Preferred Pharmacy Networks and Drug Costs

Amanda Starc and Ashley Swanson *

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Abstract

Selective contracting is an increasingly popular tool for reducing healthcare costs, but any savings must be weighed against consumer surplus losses from restricted access. Recently, many prescription drug plans utilize preferred pharmacy networks to reduce drug prices. Our results suggest that Medicare Part D plans with preferred pharmacy networks pay lower retail drug prices, while subsidized enrollees' insensitivity to preferred pharmacy cost-sharing discounts reduces these savings. We then estimate pharmacy demand models to quantify the costs and benefits of preferred pharmacy networks, finding that the average enrollee benefits from preferred pharmacy contracting, due to reduced out-of-pocket costs at preferred pharmacies.

*Amanda Starc: amanda.starc@kellogg.northwestern.edu, The Kellogg School of Management, Northwestern University and NBER, 2211 Campus Drive Evanston, IL 60208; Ashley Swanson: ats2180@gsb.columbia.edu, Graduate School of Business, Columbia University and NBER, 3022 Broadway, Uris Hall 621, New York, NY 10027. We gratefully acknowledge funding from the Wharton Public Policy Initiative, the Boettner Center and Pension Research Council (PRC) of the Wharton School, the Wharton Dean's Fund, the Wolpow Family, and the Leonard Davis Institute. Starc acknowledges additional financial support from the American Medical Association. We thank Abby Alpert, Rena Conti, David Dranove, Adam Fein, Sebastian Fleitas, Craig Garthwaite, Gautam Gowrisankaran, Matthew Grennan, Atul Gupta, Christopher Ody, Dan Polsky, Mark Shepard, Anna Sinaiko, and Bob Town, as well as numerous conference and seminar audiences, for helpful comments and discussion. Allison Briggs, Jordan Keener, Alexa Magyari, Amy Tingle, and Yihao Yuan provided excellent research assistance. All errors are our own.

1 Introduction

We examine the effects of selective contracting by insurers on prices and consumer access. Intuitively, restrictive networks could help insurers reduce costs through three key mechanisms. Selective contracting could screen out unprofitable enrollees (Shepard (2016)), steer enrollees to low-cost suppliers (Gruber & McKnight (2016), Prager (2018)), and/or give insurers additional leverage to negotiate discounts with suppliers (Ghili (2018), Gowrisankaran et al. (2015), Ho & Lee (2017), Liebman (2018), Sorensen (2003)). Any cost savings may be reduced by lack of enrollee sensitivity to prices. Furthermore, consumers may prefer access to a broad set of suppliers, making them more likely to choose plans with less restrictive networks, even if those plans have higher premiums.

We quantify this trade-off in the Medicare Part D program, the federal prescription drug benefit for the elderly in the United States. The private firms offering Part D plans are heavily regulated and subsidized, but in general have both motive and opportunity to manage utilization and seek lower prices. Duggan & Scott Morton (2010) examined the early rollout of Part D beginning in 2006 and concluded that the program pushed down average prices, due mainly to plans' use of formularies and other utilization management tools to steer enrollees to lower cost drugs and to negotiate lower prices with pharmaceutical manufacturers. More recently, Part D insurers have begun to use similar tactics in negotiation with pharmacies, by forming restrictive preferred pharmacy networks that exclude many local pharmacies. This paper is, to our knowledge, the first empirical analysis of pharmacy network contracting.

In Section 2, we describe the institutional details of the setting and document wide variation in prices for prescription medications purchased in the Medicare Part D program from 2011 to 2014 – this variation is observed for both branded and generic drugs, and remains even within narrowly-defined products.[1] Drug prices are important for policy: in April 2015, the Kaiser Family Foundation found that "making sure that high-cost drugs for chronic conditions are affordable to those who need them" and "government action to lower drug prices" were the public's top two health cost priorities for President Barack Obama and Congress (Altman (2015)). At the same time, there has been significant consolidation at multiple points of the pharmaceutical supply chain (The Health Strategies Consultancy LLC (2005)), implying that price

[1] In some of our empirical specifications, we focus particular attention on the market for generic prescription drugs. We do this because the role of unobserved manufacturer rebates is less important in generic drug markets and therefore the estimates for generics are not subject to measurement error in price (Association for Accessible Medicines (2017)). Plans are able to secure rebates of 5-25 percent for branded drugs; these rebates are carefully guarded trade secrets and are not observed in our data (CMS (2016), The Health Strategies Consultancy LLC (2005)). Generics are important in their own right, comprising 27 percent of the approximately $100 billion in spending in the Medicare Part D program in 2014.

dispersion and growth will remain policy-relevant issues.

Section 2 also describes the rise of preferred pharmacy contracting and its impact on different enrollees' prices over this period. While only 13 percent of sample plans used preferred pharmacy networks in 2011, this rose to 70 percent in 2014. The out-of-pocket price differentials between preferred and non-preferred pharmacies ranged from $6-$8 per 30-day supply for most prescription drugs, making the incentive to use preferred pharmacies within preferred-network plans substantial. While many retail pharmacies were excluded from preferred pharmacy networks, most enrollees had convenient access to a preferred pharmacy. The average enrollee had to travel only 3.7 minutes longer to reach a preferred retail pharmacy (vs. a non-preferred retail pharmacy). Importantly, the above out-of-pocket price differentials did not generally apply for low-income subsidy (LIS) beneficiaries, who comprise about 30 percent of plan enrollment. For example, for LIS beneficiaries, the maximum out-of-pocket price was $2.55 per 30-day supply for a generic drug in 2014: both preferred and non-preferred pharmacy out-of-pocket prices generally exceed this maximum, effectively removing the price differential and, in turn, the incentive to visit preferred pharmacies.

Given the market institutions, we test two reduced form hypotheses. The first hypothesis is that plans with restrictive preferred pharmacy networks will be able to achieve lower drug prices due to some combination of enrollee steering and increased bargaining leverage. The second is that plans with price-insensitive enrollees will capture limited savings from preferred pharmacy contracting, as their reduced ability to steer such enrollees limits any potential increase in bargaining leverage.

