between changes in county-level consumer surplus due to the divestiture and the average pharmacy conversion ratio of the plans in the county. The largest consumer benefits accrue to consumers in high conversion ratio counties, who experience larger reductions in drug prices and smaller increases in premiums. When the average conversion ratio is low, the increases in premiums effectively cancel out the decreases in drug prices. This illustrates that vertical integration is most harmful when consumers are "siloed" into their plan's integrated pharmacies, because insurers do not need to reduce premiums by much to increase demand for their integrated pharmacies.

Figure 8: **Correlation Between Integrated Pharmacy Conversion Ratio and the Effects of the Divestiture**



Notes: This left panel presents a binned scatter plot of the relationship between the counterfactual change in plan premiums and pharmacy network WTP due to the divestiture and the baseline pharmacy conversion ratio. The baseline pharmacy conversion ratio is averaged across all pharmacy locations for each plan. The unit of observation is a plan-county-LIS status-year cell. In the left panel, I exclude counties where the conversion ratio is zero. The right panel presents a binned scatter plot of the relationship between the counterfactual change in county-level consumer surplus due to the divestiture and the enrollment-weighted average baseline pharmacy conversion ratio of plans in the county. The unit of observation is a county-LIS status-year cell. Both binned scatter plots are weighted by county population.

Table 7 presents average changes in consumer surplus by rural status, LIS status, and consumer risk type, where risk quartile 1 represents the lowest-risk consumers and risk quartile 4 represents the highest-risk consumers. Consistent with Figure 8, rural consumers benefit the most from the divestiture because they

are more likely to be "converted" into their plan's integrated pharmacy than urban consumers (see Table 4). Thus, the divestiture results in larger increases in pharmacy network surplus for rural consumers relative to urban consumers. These increases in pharmacy network surplus trigger competitive premium reductions by non-integrated firms, causing larger decreases in premiums charged by plans in rural counties.[29] LIS consumers are more price sensitive and consume more prescription drugs than non-LIS consumers; as such, they experience larger increases in consumer surplus due to the divestiture. High-risk consumers also fill more prescriptions than low-risk consumers and thus enjoy slightly larger increases in surplus due to the divestiture.

Table 7: **Effects of Vertical Integration on Consumer Surplus, by LIS Status and Risk Type**

	All Consumers			**Rural Consumers**			**Urban Consumers**		
	Baseline	Ban VI	Δ	Baseline	Ban VI	Δ	Baseline	Ban VI	Δ
				All Consumers					
Average	539	583	44	532	602	70	541	580	39
				Non-Low Income Subsidy Consumers					
Average	511	552	41	517	586	69	510	546	36
Risk Quartile 1	434	470	36	515	577	62	421	453	32
Risk Quartile 2	401	430	28	403	447	43	401	426	25
Risk Quartile 3	633	677	44	635	710	75	633	671	38
Risk Quartile 4	670	715	45	653	731	78	674	712	38
				Low Income Subsidy Consumers					
Average	719	782	63	629	706	77	735	795	61
Risk Quartile 1	669	719	50	507	592	85	681	729	48
Risk Quartile 2	726	786	59	632	701	68	746	803	58
Risk Quartile 3	677	740	62	556	627	71	697	758	61
Risk Quartile 4	985	1,048	64	831	898	67	1,022	1,085	63

Notes: the columns display population-weighted averages.

Finally, Table 8 presents the effect of the divestiture on per-enrollee healthcare costs in Medicare Part D. Consumers adjust their plan choices and pharmacy utilization in response to the price changes presented in Table 6. As a result, weighted average drug costs and insurance bids per enrollee decline by 10% and 7%, respectively. Thus, the divestiture of vertically integrated pharmacies results in significant reductions in overall healthcare costs that are only slightly offset by increases in overall Medicare Part D enrollment. In Appendix B, I conduct a back-of-the-envelope analysis of the effects of the divestiture on government spending in Medicare Part D. Based on the estimates of my model, I predict that the divestiture of vertically integrated pharmacies would also reduce government spending on insurance subsidies, reinsurance payments, and low-income cost-sharing subsidies by $5.3 billion per year.

[29] In Table A.2, I replicate Table 6 separately for rural and urban counties.

Table 8: **Effects of Vertical Integration on Health Care Costs in Medicare Part D**

	Baseline	Ban VI	Δ (%)
Utilization-Weighted Expected Drug Costs per Enrollee	3,401	3,053	-348 (-10%)
Enrollment-Weighted Average Drug Insurance Bid	616	573	-43 (-7%)

Notes: these values reflect equilibrium outcomes predicted by my model. A plan's drug insurance bid is the sum of its drug premium and the direct subsidy amount. In the model, I predict a single drug premium rather than separate basic and supplemental premiums.

I estimate that the ownership of pharmacies by insurers and PBMs harms consumers on average due to higher drug prices that are only partially offset by lower premiums. There are three policy-relevant nuances that are important for interpreting my findings. First, vertical integration is most harmful to consumers who have limited alternatives to their plan's integrated pharmacies. This lack of pharmacy competition allows insurers to more effectively steer consumers into their integrated pharmacies, necessitating only small decreases in premiums to offset higher drug prices. Even when consumers have more plentiful pharmacy options, the consumer harm from higher drug prices more than offsets the benefits from lower insurance premiums on average. Second, vertical integration also harms consumers who must frequently fill prescriptions through greater out-of-pocket expenditures. However, even healthy consumers are harmed on average because vertical integration induces only small reductions in premiums on average. Finally, the large decreases in drug prices due to the divestiture are a direct result of the strong bargaining power of PBMs. The divestiture of vertically integrated pharmacies does not change the fact that the PBM segment of the pharmacy benefits market remains highly concentrated, which is the primary source of PBM bargaining power. As such, PBMs are able to negotiate down prices at their formerly integrated pharmacies close to marginal costs. Furthermore, the divestiture does not lead to significant changes in negotiated prices for non-integrated pharmacies who must continue to bargain with powerful PBMs. Thus, competing pharmacies are unlikely to benefit from the divestiture of vertically integrated pharmacies.

8 Conclusion

This paper analyzes the price effects of vertical integration between insurers, pharmacy benefit managers, and pharmacies. Vertically integrated firms face incentives to shift profits from their insurance division to their pharmacy division by lowering premiums while raising prescription drug prices. I estimate that vertical integration has limited competitive effects in this market; instead, it causes consumer harm by incentivizing firms to inflate the price of drugs at their integrated pharmacies. Consumers who are more reliant on their plan's integrated pharmacies, such as consumers in rural areas with limited pharmacy alternatives, bear the greatest harms from vertical integration. Forcing the divestiture of pharmacies from insurers and PBMs would increase consumer welfare through reductions in drug prices with only small changes in average premiums.

The profit-shifting incentives of vertically integrated firms are amplified by government regulations that place caps on insurer profits. I show that vertically integrated firms use their pharmacies as a means to circumvent minimum MLR regulations. These tunneling efforts directly harm consumers by raising out-

of-pocket prices. However, even without MLRs, vertically integrated firms still face incentives to set drug prices above marginal cost because of consumer cost-sharing. While I do not formally model how changes in minimum MLR requirements would affect drug prices, comparing the reduced form estimate of the effect of minimum MLR requirements on drug prices with the estimated changes in drug prices from my counterfactual exercise suggests that roughly 11% of the higher prices caused by vertical integration can be attributed to the strategic response of firms to minimum MLR requirements. The remaining 89% of the price difference can be attributed to the profit-shifting incentives introduced by consumer cost-sharing.[30] My analysis reveals that government regulations and market institutions are critical factors in determining the price effects of vertical integration.