To examine the first empirical hypothesis, Section 3 begins by estimating the impact of selective contracting between plans and pharmacies on prices. We determine the year in which each Part D plan adopted preferred pharmacy networks, and the percent of Medicare-contracting pharmacies in each Part D region that appear in plans' preferred pharmacy networks. We then analyze the extent to which preferred pharmacy contracting impacts prices.[2] The estimates from the preferred specifications indicate that preferred-network plans pay 4.2-5.1 cents per day supplied (1.9-2.3 percent) less for drugs at the point of sale. Alternatively, a standard deviation increase in the comprehensiveness of a plan's local preferred pharmacy network (27 percentage points) is associated with a retail drug price increase of 2.6 cents per day supplied. To examine the second hypothesis, in Section 3 we examine the effect of preferred pharmacy contracting on drug prices across plans with high versus low percentages of low-income subsidy beneficiaries. We find that the effects

[2]This is similar in spirit to Sorensen (2003), in which selective contracting by managed care organizations is used to characterize MCOs' "steering ability": their ability to differentially channel enrollees across providers.

of preferred pharmacy contracting are strongest in plans without substantial numbers of LIS beneficiaries. In our richest specification, the effect of a standard deviation increase in the comprehensiveness of a plan's local preferred pharmacy network is 3.3-3.7 cents per day supply for the 1st quartile of LIS enrollment, vs. 0 cents per day supply for the 4th quartile. Results are similar with and without pharmacy fixed effects, with and without bargaining pair fixed effects, and whether we classify plans based on "contemporaneous % LIS" vs. "2011 % LIS". We also explore the robustness of these results to modeling decisions, and demonstrate how preferred pharmacy network adoption correlates with other outcomes of interest, such as premiums, driving distance, selection of beneficiaries across plans, and other levers Part D plans use to constrain costs. These analyses demonstrate that plans adopting preferred pharmacy networks reduce premiums significantly, without increasing the equilibrium travel time of enrollees to retail pharmacies, and subsequently attract a more favorable enrollee population. The savings they achieve are consistent with the price reductions discussed above and do not appear to be driven by an extensive margin effect (enrollees reducing their total prescriptions) or to other cost-saving levers.

In Section 4, we estimate models of demand to examine the welfare impact of preferred pharmacy contracting. We allow for enrollees' preferences over pharmacies to depend flexibly on location, age, LIS status, and drug needs. We show that preferred status has a large positive effect on pharmacy demand, which is largest for non-LIS beneficiaries and enrollees using low-cost drugs. Making all pharmacies preferred would increase non-preferred pharmacies' market shares by 3.9 percentage points (or 9.5 percent) among non-LIS beneficiaries, versus only 0.79 percentage points (or 1.3 percent) among LIS beneficiaries. Put differently, our estimates suggest that non-LIS beneficiaries in our sample were willing to travel an extra 8.6 minutes to reach a preferred pharmacy, vs. 2.1 minutes for LIS beneficiaries.

Second, we demonstrate that plans face trade-offs in adopting preferred pharmacy networks: if we counterfactually shut down preferred networks by removing the out-of-pocket price differentials introduced between preferred and non-preferred pharmacies when preferred pharmacy networks are adopted, the consumer surplus impact diverges between non-LIS and LIS beneficiaries. Non-LIS beneficiaries fill more prescriptions at preferred pharmacies and thus experience a decrease in surplus when preferred networks are shut down: their out-of-pocket spending increases by 3.9 percent and their consumer surplus declines by \$32.71 per year. In contrast, LIS beneficiaries fill more prescriptions at non-preferred pharmacies and benefit when preferred networks are shut down: their out-of-pocket spending decreases by 2.2 percent and their consumer surplus increases by \$4.08 per year. For comparison, our most conservative estimates of the cost savings, based on the counterfactual estimates in Section 4, are $50 savings per non-LIS enrollee-year and $31 per LIS enrollee-year. Taken together, we estimate that preferred-network plans reduce costs, increase consumer surplus for non-LIS beneficiaries, and decrease consumer surplus for LIS beneficiaries.

To put these cost savings results in context, our price analyses in Section 3 show that adopting preferred networks is associated with about 2.3% savings, holding enrollee selection across plans fixed. Duggan & Scott Morton (2010) estimate that the introduction of the Part D program slowed growth in drug prices from 13% to 1% between 2003 and 2006; Dranove et al. (2017) find that privatization of drug benefits within the Medicaid program results in a within-NDC price reduction of 5.3%. Therefore, we find that introducing a new plan design element to the Medicare Part D program has approximately 19% of the effect of the initial creation of the program, and approximately 43% of the effect of privatizing drug benefits. While these savings are small relative to overall Part D spending, they add up: even if we use our most conservative savings estimate of 1.2% from Section 4, our estimates suggest that if all sample plans had used preferred pharmacy contracting throughout 2011-2014, they would have saved $2.2 billion dollars in aggregate over four years.

This paper draws on and contributes to the literature on drug pricing as well as the literature on market power and bargaining. The rising cost of drugs in the United States is the focus of much attention from economists, patient advocates, and policymakers (see, e.g., Howard et al. (2015)). While much of this attention is directed toward pharmaceutical manufacturers, retail pharmacies are quite concentrated, raising concerns about market power. For example, Dubois & Saethre (2018) estimate that pharmacies are able to realize significant margins when they have the power to foreclose access to certain products. Preferred pharmacy networks are a relatively new tool for combating pharmacy market power, analogous to plans' historical use of drug pricing schedules called formularies to combat manufacturers' market power. Research has shown that the introduction of Part D lowered the price of drugs by increasing insurer market power relative to that of drug manufacturers through insurers' use of formularies (Duggan & Scott Morton (2010)); these efficiencies, along with a shift toward generic drugs, have led to program costs lower than forecasted when the benefit was passed into law.[3] This is not to say that Part D insurers act as perfect agents of enrollees, but rather that they are well-incentivized to reduce costs; as demonstrated by Ho et al. (2017), drug prices in Part D plans increased only about 2 percent between 2007 and 2010, but plan premiums grew

[3] Scott Morton (1999) demonstrates that branded drug patent expiration has historically been followed by generic entry capturing half of molecule volume at prices 30-50 percent lower than the branded price.

by 62.8 percent. Finally, our paper is closely related to the relatively new literature on bilateral bargaining in health care markets – this literature articulates the important insight that demand intermediaries can exert competitive pressure in markets with price-insensitive end-users.[4] In closely related work, Gruber & McKnight (2016) find that limited network plans generate large savings on medical care, while Prager (2018) finds savings from tiered hospital network plans of 8-17 percent. We build on these findings in the context of prescription drug insurance, and focus explicitly on a key prediction from theory: limited or preferred pharmacy networks are only likely to generate savings to the extent that a plan can steer consumers.

2 Setting and Data

2.1 Overview of the setting

Medicare is a social insurance program providing health insurance to elderly Americans. Initially passed in 1965, the plan did not cover prescription drugs. A prescription drug benefit was added in 2003, and nearly 41 million of the 57 million people on Medicare (71 percent) enrolled in a Part D plan in 2016 (Hoadley et al. (2016)). The law authorizing this additional benefit – known as Medicare Part D – stipulated that prescription drug coverage be provided by private health insurers. As a result, enrollees are able to choose from dozens of plans offered in their local geographic markets.[5]

Part D plans are regulated by the federal Centers for Medicare and Medicaid Services (CMS), but private Part D sponsors have flexibility in terms of plan design. CMS mandates coverage generosity in Part D plans in terms of actuarial value, types of drugs covered, and pharmacy network breadth. See Appendix A for more details. Enrollees are entitled to basic coverage of prescription drugs by a plan with actuarial value equal to or greater than that available in a standard Part D plan with a deductible, an initial coverage region with 75 percent plan coverage of drug costs, another coverage gap known as the "donut hole", and a final, "catastrophic" region with 95 percent plan coverage of drug costs. Within these constraints, plans can vary

[4]For example, Grennan (2013) estimates a model of bargaining between hospitals and medical device suppliers, and Capps et al. (2003), Sorensen (2003), Gowrisankaran et al. (2015), and Ho & Lee (2017) examine bargaining between insurers and hospitals. Some papers in this literature explore the nuances of bilateral hospital-insurer contracting when restrictive networks are possible in equilibrium, as they are in our pharmacy network setting: Shepard (2016) shows that restrictive networks can be used to select against high-cost enrollees; and Ghili (2018) and Ho & Lee (2018) develop methods for estimating models with endogenous restrictive networks and show that restrictive networks can increase plans' bargaining leverage with respect to in-network hospitals.

[5]Medicare-eligible individuals can acquire prescription drug coverage through standalone Part D plans, or can alternatively obtain drug coverage bundled with medical and hospital coverage by enrolling in "Medicare Advantage" plans. We limit our analysis to standalone Part D plans in this study, covering about 60 percent of enrollees. Part D plans are offered in one of 34 PDP regions covering the 50 states and the District of Columbia. Some of the 34 PDP regions are made of single states, while others include more than one state. For example, Region 1 includes both Maine and New Hampshire.

premiums and generosity of coverage of drugs and pharmacies. The majority of Part D enrollees are not in standard plans, but rather in actuarially equivalent or "enhanced" plans with non-standard deductibles and/or donut holes, with drugs grouped into formulary tiers, and with specific networks of pharmacies. Plan design elements such as formularies and pharmacy networks are often designed with the assistance of pharmacy benefit managers (PBMs).[6]

Medicare Part D retail pharmacy "network adequacy" standards require that at least 90 percent of urban beneficiaries reside within two miles of a network retail pharmacy; the analogous standards for suburban and rural areas are 90 percent within five miles, and 70 percent within fifteen miles, respectively (CMS 2015*a*). Subject to meeting these standards, the pharmacy networks of plans in the Part D program may exclude individual pharmacies or entire pharmacy chains. Exclusion means that enrollees will not be able to use plan coverage for prescription fills at those pharmacies.[7] Additionally, some plans establish preferred pharmacy networks, in which each in-network pharmacy is designated as preferred or non-preferred, and preferred status means reduced out-of-pocket costs to enrollees.[8] Critically, retail pharmacy network adequacy standards apply to *overall* pharmacy networks but do not apply to *preferred* pharmacy networks, so *preferred* networks can be much more restrictive than plans' overall networks. This distinction prompted CMS to investigate Part D preferred pharmacy network coverage in 2015: the report found that plans' overall networks met or exceeded the statutory network adequacy standard based on distance to network pharmacies. However, in one in ten *preferred* pharmacy networks, fewer than 40 percent of urban beneficiaries had sufficient preferred pharmacy access in their plans' service areas (CMS (2015*b*)).

The private insurers participating in the Medicare Part D program – either directly or via their contracted PBMs – are free to negotiate drug prices with upstream suppliers. Plans pay negotiated prices to both drug manufacturers and pharmacies. For example, insurers/PBMs can obtain "rebates" from drug manufacturers in exchange for preferred placement of their drugs on plan formularies. Essentially, pharmaceutical man-

[6]Unfortunately, we are unaware of comprehensive data on which issuers use which PBMs, or for what purposes; e.g., some insurers have PBMs contract with drug manufacturers and pharmacies on their behalf, while others use external PBMs only for claims processing. Thus, we focus on negotiations between plans and pharmacies. Given that some PBMs negotiate with pharmacies on behalf of multiple issuers, this will tend to bias our estimate of the variation in prices across "bargaining pairs" toward zero.

[7]Another way for insurers to save on pharmacy costs is to push enrollees to fill their prescriptions at mail-order pharmacies. Utilization of mail-order pharmacies is fairly low in our sample: about 6.9 percent of claims in our sample were at pharmacies whose primary dispenser type was "mail-order pharmacy." This is higher than Ketcham & Simon (2008)'s mail-order fill rate of 2.1 percent in a near-elderly, commercially-insured population, and lower than Carroll (2014)'s mail-order fill rate of 7.8 percent in a 5 percent sub-sample of Part D claims for the top 300 drugs.