Although my analysis measures the effects of vertical integration in Medicare Part D, several factors suggest that my findings generalize to other insurance markets. The Affordable Care Act instituted minimum MLR requirements of 80% in the individual and small group insurance markets and 85% in the large group insurance market (Ortaliza and Cox 2024). Thus, vertically integrated firms face incentives to tunnel profits from their insurance division to their pharmacy division in other markets. Consumers in other insurance markets may have more generous insurance that protects them from drug prices. However, in those markets, insurers and PBMs typically act as agents of self-insured sponsors. Thus, insurers and PBMs may pass the burden of higher prices onto employers rather than consumers. A key takeaway of my analysis is that the regulatory design of insurance markets dictates the behavior of vertically integrated firms. As such, future research should explore how other regulations alter the incentives of vertically integrated firms.

My analysis also highlights the important role that PBMs play in containing prescription drug costs. The scale and bargaining ability of PBMs allows them to secure low prices for prescription fills at pharmacy chains. This directly benefits consumers, who face lower out-of-pocket prices and lower premium payments, and insurers, who enjoy higher profits due to reduced costs. Regulators should consider how policy design affects the incentives for PBMs to exert effort in controlling prices. However, while PBM bargaining effort results in savings to consumers and plan sponsors in Medicare Part D, those savings may be retained as rents by PBMs rather than passed through in other insurance markets. Informational asymmetries and PBM market power in negotiations with plan sponsors may prevent consumers from fully benefiting from PBMs' bargaining leverage. Future empirical research on PBM interactions with different market participants is essential for improving regulation of prescription drug markets.

[30] Based on Figure 4, minimum MLR requirements raised fully integrated generic drug prices by \$0.03 per days supply. Based on Table 6, the divestiture of vertically integrated pharmacies would reduce generic drug prices by \$0.28 per days supply.

References

Abaluck, Jason and Jonathan Gruber, "Choice Inconsistencies among the Elderly: Evidence from Plan Choice in the Medicare Part D Program," *American Economic Review*, June 2011, *101* (4), 1180–1210.

_ and _ , "Evolving Choice Inconsistencies in Choice of Prescription Drug Insurance," *American Economic Review*, August 2016, *106* (8), 2145–2184.

_ and _ , "When Less is More: Improving Choices in Health Insurance Markets," *The Review of Economic Studies*, May 2023, *90* (3), 1011–1040.

Adolph, Nicholas, Benjamin Engbers, and Anjali Kokra, "Pharmacy Discount Card Utilization and Impact," Technical Report, IQVIA U.S. Market Access Strategy Consulting August 2022.

Atalay, Enghin, Ali Hortaçsu, and Chad Syverson, "Vertical Integration and Input Flows," *American Economic Review*, April 2014, *104* (4), 1120–1148.

Baker, Laurence C., M. Kate Bundorf, and Daniel P. Kessler, "Vertical Integration: Hospital Ownership Of Physician Practices Is Associated With Higher Prices And Spending," *Health Affairs*, May 2014, *33* (5), 756–763.

_ , _ , and _ , "The effect of hospital/physician integration on hospital choice," *Journal of Health Economics*, December 2016, *50*, 1–8.

Breslin, Bernadette, "Hawley, Warren Introduce Bipartisan Bill to Control PBMs, Put Patients First," December 2024.

Brot-Goldberg, Zarek and Mathijs de Vaan, "Intermediation and Vertical Integration in the Market for Surgeons," *Working paper*, November 2018.

Brot-Goldberg, Zarek C., Catherine Che, and Benjamin R. Handel, "Pharmacy Benefit Managers and Vertical Relationships in Drug Supply: State of Current Research," Working Paper 29959, National Bureau of Economic Research April 2022.

Capps, Cory, David Dranove, and Mark Satterthwaite, "Competition and Market Power in Option Demand Markets," *The RAND Journal of Economics*, 2003, *34* (4), 737.

Carlin, Caroline S., Bryan Dowd, and Roger Feldman, "Changes in Quality of Health Care Delivery after Vertical Integration," *Health Services Research*, August 2015, *50* (4), 1043–1068.

Centers for Medicare and Medicaid Services, "Medicaid State Drug Utilization Data Field Descriptions."

Chipty, Tasneem, "Vertical Integration, Market Foreclosure, and Consumer Welfare in the Cable Television Industry," *American Economic Review*, June 2001, *91* (3), 428–453.

Cho, Hyein, "Provider-Insurer Integration and Healthcare Delivery," January 2025.

Cicala, Steve, "When Does Regulation Distort Costs? Lessons from Fuel Procurement in US Electricity Generation," *American Economic Review*, January 2015, *105* (1), 411–444.

_ , Ethan M. J. Lieber, and Victoria Marone, "Regulating Markups in US Health Insurance," *American Economic Journal: Applied Economics*, October 2019, *11* (4), 71–104.

Ciliberto, Federico and David Dranove, "The effect of physicianâhospital affiliations on hospital prices in California," *Journal of Health Economics*, January 2006, *25* (1), 29–38.

Conlon, Christopher and Julie Holland Mortimer, "Empirical properties of diversion ratios," *The RAND Journal of Economics*, December 2021, *52* (4), 693–726.

Conti, Rena M., Brigham Frandsen, Michael L. Powell, and James B. Rebitzer, "Common Agent or Double Agent? Pharmacy Benefit Managers in the Prescription Drug Market," Working Paper 28866, National Bureau of Economic Research May 2021.

Cooper, Zack, Stuart V. Craig, Aristotelis Epanomeritakis, Matthew Grennan, Joseph R. Martinez, Fiona Scott Morton, and Ashley T. Swanson, "Are Hospital Acquisitions of Physician Practices Anti-competitive?," July 2025.

Crawford, Gregory S., Robin S. Lee, Michael D. Whinston, and Ali Yurukoglu, "The Welfare Effects of Vertical Integration in Multichannel Television Markets," *Econometrica*, 2018, *86* (3), 891–954.

Cuesta, José Ignacio, Carlos E. Noton, and Benjamin Vatter, "Vertical Integration and Plan Design in Healthcare Markets," August 2024.

Cutler, David M., Leemore Dafny, David C. Grabowski, Steven Lee, and Christopher Ody, "Vertical Integration of Healthcare Providers Increases Self-Referrals and Can Reduce Downstream Competition: The Case of Hospital-Owned Skilled Nursing Facilities," Working Paper 28305, National Bureau of Economic Research December 2020.

Decarolis, Francesco, "Medicare Part D: Are Insurers Gaming the Low Income Subsidy Design?," *American Economic Review*, April 2015, *105* (4), 1547–1580.

_ , Maria Polyakova, and Stephen P. Ryan, "Subsidy Design in Privately Provided Social Insurance: Lessons from Medicare Part D," *Journal of Political Economy*, May 2020, *128* (5), 1712–1752.

Einav, Liran, Amy Finkelstein, and Maria Polyakova, "Private Provision of Social Insurance: Drug-Specific Price Elasticities and Cost Sharing in Medicare Part D," *American Economic Journal: Economic Policy*, August 2018, *10* (3), 122–153.

Encinosa, William, Avi Dor, and PhuongGiang Nguyen, "Does Physician-Hospital Vertical Integration Signal Care-Coordination? Evidence from Mover-Stayer Analyses of Commercially Insured Enrollees," Working Paper 29599, National Bureau of Economic Research December 2021.