[8]A note on terminology: throughout this paper, we refer to "preferred-network plans" and "non-preferred-network plans." All plans form retail pharmacy networks ("overall pharmacy networks"), but preferred-network plans engage in "preferred network contracting" by establishing both preferred networks and overall networks. In non-preferred-network plans, all in-network pharmacies are effectively "preferred," so that the preferred network and the overall network coincide.

ufacturers give plans a discount in exchange for plans steering consumers to their drugs using formulary structure. Similarly, insurers/PBMs can obtain price discounts from pharmacies in exchange for preferred pharmacy status. Each of these approaches is a lever for insurers/PBMs to combat suppliers' market power, which is substantial: pharmaceutical manufacturers have limited-term monopolies, and pharmacies are quite concentrated, with four companies sharing 51 percent of retail prescription revenues in our sample.[9] Given that we are not aware of researcher-accessible data on manufacturer rebates, we treat these negotiations – between insurers/PBMs and drug manufacturers, and between insurers/PBMs and pharmacies – as occurring independently, while recognizing that each contributes to the final retail price we observe in claims data. To provide reassurance on this point, we perform some analyses only within generic drugs, for which rebates are less prevalent. We also explore the extent to which insurers' use of alternative savings levers is correlated with preferred pharmacy contracting in Section 3.1.

Out-of-pocket prices can be used to steer consumers and in turn reduce costs, but also expose enrollees to additional financial risk and reduced access. This may be harmful for low-income beneficiaries in particular; accordingly, approximately 30 percent of Part D enrollees (LIS beneficiaries) qualify for low-income subsidies, which entitles them to substantial reductions in premiums and out-of-pocket costs. In 2014, the maximum out-of-pocket price for LIS beneficiaries prior to the catastrophic threshold was \$2.55 for generic drugs and \$6.35 for branded drugs, and many LIS beneficiaries qualify for more generous subsidies based on income. The subsidy structure means that LIS beneficiaries will not be exposed to the out-of-pocket price differentials between preferred and non-preferred pharmacies in preferred-network plans. Industry participants seem to have been keenly aware of this feature of the LIS program and factored it into their decisions to form preferred pharmacy relationships: in 2017, for example, AmerisourceBergen (a Pharmacy Services Administrative Organization that provides administrative services to independent pharmacies) recommended that pharmacies not join a preferred provider network offered by a large national plan, because the plan population was documented to be loyal to their pharmacies and were largely low-income-subsidy patients (Gebhart (2018)).

[9] Furthermore, vertical and horizontal consolidation is ongoing: CVS Health acquired Aetna in 2018; and Walgreens acquired about half of Rite Aid locations in 2017 (Schencker (2017)). See also Zhu & Hilsenrath (2014).

2.2 Data

Our analyses use data on prescription drug events, plan choice, pharmacy choice, plan characteristics, beneficiary costs, and pricing from CMS. We observe every prescription fill for the years 2011-2014 for a random 10 percent sample of all Medicare eligibles. We augment these data with additional information on plans' formularies, out-of-pocket prices, and premiums. Retail prices are calculated from the prescription drug event data as the total (enrollee plus plan) cost per day supply. Out-of-pocket prices charged to enrollees when they fill prescriptions may take the form of copays, in which enrollees pay a flat fee out-of-pocket, or coinsurances, in which enrollees pay a percentage of the total point-of-sale price.[10] Copays and coinsurances are generally specified for each formulary tier and for multiples of 30-day supplies.

In our empirical specifications, we examine prices within drugs defined at two levels: "brand," as identified by the brand name or generic name on the prescription drug claim; or national drug code (NDC), a 10-digit code that uniquely identifies the labeler (roughly, the pharmaceutical manufacturer); the specific strength, dosage form (i.e, capsule, tablet, liquid) and formulation, and the package size and type. A given drug brand (e.g., atorvastatin calcium for treatment of hypercholesterolemia, or the original atorvastatin brand Lipitor) may have many associated NDCs.

Appendix B describes the price variation in our data. The mean price of branded drugs is 9-15 times as large as that for generic drugs, which accounts for the disproportionate policy attention given to the less-frequently prescribed branded drugs.[11] There is substantial heterogeneity in drug prices, and the distribution of prices has a long upper tail within each generic status-year pair. The standard deviation of price across plans, for the same year-drug-pharmacy chain, is 14-23 percent of the mean for branded drugs, versus 32-42 percent of the mean for generic drugs. To more concretely show how price dispersion persists even within narrowly defined product categories, Appendix Figure A.1 describes two prominent examples of this phenomenon. Drug price variation may reflect a number of underlying economic mechanisms: e.g., enrollees' preferences or price-sensitivity, regional dispensing or distribution costs, or plans' bargaining power or bargaining position with respect to drug manufacturers or pharmacy chains. To the extent that

[10] The total retail price we observe is the sum of a fixed fee per prescription fill, plus a fee for the specific drug. Each is subject to negotiation by a given pharmacy-plan pair. In this paper, we use the terms "retail price" and "point-of-sale price" interchangeably.

[11] The vast majority of claims in the data are for generic, rather than branded, drugs, and that proportion is increasing over the time horizon we consider. We follow convention in using days supply as our quantity variable. This has the advantage of being a common unit across drugs, regardless of dosage form. Pharmacies grouped together into chains using the "pharmacy relationship identifier" and "pharmacy parent organization identifier" variables in the Part D Pharmacy Characteristics files. Retail pharmacies without such identifiers populated are classified as "independent."

any of these drivers of price variation are sensitive to plan design elements like pharmacy networks, these calculations suggest ample opportunities for saving.

Table 1 describes the plans in our data. The first row indicates whether a given plan relied on preferred pharmacy networks; the proportion of plans with preferred pharmacy networks increased from 13 percent in 2011 to 70 percent in 2014.[12] The next rows show several measures of pharmacy network coverage for each plan-year. The first, "% In-Network (All)" equals the percent of Medicare Part D-contracting pharmacies that are physically located in a given plan's Part D region and are in the plan's network in that year. Overall networks are stable over this time period, decreasing only slightly from 68 percent to 67 percent. However, coverage differs dramatically across pharmacy types: as shown in the following rows, the average plan had 91-94 percent of chain pharmacies in-network during 2011-2014, vs. only 27-30 percent for independent pharmacies.