Farronato, Chiara, Andrey Fradkin, and Alexander MacKay, "Vertical Integration and Consumer Choice: Evidence from a Field Experiment," March 2025.

Federal Trade Commission, "FTC Releases Second Interim Staff Report on Prescription Drug Middlemen," January 2025.

Feng, Josh and Luca Maini, "Demand Inertia and the Hidden Impact of Pharmacy Benefit Managers," *Management Science*, December 2024, *70* (12), 8940–8961.

Fleitas, Sebastian, Gautam Gowrisankaran, Amanda Starc, Ashley Swanson, and Robert Town, "The Power of Exclusion: Pharmacy Networks and Bargaining in Medicare Part D," 2025.

Frank, Richard G. and Conrad Milhaupt, "Medicare Advantage spending, medical loss ratios, and related businesses: An initial investigation," March 2023.

Gandhi, Ashvin and Andrew Olenski, "Tunneling and Hidden Profits in Health Care," March 2024.

Geruso, Michael and Timothy Layton, "Upcoding: Evidence from Medicare on Squishy Risk Adjustment," *Journal of Political Economy*, March 2020, *128* (3), 984–1026.

Gowrisankaran, Gautam, Aviv Nevo, and Robert Town, "Mergers When Prices Are Negotiated: Evidence from the Hospital Industry," *American Economic Review*, January 2015, *105* (1), 172–203.

Gray, Charles, Abby E. Alpert, and Neeraj Sood, "Disadvantaging Rivals: Vertical Integration in the Pharmaceutical Market," August 2023.

Grennan, Matthew, "Price Discrimination and Bargaining: Empirical Evidence from Medical Devices," *American Economic Review*, February 2013, *103* (1), 145–177.

Gross, Tal, Timothy J. Layton, and Daniel Prinz, "The Liquidity Sensitivity of Healthcare Consumption: Evidence from Social Security Payments," *American Economic Review: Insights*, June 2022, *4* (2), 175–190.

Hastings, Justine S. and Richard J. Gilbert, "Market Power, Vertical Integration and the Wholesale Price of Gasoline," *Journal of Industrial Economics*, December 2005, *53* (4), 469–492.

Ho, Kate and Robin S. Lee, "Insurer Competition in Health Care Markets," *Econometrica*, 2017, *85* (2), 379–417.

_ **and** _ , "Contracting over Pharmaceutical Formularies and Rebates," August 2024.

Ho, Katherine, "Barriers to Entry of a Vertically Integrated Health Insurer: An Analysis of Welfare and Entry Costs," *Journal of Economics & Management Strategy*, June 2009, *18* (2), 487–545.

Hortaçsu, Ali and Chad Syverson, "Cementing Relationships: Vertical Integration, Foreclosure, Productivity, and Prices," *Journal of Political Economy*, April 2007, *115* (2), 250–301.

Houde, Jean-François, "Spatial Differentiation and Vertical Mergers in Retail Markets for Gasoline," *American Economic Review*, August 2012, *102* (5), 2147–2182.

House Committee on Oversight and Accountability, "The role of pharmacy benefit managers in prescription drug markets," Technical Report July 2024.

Johnson, Simon, Rafael La Porta, Florencio Lopez de Silanes, and Andrei Shleifer, "Tunneling," *American Economic Review*, May 2000, *90* (2), 22–27.

Kakani, Pragya, Swayami Navangul, Christie Lee Luo, Kayla N. Tormohlen, Genevieve P. Kanter, Mary Beth Landrum, Nancy L. Keating, and Amelia M. Bond, "Use of and Steering to Pharmacies Owned by Insurers and Pharmacy Benefit Managers in Medicare," *JAMA Health Forum*, January 2025, *6* (1), e244874.

Koch, Thomas G., Brett W. Wendling, and Nathan E. Wilson, "How vertical integration affects the quantity and cost of care for Medicare beneficiaries," *Journal of Health Economics*, March 2017, *52*, 19–32.

Lee, Robin S, "Vertical Integration and Exclusivity in Platform and Two-Sided Markets," *American Economic Review*, December 2013, *103* (7), 2960–3000.

Lin, Haizhen, Ian M. McCarthy, and Michael R. Richards, "Owning the Agent: Hospital Influence on Physician Behaviors," Working Paper 28859, National Bureau of Economic Research May 2021.

Luco, Fernando and Guillermo Marshall, "The Competitive Impact of Vertical Integration by Multiproduct Firms," *American Economic Review*, July 2020, *110* (7), 2041–2064.

_ and _ , "Diagnosing Anticompetitive Effects of Vertical Integration by Multiproduct Firms," *Review of Industrial Organization*, September 2021, *59* (2), 381–392.

Mattingly, T. Joseph, Kenechukwu C. Ben-Umeh, Ge Bai, and Gerard F. Anderson, "Pharmacy Benefit Manager Pricing and Spread Pricing for High-Utilization Generic Drugs," *JAMA Health Forum*, October 2023, *4* (10), e233660.

National Association of Chain Drug Stores, "Prescription Drug Pricing," April 2018.

National Council for Prescription Drug Programs, Inc., "dataQ Pharmacy Database v3.1," 2012-2017.

Office of the Governor of Arkansas, "Sanders Signs Legislation to Ban Anti-Competitive PBM Practices," April 2025.

Olssen, Alexander and Mert Demirer, "Drug Rebates and Formulary Design: Evidence from Statins in Medicare Part D," *Working paper*, 2021.

Ortaliza, Jared and Cynthia Cox, "2024 Medical Loss Ratio Rebates," June 2024.

Panhans, Matthew, "Vertical Integration in a Sequential Model of a Supply Chain with Bargaining," September 2024.

Shepard, Mark, "Hospital Network Competition and Adverse Selection: Evidence from the Massachusetts Health Insurance Exchange," *American Economic Review*, February 2022, *112* (2), 578–615.

Song, Lina, Soroush Saghafian, Joseph P. Newhouse, Mary Beth Landrum, and John Hsu, "The Impact of Vertical Integration on Physician Behavior and Healthcare Delivery: Evidence from Gastroenterology Practices," SSRN Scholarly Paper ID 3704941, Social Science Research Network, Rochester, NY October 2020.

Starc, Amanda and Ashley Swanson, "Preferred Pharmacy Networks and Drug Costs," *American Economic Journal: Economic Policy*, August 2021, *13* (3), 406–446.

_ **and Robert J Town**, "Externalities and Benefit Design in Health Insurance," *The Review of Economic Studies*, November 2020, *87* (6), 2827–2858.

_ **and Thomas Wollmann**, "Does Entry Remedy Collusion? Evidence from the Generic Prescription Drug Cartel," Technical Report w29886, National Bureau of Economic Research, Cambridge, MA March 2022.

Venkatesh, Shruthi, "The Effects of Physician Practice Acquisitions on Hospital Competition," January 2024.