The next few rows focus on preferred status: "% Preferred (All)" equals the percent of Medicare Part D-contracting pharmacies that are physically located in a given plan's Part D region and are in the plan's *preferred* pharmacy network in that year. The average plan's coverage of preferred pharmacies dropped from 63 percent to 35 percent between 2011 and 2014. This had a dramatic effect on coverage of chain pharmacies, with coverage dropping from 86 percent to 51 percent. Coverage of independent pharmacies falls even more dramatically: only 9 percent were preferred in the average plan by 2014.[13] If we limited our consideration to preferred-network plan-years, average "% Preferred" would decline from 36 percent to 23 percent. Thus, the rise of preferred pharmacy networks and the narrowing of preferred networks

[12]We classified each plan as having a preferred pharmacy network if we observed different preferred and non-preferred cost-sharing for any formulary tier in the beneficiary cost files. We classified each plan-pharmacy pair as in-network in a given year if we observed non-zero covered claims for that pair, *or* if the pair appeared in the CMS public use plan network files. We then classified each plan-pharmacy pair as preferred by augmenting the CMS public use plan network files with an "empirical" networks file. The empirical networks file was created by analyzing the observed enrollee out-of-pocket cost for all claims for the initial coverage phase, for non-LIS beneficiaries, in fills that were for multiples of a 30-day supply, and that had a formulary tier assignment. We only analyzed "informative" claims where network status could potentially be detected (i.e., if enrollee out-of-pocket cost equaled total retail cost, we could not infer the cost-sharing being applied on that claim). For this subset of claims, we compared observed out-of-pocket costs to the copays/coinsurances for preferred and non-preferred retail pharmacies as stipulated in the beneficiary cost files. We generated two "preferred" flags: (1) an indicator for the plan-pharmacy being flagged as preferred more often than not, and (2) a more conservative indicator that (a) there were at least 25 informative claims for the plan-pharmacy, (b) the plan-pharmacy had at least 5 "preferred" claims, and (c) the plan-pharmacy matched as "preferred" for at least 5 more claims than as "non-preferred." To combine the empirical and public use network files, we prioritized the more conservative empirical networks "preferred" flag, then the less conservative empirical networks "preferred" flag, then the public use flag. This approach appears to be highly successful: where we have both empirical and public use network observations, they are consistent 99 percent of the time. Finally, we combine observations across pharmacies in the same chains to generate a "preferred" flag for each plan-chain: preferred status is consistent across pharmacy within plan-chain 99 percent of the time.

[13]"% Preferred" combines preferred network generosity within preferred-network plans, with overall network generosity within non-preferred-network plans. I.e., for plans without preferred networks, all pharmacies in the retail network are considered preferred.

implies significant growth in the prevalence of restrictive-network plans with fewer than 50 percent of local pharmacies preferred. The next row shows that the prevalence of restrictive networks grew from 22 percent in 2011 to 76 percent in 2014. A plan can have a restrictive preferred network either if it has a restrictive overall network (whether it relies on preferred pharmacy contracting or not) or if it only has a restrictive *preferred* network – 60 percent of preferred networks were restrictive in 2011, versus 99 percent in 2014. By contrast, Table 1 shows that the prevalence of complete exclusion is consistent over time and rare for chain pharmacies.

For our empirical analyses, it is important to consider whether preferred pharmacy contracting interacts with other important savings levers in this setting. One could be concerned that other supply- or demand-side savings levers are either complementary or substitutable with preferred pharmacy contracting. The most prominent of these in the pharmacy space is mail-order: more than 90 percent of the plan-years in our sample offer some mail-order coverage. In fact, whereas preferred treatment of retail pharmacies is a new phenomenon during the years we consider in this paper, preferred treatment of mail-order pharmacies is common even at the beginning of our study: 55 percent of plans in our sample had preferred mail-order networks in 2011.

Two facts reassure us that plan reliance on mail order should not be a large source of bias in this paper. First, utilization of mail-order pharmacies is fairly low in our sample: about 6.9 percent of claims in our sample were at pharmacies whose primary dispenser type was a mail-order pharmacy. This is higher than Ketcham & Simon (2008)'s mail-order fill rate of 2.1 percent in a near-elderly, commercially-insured population, but lower than Carroll (2014)'s mail-order fill rate of 7.8 percent in a 5 percent subsample of Part D claims for the top 300 drugs. Second, in contrast to the steep uptick in reliance on preferred retail networks we document above, we see little change in mail-order contracting over the same period. The rate of mail-order coverage declined very slightly from 2011-2014, from 93 percent to 91 percent; the rate of preferred mail-order contracting declined more, from 55 percent in 2011 to 43 percent in 2014.

A natural question that arises is why plans began relying heavily on preferred pharmacy contracting only after 2011. A complete answer to this question is outside the scope of this paper, but we note several factors that may have been influential. First, early preferred pharmacy networks involved plan-pharmacy co-branding arrangements (e.g., The Humana Walmart-Preferred Rx Plan, introduced in 2011 (Snook & Filipek (2011), Hoadley et al. (2015))). Second, Walgreens was involved in high-profile conflicts with CVS Caremark in 2010 and Express Scripts in 2012; the former resulted in Walgreens threatening publicly not

Table 1: Plan Summary Statistics

	2011	2012	2013	2014	Total
1{Preferred-Network Plan}	0.130	0.203	0.412	0.701	0.361
% In-Network (All)	0.679	0.698	0.702	0.671	0.687
	(0.172)	(0.164)	(0.162)	(0.180)	(0.170)
% In-Network (Chains)	0.918	0.934	0.937	0.910	0.924
	(0.139)	(0.130)	(0.130)	(0.162)	(0.142)
% In-Network (Independents)	0.278	0.297	0.300	0.266	0.285
	(0.269)	(0.268)	(0.265)	(0.266)	(0.285)
% Preferred	0.633	0.623	0.505	0.351	0.528
	(0.229)	(0.249)	(0.266)	(0.236)	(0.271)
% Preferred (Chains)	0.857	0.837	0.698	0.511	0.726
	(0.247)	(0.280)	(0.318)	(0.294)	(0.317)
% Preferred (Independents)	0.258	0.261	0.181	0.088	0.197
	(0.271)	(0.272)	(0.240)	(0.189)	(0.256)
1{<50% Preferred}	0.218	0.214	0.453	0.756	0.410
% LIS	0.195	0.200	0.190	0.173	0.190
	(0.141)	(0.148)	(0.141)	(0.129)	(0.140)
Non-LIS Beneficiaries Avg. Spend	2,337	2,374	2,468	2,597	2,443
	(1,093)	(1,164)	(2,035)	(1,633)	(1,516)
Non-LIS Beneficiaries Avg. Days Supply	1,400	1,480	1,540	1,564	1,494
	(383)	(387)	(432)	(477)	(426)
LIS Beneficiaries Avg. Spend	4,980	5,034	5,167	5,566	5,185
	(3,020)	(2,562)	(2,977)	(4,724)	(3,438)
LIS Beneficiaries Avg. Days Supply	1,719	1,809	1,896	1,831	1,810
	(508)	(469)	(500)	(523)	(504)

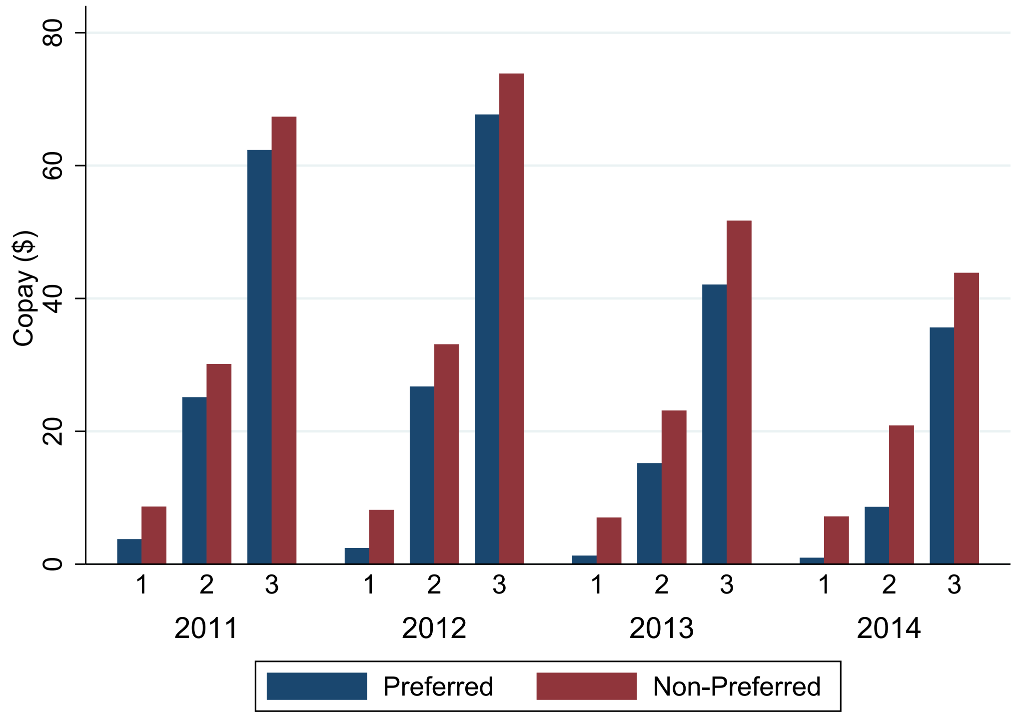
Notes: Top panel: plan-year-level statistics on preferred pharmacy contracting and low-income subsidy beneficiary coverage. N=4,186 across 2011-2014. Bottom panel: individual-year level statistics on non-LIS (N=2,927,807) and LIS (N=2,405,851) beneficiary-years. The "% Preferred" variable is calculated as the ratio of the count of preferred pharmacies in the plan's PDP region to the count of pharmacies in the same PDP region across all sample plans' overall pharmacy networks. LIS beneficiaries identified as those with any low-income cost-sharing subsidies in the prescription drug event data.

to participate in Caremark networks and the latter resulted in removal of Walgreens from Express Scripts' networks for most of 2012. During these short-term contracting disputes, the PBMs may have observed that dramatically reducing the sizes of their retail pharmacy networks had little impact on beneficiary enrollment or satisfaction (Casey (2013)). To provide more granular detail on this phenomenon, Table A.5 in the Appendix displays transition matrices regarding several large (anonymous) retail chains' preferred status across all plans in 2012-2013. While chains C and D were preferred in over half of preferred-network plans in 2013, chain A was preferred in only 38 percent of plans and chain B in only 5 percent of plans. Preferred network status is fairly stable within plans across years, though there are notable exceptions. For example, chain A was dropped from 7 percent of preferred networks between 2012 and 2013, while chain C was added to 6 percent of preferred networks in the same time frame.

Given the comprehensiveness of overall pharmacy networks and the relative sparsity of preferred pharmacy networks, we next characterize the trade-off facing enrollees in choosing to visit preferred vs. non-preferred pharmacies. Figure 1 summarizes the differences between preferred and non-preferred pharmacy copays for a 30-day supply in the initial coverage phase of Part D plans' benefit structure, by year and formulary tier. We focus on copays for drugs on tiers one through three of Part D plan formularies, as preferred cost-sharing is rarely used for higher drug formulary tiers. Copays are far more frequently used than coinsurances to structure cost-sharing on tiers one through three. Appendix Table A.4 summarizes preferred and non-preferred copays and coinsurances in the initial coverage phase across all preferred-network plans.[14] As expected, Figure 1 shows that copays increase in formulary tier within each year, as drugs become less and less preferred on plans' formularies – the average tier one (three) preferred pharmacy copay was \$1 (\$43) over this time period. Second, the absolute differences in copays across preferred and non-preferred pharmacies were relatively flat across formulary tier, equaling \$6 for tier one drugs and \$8 for tier three drugs in the average plan-year. Accordingly, relative copay differentials were often largest for tier one drugs, which are typically preferred generics. At an extreme, copays for tier one fills for preferred pharmacies were \$0 for 36 percent of preferred-network plan-years, implying that the non-preferred pharmacy copays for tier one fills were infinitely higher. While price differences of \$6 or \$8 may seem small, and while enrollees spend only part of the year in the initial coverage range portion of the prescription drug benefit (where copay differences most often apply), these differences would nevertheless add up. There is an average OOP price

[14]High drug tiers are generally reserved for particularly expensive branded drugs, implying that copay differentials in the ranges we observe for tiers one through three would be quite small, relative to mean price, if they were applied to higher tiers.