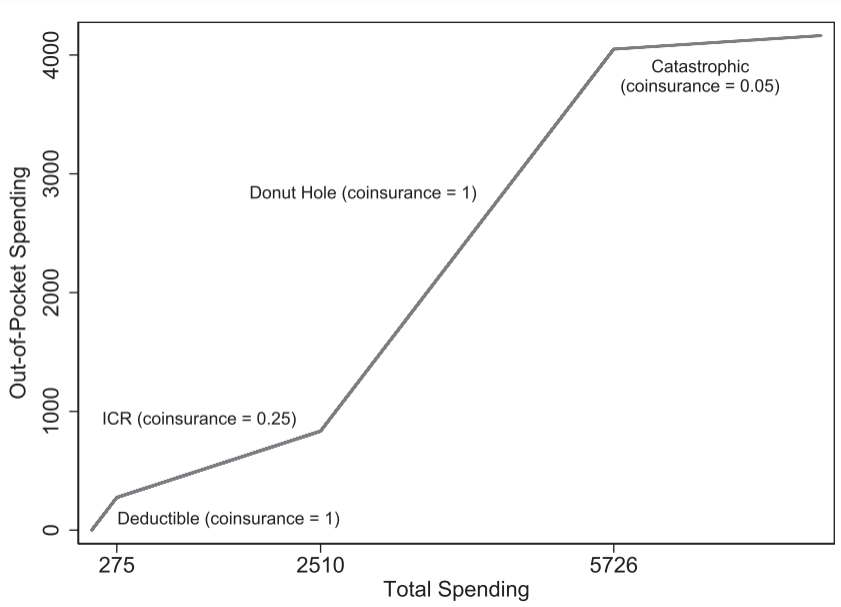
Whaley, Christopher M. and Xiaoxi Zhao, "The effects of physician vertical integration on referral patterns, patient welfare, and market dynamics," *Journal of Public Economics*, October 2024, *238*, 105175.

Zahn, Matthew, "Entry and Competition in Insurance Markets: Evidence from Medicare Advantage," *Working Paper*, March 2025.

Zhao, Xiaoxi, "Medical Loss Ratio Regulation and Insurer Pricing," March 2021.

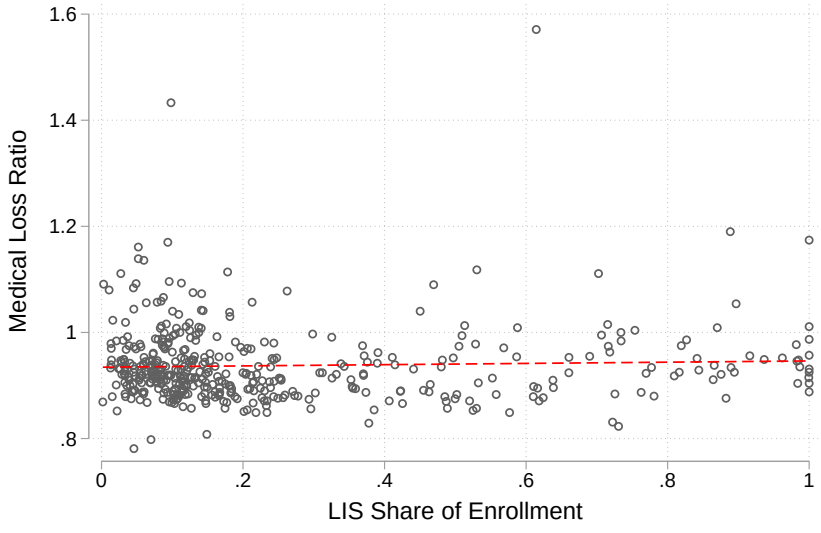
A Appendix Tables and Figures

Figure A.1: **Standard Benefit Design of a Medicare Part D Plan**



Sources: This figure was repurposed directly from Figure 2 of Starc and Town 2020

Figure A.2: **Correlation between LIS Enrollment Share and MLR, 2014**



Notes: Each dot represents a Medicare contract. The red dashed line is the linear fit line generated by a regression of MLR on LIS share. I exclude Medicare contracts for which I have data on fewer than 100 enrollees.

Figure A.3: **Diagram of Different Pharmacy Pricing Models**

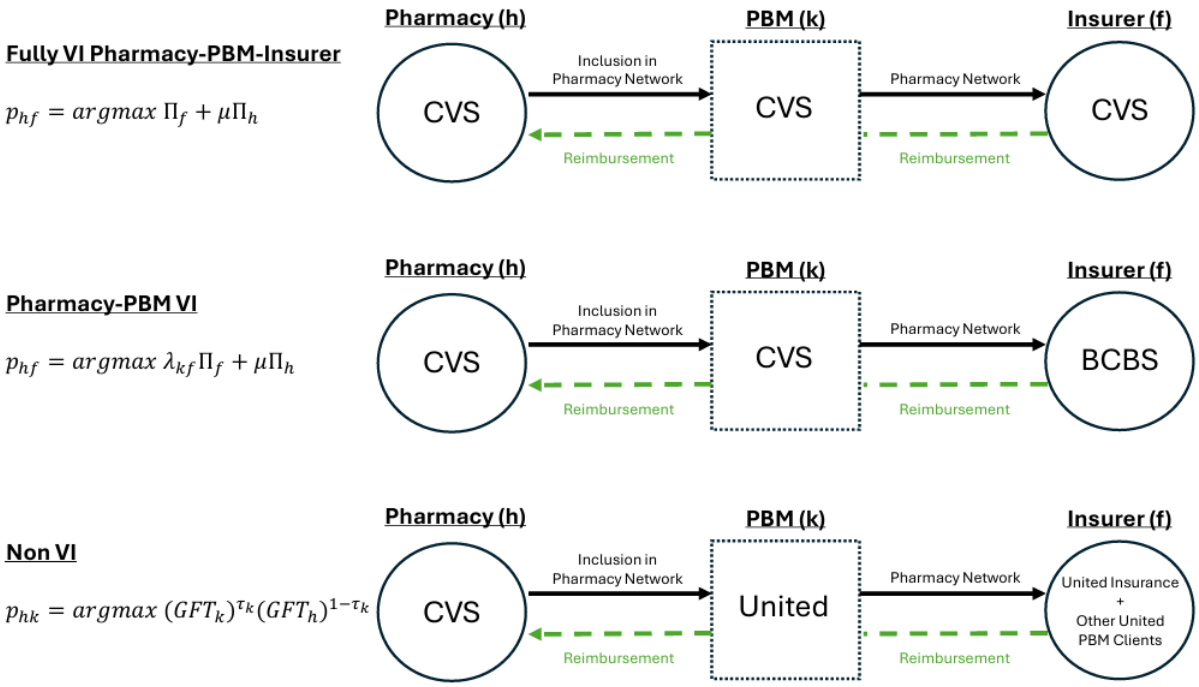
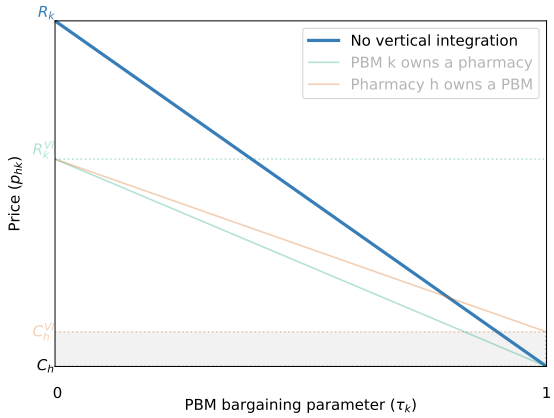
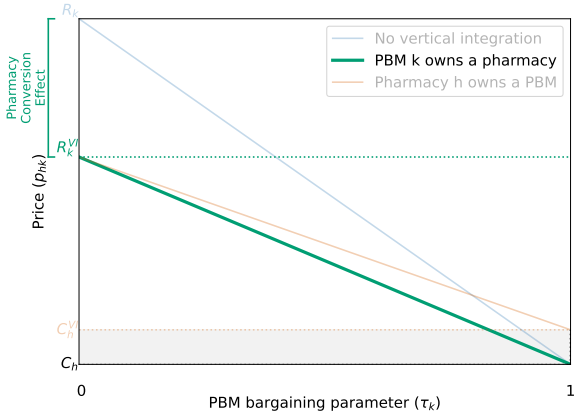


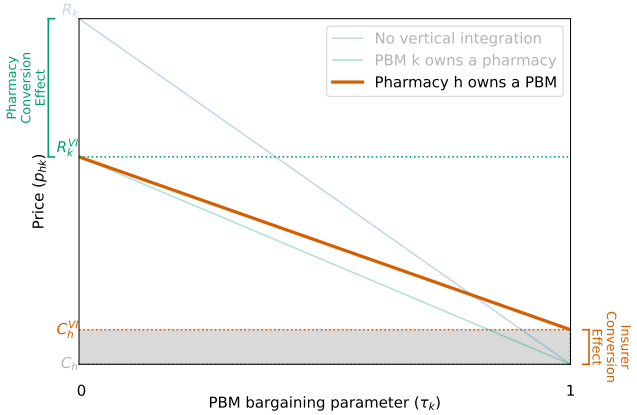
Figure A.4: **Effect of Vertical Integration on PBM-Pharmacy Bargaining**



(a) No Vertical Integration



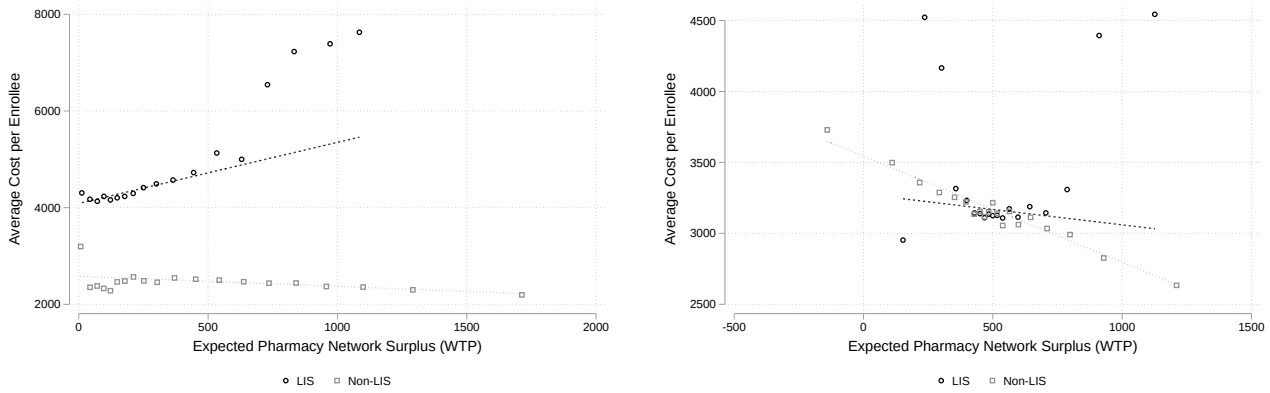
(b) PBM Owns Pharmacy



(c) Pharmacy Owns Insurer

Notes: These figures present a simple example of Nash bargaining between a PBM and pharmacy. R_k represents PBM k's reservation price for pharmacy chain h and C_h reprsents pharmacy h's reservation price for PBM k. In panel (a), neither PBM k nor chain h are vertically integrated. In panel (b), PBM k is integrated with a different pharmacy, which shifts the reservation price R_k down through the pharmacy conversion effect. In panel (c), pharmacy chain h is integrated with a different plan, which shifts the reservation price C_h up through the insurer conversion effect.

Figure A.5: **Correlation Between Pharmacy Network Surplus and Expected Enrollee Drug Costs**



(a) Raw Correlation (b) Controlling for County-Year Fixed Effects

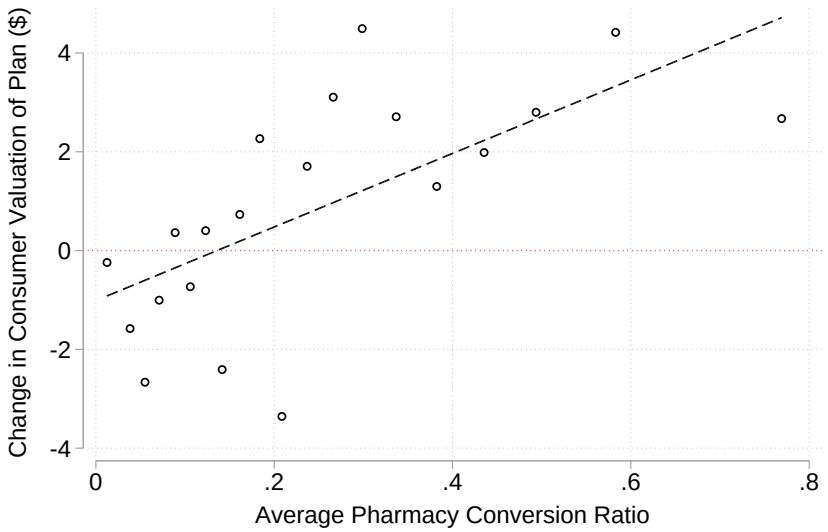
Notes: This figure presents a binned scatter plot of the relationship between the counterfactual change in the consumer surplus contribution of a plan due to the divestiture and its baseline pharmacy conversion ratio. The baseline pharmacy conversion ratio is averaged across all pharmacy locations for each plan. The unit of observation is a plan-county-LIS status-year cell. I calculate the consumer surplus contribution of plan j in county c for income subsidy type ℓ as $CS_{\ell(i)jct} = \frac{1}{\alpha^b_{\ell(i)}}(log(1+\sum_{k\in\mathcal{J}} exp(\frac{\bar{u}^F_{\ell(i)ckt}}{1-\sigma_{\ell(i)}})) - log(1+\sum_{k\in\mathcal{J}/j} exp(\frac{\bar{u}^F_{\ell(i)ckt}}{1-\sigma_{\ell(i)}})))$. The scatterplot is weighted by county population.

Table A.1: **Bargaining Model Parameter Estimates**

Pharmacy Network Adequacy Penalty (κ)	0.382*	**Pharmacy MC (c)**	2014	2015	2016	2017
	(0.231)	Ahold USA	0.307***	0.429***	0.421***	0.408***
Bargaining Parameters (τ)			(0.094)	(0.073)	(0.077)	(0.047)
CVS	0.983***	Albertsons	0.495***	0.426***	0.426***	0.389***
	(0.111)		(0.046)	(0.057)	(0.086)	(0.042)
Express Scripts	0.905***	Costco	0.329***	0.339***	0.303***	0.278***
	(0.112)		(0.044)	(0.063)	(0.049)	(0.048)
Humana	0.959***	Delhaize	0.492***	0.476***	0.483***	—
	(0.114)		(0.044)	(0.052)	(0.042)	—
United Healthcare	0.753***	Giant Eagle	0.364***	0.382***	0.401***	0.378***
	(0.104)		(0.035)	(0.041)	(0.046)	(0.043)
		HEB	0.466***	0.315***	0.206***	0.218***
			(0.039)	(0.083)	(0.051)	(0.038)
		Hy-Vee	0.449***	0.447***	0.352***	0.282***
			(0.044)	(0.071)	(0.035)	(0.045)
		Kroger	0.350***	0.340***	0.349***	0.361***
			(0.000)	(0.076)	(0.036)	(0.074)
		Meijer	0.465***	0.390***	0.353***	0.319***
			(0.000)	(0.079)	(0.038)	(0.059)
		Publix	0.473***	0.427***	0.444***	0.380***
			(0.000)	(0.054)	(0.051)	(0.045)
		Rite-Aid	0.557***	0.482***	0.469***	0.453***
			(0.041)	(0.033)	(0.032)	(0.058)
		Safeway	0.508***	—	—	—
			(0.000)	—	—	—
		Shopko	0.573***	0.470***	0.405***	0.378***
			(0.038)	(0.104)	(0.042)	(0.049)
		Walgreens	0.495***	0.441***	0.431***	0.384***
			(0.033)	(0.093)	(0.034)	(0.080)
		Walmart	0.349***	0.326***	0.310***	0.293***
			(0.026)	(0.074)	(0.046)	(0.060)
		Wegmans	0.380***	0.340***	0.333***	0.317***
			(0.031)	(0.088)	(0.054)	(0.048)