Figure 1: Copays by Formulary Tier and Preferred Status



Notes: Mean copays across plans within each year and drug formulary tier, preferred-network plans only. Copays reported for one-month supplies, retail fills, initial coverage phase.

differential between preferred and non-preferred pharmacies of 8.1 cents per day supply for tier one drugs in preferred-network plans in 2014, after accounting for deductibles, donut holes, and catastrophic phases. The average non-LIS enrollee fills 1,494 days supply per year in our data, so this $2.43 price differential per 30-day supply would sum to about $121 over the course of the year. The differentials are larger for drugs on tiers two ($4.44) and three ($4.26) are much higher, so this is a lower bound on the average steering incentive over the course of the year.

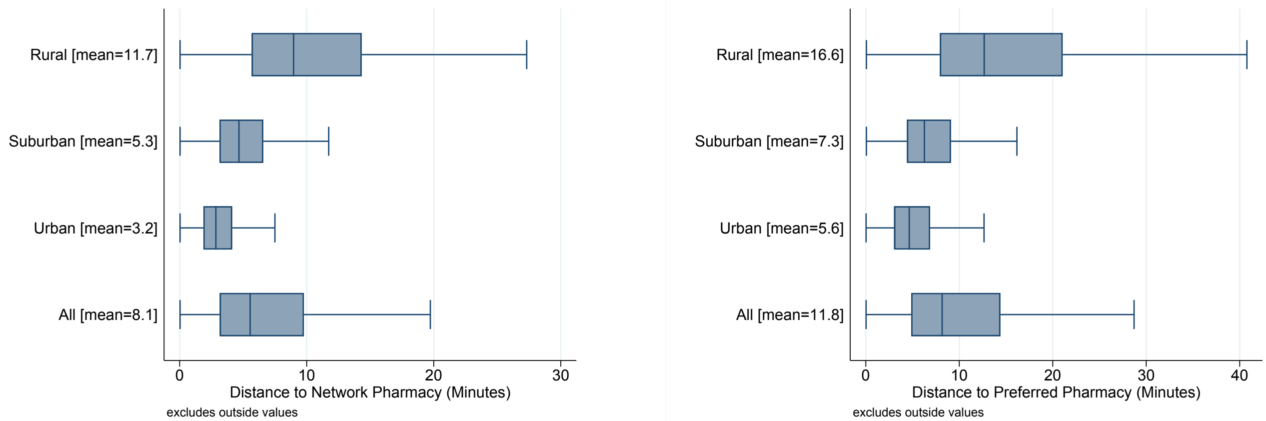
It is notable that these average preferred-network copay differentials would typically only be relevant for LIS beneficiaries for tier one generic drug fills: as noted above, LIS beneficiaries faced maximum copays of $2.55 and $6.35 in 2014 (and in a similar range in earlier years). For example, suppose the out-of-pocket price for a tier 2 preferred branded drug were $10 in a preferred pharmacy in a 2014 preferred-network plan, vs. $20 in a non-preferred pharmacy. In this case, a non-LIS beneficiary would pay $10 more out-of-pocket to go to a non-preferred pharmacy, while an LIS enrollee with income above 100 percent of the federal poverty level (FPL) would pay $6.35 at any retail pharmacy. The relevance of this issue to a particular plan will depend on that plan's coverage of LIS enrollees. Table 1 summarizes plans' coverage of LIS beneficiaries in our data. We construct the "% LIS" variable as the percentage of the plan's total drug bill paid for by the federal government in the form of cost-sharing subsidies for low-income beneficiaries. While the average coverage of LIS beneficiaries is stable at around 17 to 20 percent of drug spending, this conceals considerable variation. Appendix Figure A.3 shows that the distribution of this variable is bimodal; there are a set of plans with very few enrollees eligible for these subsidies, and plans for which LIS subsidies represent a major component (nearly 40 percent) of spending. LIS beneficiaries also have particularly high utilization: Table 1 summarizes total prescription quantities and spending for non-LIS and LIS beneficiaries; on average, LIS beneficiaries spend more than twice as much as non-LIS beneficiaries on prescription drugs.

The above discussion establishes that, in preferred-network plans, non-LIS beneficiaries can save significantly by frequenting preferred pharmacies. The other side of the trade-off embodied in preferred pharmacy contracting is convenience: enrollees may have to drive longer to go to a preferred pharmacy and obtain co-pay savings. Figure 2 shows evidence of reduced access. Focusing on preferred-network plans in 2014, the first box plot in Figure 2 shows that the average Part D enrollee in a preferred-network plan has to travel 8.1 minutes to a network retail pharmacy; this distance is greatest for rural enrollees and lowest for urban enrollees, as expected. In contrast, the second box plot in Figure 2 shows that the average enrollee has to travel 11.8 minutes to a preferred retail pharmacy. The differential distance between a preferred pharmacy and an in-network pharmacy is plotted in the third box plot in Figure 2, showing that the average enrollee has to travel 3.7 minutes longer to a preferred pharmacy. Appendix Figure A.5 shows how access to preferred pharmacies varies across regions: in the PDP regions with the lowest average "% Preferred" within preferred-network plans, enrollees have to travel relatively farther than enrollees in regions with more comprehensive preferred networks.[15]

Perhaps more striking is that these averages conceal quite a bit of heterogeneity across plans and geography. More than 75 percent of Part D enrollees have to travel less than 5 minutes farther to go to a preferred pharmacy. Each of the averages above is driven upward by a heavy tail in which a small subset of enrollees have to travel 30 minutes or more to access a preferred pharmacy. There is more variation within than across regions: while the overall standard deviation of differential distance across enrollees is 7 minutes, Appendix Figure A.5 shows that weighted average differential distance to preferred pharmacies by region is almost

[15]In Appendix Figure A.5, both "Differential Distance to Preferred Pharmacy" and "% Preferred" are weighted averages across enrollees in preferred-network plans in 2014.