Notes: This table presents the full set of estimates from my bargaining model. I report bootstrapped standard errors that are calculated by resampling PBMs within each pharmacy-year combination with replacement. Safeway was acquired by Albertsons in 2015, so I treat all Safeway stores as part of Albertsons starting in 2015. Delhaize merged with Ahold USA in 2017, so I treat all Delhaize stores as part of Ahold USA starting in 2017.

Figure A.6: **Correlation between Integrated Pharmacy Conversion Ratio and The Effect of the Divestiture on Plan Valuation**



Notes: Each dot represents a Medicare contract. The red dashed line is the linear fit line generated by a regression of MLR on LIS share. I exclude Medicare contracts for which I have data on fewer than 100 enrollees.

Table A.2: **Effect of Vertical Integration on Prices, Premiums, and Consumer Surplus by Rural Status**

	Rural			Urban		
	Baseline	Ban VI	% Change	Baseline	Ban VI	% Change
Pharmacy Prices						
Fully Integrated	0.56	0.29	-48.0%	0.59	0.31	-47.9%
Vertically Integrated with PBM	0.65	0.23	-65.2%	0.59	0.22	-63.3%
Non-Integrated	0.40	0.40	0.1%	0.39	0.39	0.1%
All	0.42	0.38	-8.8%	0.41	0.38	-7.1%
Pharmacy Market Shares						
VI Pharmacies	29.4%	32.7%	11.1%	32.9%	35.5%	8.0%
Non-VI Chain Pharmacies	33.6%	31.2%	-6.9%	42.0%	39.9%	-5.1%
Independent Pharmacies	37.0%	36.1%	-2.5%	25.1%	24.6%	-1.9%
Pharmacy Network Surplus						
VI Plan	877	950	8.3%	1,209	1,265	4.7%
Non-VI Plan	688	715	3.9%	931	963	3.5%
All	783	833	6.4%	1,057	1,100	4.1%
Annual Drug Premium						
VI Plan	489	484	-1.0%	565	593	5.1%
Non-VI Plan	687	634	-7.8%	779	777	-0.2%
All	587	558	-4.9%	682	694	1.8%
Consumer Surplus	532	602	13.2%	541	580	7.2%

Notes: Pharmacy prices represent the "base" negotiated rate between PBMs and pharmacies per unit of resources, which is benchmarked to the average formulary tier 1 drug cost. The columns display county population-weighted averages.

B Effects of Vertical Integration on Government Spending

In this section, I use the estimates from my counterfactual simulation to predict how the divestiture of vertically integrated pharmacies would affect three sources of government spending in Medicare Part D. The first source of spending is the direct subsidies paid to plans for providing drug insurance. These are set by statute at 74.5% of the enrollment-weighted national average bid for providing basic drug coverage. The second source of spending is reinsurance payments. The federal government covers 80% of all drug expenditures in the catastrophic coverage phase. In 2017, the drug spending threshold at which consumers enter the catastrophic coverage phase was $7,425. The third source of spending is low-income cost-sharing subsidies. The government covers the majority of out-of-pocket expenditures for qualifying enrollees.

I make several simplifications to the complex regulatory environment of Medicare Part D in my model for tractability. Before presenting my findings, I briefly discuss several of the simplifications I make and how they may affect the magnitudes of my estimated effects of vertical integration on government spending. First, in my counterfactual simulation, I hold per-enrollee prescription drug demand fixed. If consumers increase their prescription drug utilization after the divestiture reduces drug prices, my analysis will overstate the savings in reinsurance and low-income cost-sharing payments. Second, the counterfactual exercise takes as given the observed direct subsidy amounts and predicts how premiums change. In reality, the direct subsidy paid to plans is a function of both the equilibrium bids and the average risk score of a plan's enrollees. Nevertheless, I view my approach as a reasonable approximation to reality that vastly simplifies computation. Third, I model plans as setting a single drug premium, while in reality the premium paid by consumers is the sum of a basic premium and a supplemental premium. The bid amount used to determine the direct subsidy is the basic bid amount. In this exercise, I estimate the basic bid amounts by scaling down the model-predicted premiums based on the basic premium's observed share of the overall premium in the data for each plan. Fourth, my model simplifies the provision of low-income cost-sharing subsidies. In reality, these subsidies vary by drug and the income level of the enrollee. In my model, I simply assume that the share of drug prices borne by the government for LIS enrollees is equal to that observed in the data.

With these caveats in mind, Table A.3 presents the estimated effects of vertical integration on government spending. All numbers in the table are based on my analytic sample, which is composed of a 20% random sample of Medicare enrollees. Holding the observed subsidy amount fixed, my model predicts that the average Part D insurance bid (the sum of the subsidy and premiums) would fall from $616 to $573 following the divestiture of vertically integrated plans. Even though the average plan increases premiums following the divestiture, consumers sort into plans with lower premiums, which causes the enrollment-weighted average premium to decrease. Given that the Part D direct subsidy is set at 74.5% of the national average bid amount, this implies that average subsidies decline by 7%. Savings from the reduced direct subsidy amount are partially offset by increased Part D enrollment, leading to a 5% reduction in overall direct subsidy payments.

The average expected annual drug cost per enrollee falls from $3,401 to $3,053 following the divestiture because of the decreases in average drug prices. I calculate the expected reinsurance payments in each scenario by multiplying these totals by the observed share of spending that falls in the catastrophic coverage phase. After accounting for changes in overall Part D enrollment, I predict that divestiture would decrease

reinsurance payments by 8%. Finally, I predict that total subsidies paid to cover cost-sharing expenses for LIS enrollees would decline by 5% following the divestiture. In sum, I predict that the divestiture of vertically integrated pharmacies would reduce government spending in Medicare Part D for these three categories (direct subsidies, reinsurance, and low-income cost-sharing subsidies) by $5.26 billion per year, after scaling up my estimates such that the model-predicted Part D enrollment matches the observed enrollment in 2017. While the precise estimates of government spending are subject to the caveats above, this analysis illustrates that vertical integration between payers and pharmacies not only harms consumers but also likely increases government spending in Medicare Part D.

Table A.3: **Effects of Vertical Integration on Government Spending in Medicare Part D**

		Baseline	Ban VI	Δ	Δ %
(1)	Weighted Average Insurance Bid	616	573	-43	-7%
(2)	Expected Drug Costs per Enrollee	3,401	3,053	-348	-10%
(3)	Direct Subsidy	419	389	-30	-7%
(4)	Reinsurance Payments per Enrollee	993	891	-102	-10%
(5)	Cost-Sharing Subsidies per LIS Enrollee	1,543	1,451	-93	-6%
(6)	Total Direct Subsidy Payments	17,890,539,839	16,997,498,820	-893,041,018	-5%
(7)	Total Reinsurance Payments	42,430,428,793	38,995,402,535	-3,435,026,259	-8%
(8)	Total Cost-Sharing Subsidy Payments	18,913,264,291	17,979,604,649	- 933,659,642	-5%
(9)	Total Spending	79,234,232,923	73,972,506,004	-5,261,726,919	-7%

Notes: In rows (6) through (9), I scale up spending such that the baseline Part D enrollment from my 20% sample equals the observed Part D enrollment in 2017 for the relevant population. The baseline and ban VI values reflect model-predicted equilibrium outcomes. I filter Medicare enrollment within my sample as described in Appendix C.

C Technical Appendix

C.1 Data Sources

- **Medicare Part D Event (PDE) Data:** this dataset contains information on prescription drug claims for a random 20 percent sample of Medicare enrollees for 2012 through 2017. Each observation in the data represents a prescription drug claim. For each claim, I observe the total payment received by the pharmacy, the amount paid by the plan, and the amount paid by the consumer. I also observe the date of the claim, the 11-digit National Drug Code (NDC) of the dispensed drug, the plan-reported branded/generic status of the drug, the pharmacy's National Provider Identification (NPI) code, and the Medicare Contract ID and Plan ID that the consumer was enrolled in.

- **Medicare Beneficiary Summary File:** this dataset contains information on a random 20 percent sample of Medicare enrollees for 2012 through 2017. For each enrollee, I observe their demographics, including their age, sex, low-income subsidy status, zip-code of residence, and reason for Medicare eligibility. I combine this data with the PDE to add additional beneficiary information to the claims data.

- **Medicare Part D Formulary Files:** these files contain information on the design of formularies for each Medicare Part D plan. The data report the formulary tier for each NDC for each Medicare Part D plan, including whether the formulary tier is a "specialty" tier. I use these data to identify the formulary tier for each drug that I observe in the PDE, which is important for determining consumer out-of-pocket costs.

- **Medicare Part D Plan Characteristics Files:** these files contain information on the other features of plan design, including their cost-sharing schedules, premiums, service area, and deductibles. I use these data to collect characteristics on plans for my plan demand estimation, to determine the choice set of plans for each county, and to calculate the effective coinsurance rates.

- **Medicare Part D Pharmacy Network Public Use Files**: these files contain plan-reported information on the pharmacy networks of Part D plans. For a given quarter, the data report indicators for whether a given pharmacy (identified as the National Provider Identifier) was in-network for a given Part D plan, as well as whether the pharmacy was preferred. I use these data to validate the pharmacy networks that I construct empirically. I elect not to rely solely on these data for several reasons. First, not all plans report their pharmacy network data. Second, for the plans that do report their pharmacy network data, there are many pharmacies that are not listed in the data but that do appear as filling prescriptions for the plan's enrollees in that quarter. Given these data quality issues, I use this file only to validate the construction of the empirical pharmacy networks. I provide more detail on that construction process below.

- **National Council of Prescription Drug Plans DataQ:** these data contain snapshots of information on pharmacies in the United States. For each pharmacy, these data report the NPI, legal and doing-business-as names, address, pharmacy type, and parent organization at a given point in time. I

performed additional data cleaning to identify the chain affiliation of some pharmacies based on the legal and doing-business-as names, to adjust chain affiliations to account for pharmacy acquisitions, and to identify pharmacies that are owned by a PBM or insurer. I link these data to the PDE by the NPI to identify the pharmacy type, location, and parent company of each pharmacy, which are necessary to conduct my descriptive analysis and to estimate my pharmacy demand model.

- **CMS Health Plan Management System Subcontractor Data:** these data contain information on the subcontractors used by each Medicare insurer who offered a Part D plan from 2010 through 2021. I use these data to identify the PBMs that worked for each plan in the data. For each Medicare contract in each year, CMS requires the sponsor to report the identity of the firm that performed specific plan functions. For each such function, the insurer may state that it performed the function itself or identify the firms with which it subcontracted to perform this function. I manually cleaned the data to standardize the names of PBMs across contracts and to account for PBM mergers. If a sponsor lists a PBM as providing a function, I assume that the PBM performed the function even if the sponsor also states that it provided the function itself. Some plans may use multiple PBMs, particularly to handle different functions.[31] In my analysis, I assign each Medicare contract to the PBM that was listed as providing "Development and maintenance of a pharmacy network." Some contracts list multiple PBMs as providing this function. There are two reasons why this may occur. First, a sponsor may switch PBMs mid-year. Second, a sponsor's PBM may be acquired by another PBM. Finally, a sponsor may simply use multiple PBMs to perform the function. I rely on public information about PBM acquisitions and PBM-insurer contracts to account for the first two reasons. I then assign any remaining contracts with multiple PBMs to the PBM that was responsible for the largest number of other functions in the HPMS.

- **CMS Medical Loss Ratio Public Use Files:** these data provide accounting information for Medicare Part D contracts, including their medical loss ratio. The data are available for all MA-PD contracts with more than 2,400 member months in a given year and all PDP contracts with more than 4,8000 member months in a given year. I use these data to back out the non-pharmacy costs for Medicare Part D plans.

- **CMS Annual Releases of Part D National Average Bid Amounts:** these documents state the national average bid amount (NAMBA) in each year. I use these data to infer the Part D bids for each plan.

- **CMS Rate Book Data and Prescription Drug Rate Information:** these documents state information on benchmarks and plan payments, including the low income subsidy premium amount for each Part D service region in each year. I use these data to adjust premiums for LIS consumers when estimating my plan demand model.

- **Medicare Advantage Bid Template Data:** these data contain the information provided by MA-PD plan to determine their subsidy and rebate payments. I use these data to recover the total payment

[31] The average number of PBMs that Medicare insurers reported was 1.15 during my study period.

received by each MA-PD plan, as well as their reported expected medical costs. I use these data to provide information on revenues and costs for MA-PD plans.

- **Department of Housing and Urban Development Zip Code Centroid Data:** these data report the centroid of each zip code in the United States. I use these data to compute the distance from each consumer's zip code to each pharmacy.

C.2 Pharmacy and Plan Demand Dataset

Each plan in the data has a contract ID, a plan ID, and a segment ID. The geographic markets are defined differently for PDP and MA-PD plans. The set of PDP plans available to consumers depends on their location in one of 34 service regions, which can be individual states (e.g., New Jersey) or groups of states (e.g., North and South Dakota). Medicare typically assigns national "contract" identifiers to insurers, who then design PDP plans that vary by service region. Insurers can design specific MA-PD plans for each county. As a result, plan choice sets vary across counties for consumers.

I define a PDP plan as a combination of contract ID and plan ID, and assign each PDP plan the plan design features associated with the lowest-numbered segment ID for the given contract/plan ID combination. For MA-PD plans, I define a plan as a contract ID. In each county, I assign each MA-PD plan the plan design features associated with the lowest-numbered plan ID for the given contract ID, which is consistent with the standard approach in the literature (Starc and Town 2020).

Consumer premiums for a given plan are set by CMS as 25.5% of the national average bid across all plans (NAMBA) plus the difference between the plan's bid and the national average. If the bid is less than 74.5% of the NAMBA, consumers pay nothing for the plan. I observe the drug premiums charged by each plan as well as the NAMBA in each year, which I use to infer the bid for each plan. MA-PD plans submit separate bids for medical insurance. Consumer premiums are determined by comparing these bids to regional benchmarks. I directly observe the bids placed by all MA-PD plans and the resulting consumer premiums through the Medicare Advantage Bid Template Data, but I do not model the process by which MA-PD plans place their bids for medical insurance in this paper. I assume those bids are independent of the drug insurance bids.

I make several restrictions based on enrollee and plan characteristics to construct my analytical sample of beneficiaries:

1. I exclude individuals that are younger than 65 years old, that live in US territories, that have an invalid zip code, or that are listed as being ineligible for Part D.
2. I exclude individuals who were automatically enrolled in a Part D plan.
3. I exclude individuals if they are enrolled in a plan for which I am missing data on plan design.
4. I exclude individuals who were enrolled in a plan that is not offered in their service area.
5. I consider only Standalone Prescription Drug plans and local HMO Medicare Advantage Prescription Drug plans. I group all other Medicare Advantage and Part D plans into the outside option.

6. I drop plans for which I do not observe any pharmacy claims, because I am unable to estimate consumer WTP for their pharmacy networks. I also exclude Kaiser Permanente plans because their pharmacy claims data appear to be incomplete.

I make some additional sample restrictions to the PDE data based on pharmacy characteristics before estimating my pharmacy demand model:

1. I exclude prescription fills made at long-term care pharmacies, government-owned pharmacies, non-chain pharmacies without a pharmacy type listed in the DataQ, and pharmacies that do not appear in the DataQ.

2. I exclude prescription fills made at pharmacies more than 50 miles from the centroid of the consumer's zip code, unless the pharmacy is a mail-order pharmacy.

3. I exclude Kaiser Permanente plans because their pharmacy claims data appear to be incomplete.

C.3 Prices and Resource Weights

This section provides greater details on how I construct the pharmacy prices for my empirical model. The empirical model requires a parsimonious representation of the prices paid to pharmacies while still capturing the reality that reimbursement rates vary significantly across drugs. I follow the approach of other papers in the hospital bargaining literature (Cuesta et al. 2024; Gowrisankaran et al. 2015) and summarize every observed reimbursement rate with two objects:

1. a "base price" p_{ry} that varies by contracting pair r and calendar year y; and

2. a resource weight ω_{dy} that rescales prices and marginal costs for drugs in formulary tier d relative to formulary tier 1 drugs in the same year.

Each claim in the data maps uniquely to a contracting pair, which can be one of three different types:

1. Integrated: a pharmacy chain h transacting with plan j through its integrated PBM k;

2. Non-integrated chain: a chain h contracting with a non-integrated PBM k; or

3. Independent: an independent pharmacy (located in state s) contracting with PBM k.

To construct prices and resource weights, I begin by regressing the logarithm of the observed reimbursement on a full set of contracting-pair-year and NDC-quarter-year fixed effects:

$$\ln\left(\text{price}_{injkqy}\right) = \delta_{ry} + \gamma_{iqy} + \varepsilon_{injkqy}. \tag{19}$$

Equation (19) absorbs all variation that is common to a contracting pair in year y into δ_{ry}, while γ_{iqy} captures variation in prices that is driven by drug-time-specific factors. Because the fixed effects transformation removes the constant, I add a year-specific intercept c_y chosen so that the average fitted log price for Tier 1

prescriptions equals the observed mean price for Tier 1 prescriptions in year y. Thus, the base price can be interpreted as the mean Tier 1 reimbursement rate for contracting pair r. Formally,

$$p_{ry} \;=\; \exp\!\big(\hat{\delta}_{ry} + c_y\big). \tag{20}$$

The drug fixed effects $\hat{\gamma}_{iqy}$ embody the tier-specific departures from the base price. For each tier d I compute the average fitted log price across all NDCs in that tier,

$$m_{dy} \;=\; \frac{1}{\#\{i : d(i) = d\}} \sum_{i : d(i) = d} \hat{\gamma}_{iqy}, \tag{21}$$

and translate these averages into multiplicative resource weights,

$$\omega_{dy} \;=\; \frac{\exp\!\big(m_{dy}\big)}{\exp\!\big(m_{1y}\big)}, \qquad \text{with } \omega_{1y} \equiv 1 \text{ by normalisation.} \tag{22}$$

Intuitively, ω_{dy} tells us how much more expensive a Tier d drug is relative to an otherwise identical Tier 1 drug in the same calendar year. Any price in the claims data can now be reconstructed as

$$\tilde{p}_{injkqy} \;=\; p_{ry}\, \omega_{d(i)\,y}\, \exp\!\big(\varepsilon_{injkqy}\big). \tag{23}$$

I make implicit assumptions about the nature of pharmacy price negotiations through this procedure. First, I assume that pharmacies can set separate prices for each plan that they are either integrated with or that is served by their integrated PBM. Second, I assume that PBMs and non-integrated chain pharmacies negotiate a single price for all plans and all geographies. Third, I assume that a PBM pays all independent pharmacies in the same state the same price.

C.4 Accounting for Consumer Health Risk

In some analyses, I allow my estimates of expected utility for pharmacy networks and consumer preferences for plans to vary by underlying consumer health risk. This section describes the steps I take to define consumer health risk and produce the analyses. Following Decarolis et al. 2020, I regress annual gross drug costs on dummy variables for race, age, sex, LIS status, and end-stage renal disease status. I then group consumers into risk groups based on their LIS status and quantile of predicted drug spending based on that regression. For each risk group, state, year, formulary tier, and LIS status combination, I calculate the expected days supply of drugs (γ) as the average days supply per enrollee observed in the data. Based on these new estimates of γ, I re-compute WTP for each plan separately by risk group.[32] Finally, using these new estimates of WTP, I estimate my plan demand model separately by LIS status and risk group.

[32] I assume that preferences for plan characteristics and expected pharmacy utilization vary with health risk, but that preferences for pharmacy characteristics do not.

C.5 Solving for Counterfactual Equilibria

I solve for equilibrium prices and premiums using a nested fixed-point algorithm. In the first step, I predict new drug premiums based on the premium-setting FOC for each plan in each county, given pharmacy prices. I make two simplifications to the insurer premium setting decision for computational reasons. First, I allow all plans to set premiums separately for each county. In reality, an insurer sets a plan's premium to be the same across several regions (e.g., counties or states). Second, I do not model how the random assignment of some LIS consumers to benchmark plans affects the premium choices of plans. When solving for equilibrium premiums, I constrain the solver to search for equilibrium premiums that satisfy the minimum MLR requirement of 85% when possible. When the solver cannot find an equilibrium for which all plans satisfy the minimum MLR requirement, I use the unconstrained solution. I view this as a reasonable approximation to the constraints imposed by MLRs in reality. CMS requires insurers to report MLRs for each Medicare contract, which may include many plans across many counties. As such, not every plan should be expected to satisfy the minimum MLR requirement in every county.

In the second step, I update pharmacy and plan demands given the new premiums and predict new prices using the integrated pricing and bargaining FOCs. In keeping with my estimation strategy, I assume that integrated firms consider only the demand of non-LIS consumers when setting pharmacy prices. For simplicity, I assume that pharmacies pick one price for all integrated insurance plans and one price for all non-integrated plans served by their integrated PBM. Within this second step, I solve for prices using a fixed-point algorithm, looping until prices converge within a tolerance of $0.01 per days supply. I loop over the first and second steps until equilibrium annual premiums converge within a tolerance of $1.