Figure 2: Distributions of Driving Distance to Network Pharmacies



Notes: Driving distances to nearest in-network and preferred retail pharmacies, respectively. Statistics are enrollment-weighted, for sample enrollees in preferred-network plans in 2014. Urban/suburban/rural flags for enrollee ZIP codes based on US Census data for 2010.

entirely in the range of 2-6 minutes in drive time. However, even with this heavy tail, it is clear that the vast majority of enrollees have convenient access to preferred pharmacies. This does not prove that enrollees have convenient access to "high-quality" preferred pharmacies that they would otherwise like to frequent; we will be able to shed light on this using the demand analysis in Section 4.

2.3 Preferred network contracting: mechanisms and predictions

Before turning to our reduced form results, we describe the literature on bargaining in bilateral oligopoly that motivates our empirical analysis. Within the health care context, many papers use empirical models based on Nash equilibrium solution concepts: Ho (2009) and Pakes et al. (2015) form inequality conditions that negotiated prices must satisfy, and numerous studies use the Nash equilibrium of simultaneous Nash bargains, or "Nash-in-Nash" (Gowrisankaran et al. (2015), Grennan (2013), Grennan & Swanson (2019), Ho & Lee (2017)). While the Nash-in-Nash framework illustrates how the threat of network exclusion allows purchasers to extract discounts from suppliers, it has difficulty rationalizing any exclusion of suppliers from equilibrium networks. Given this limitation, a new literature has recently emerged that both allows for equilibrium exclusion and demonstrates how restrictive networks can provide purchasers additional leverage to reduce negotiated prices (Ghili (2018), Ho & Lee (2018), Liebman (2018)). For example, Ho & Lee (2018) use a concept they term "Nash-in-Nash with Threat of Replacement," in which purchasers can threaten to replace suppliers with viable alternative suppliers that are outside the network, and use this threat to extract discounts. Accommodating (partial) exclusion is crucial in our setting, given how commonly we observe exclusion of pharmacies or entire chains from preferred networks.

Recent empirical evidence supports the notion that exclusion or partial exclusion can reduce insurer spending via price reductions (Gruber & McKnight (2016), Prager (2018)), and that advantageous selection into narrow network plans may also lead to lower expenditure (Shepard (2016)). By focusing on prescription drugs, we can document the relationship between preferred network contracting and prices within narrow, well-defined product categories. In doing so, we can separately examine the impacts of selection and prices on spending for a given plan. Furthermore, the impact of preferred network contracting depends on enrollees' preferences over preferred network breadth, and on enrollees' behavioral responses to preferred network design. The above models predict that plans with more restrictive preferred networks will have lower drug prices, both across and within pharmacies. However, as highlighted by Gowrisankaran et al. (2015), this relationship will only hold if enrollees are sensitive to out-of-pocket prices.[16] In our setting, LIS beneficiaries are unlikely to respond to preferred/non-preferred pharmacy copay differentials. Therefore, LIS enrollment will limit the cost savings available with preferred pharmacy networks. We begin by documenting the relationship between preferred network contracting and prices, and then test this prediction.

3 Reduced Form Analyses of Price Levels

In this Section, we test the two key empirical predictions outlined above. First, we estimate the effect of preferred pharmacy contracting on prices. Second, we examine heterogeneity in the effect to show that the presence of the low-income subsidy limits the savings associated with selective contracting.

3.1 Prices and preferred network contracting

We expect that selective pharmacy contracting will be associated with lower drug prices. In this Section, we examine the relationship between preferred network contracting and retail prices. We estimate specifications of the following type:

$$p_{djhq} = \alpha + \beta * N_{jy} + \mathbf{X}'_{djhq}\gamma + \varepsilon_{djhq}.$$

[16]Gowrisankaran et al. (2015) allow for this to be an important factor in analyzing how enrollees' response to coinsurance affects negotiated prices. Prager (2018) considers steering of a form more similar to ours, and explores how enrollees respond to tiered hospital networks.

We model drug prices at the plan-quarter-pharmacy-NDC level. Here, d denotes NDC, j denotes plan, h denotes pharmacy, and q denotes quarter, and all specifications include quarter-by-region fixed effects. Let N_{jy} denote our measure of preferred network contracting. Our coefficient of interest is β, which represents our estimate of the impact of preferred network contracting on negotiated prices. We primarily operationalize N_{jy} as a dummy for whether or not the plan utilizes a preferred network. In alternative specifications, we use the percent of local Part D-contracting pharmacies included in the preferred network, a dummy for fewer than 50 percent of local Part D-contracting pharmacies being included in the preferred network, and a dummy for the top quartile of the network breadth distribution (as measured by percent preferred).[17] In $\mathbf{X}_{djhq}$, we include a rich set of fixed effects to isolate the impact of preferred pharmacy contracting on price: for example, our richest specification includes fixed effects for quarter-region pair (e.g., Texas in the fourth quarter of 2012), plan (e.g., Humana Enhanced PDP offered in Texas), NDC (e.g., 40 mg of Lipitor), and contract-pharmacy chain pair (e.g., Humana-Walgreens).[18]

Table 2 presents the results of the regression described above. In this Table, each coefficient shown is the result of a separate regression of price per day supplied on a particular sample (Panel A: All Drugs; versus Panel B: Generic Drugs only), with a particular set of fixed effects (across columns), and with a different right-hand-side variable (N_{jy}) (across sets of rows within each panel). Below each coefficient estimate, we report the standard error in parentheses. Below the standard error, we report the coefficient normalized by the mean price per day supplied in the regression sample. All regressions weight each plan-quarter-pharmacy-NDC observation by days supply.

First, we focus on the top row in each panel, in which the independent variable is a dummy for whether the plan utilizes a preferred network. Column (1) shows that negotiated prices are 59 cents lower per day supplied in preferred-network plans (26 percent of the mean; results are similar for generics only, as shown in Panel B). However, column (1) controls only for quarter-by-region fixed effects: it does not account for the potential that plans with more restrictive pharmacy networks may have different actuarial value, may send enrollees to different pharmacies, or may attract healthier enrollees who take cheaper drugs.

To address selection concerns, column (2) includes plan fixed effects; we are now effectively estimating a differences-in-differences regression examining the association between preferred network status and prices within a plan over time, and controlling for secular trends in (regional) drug prices. The coefficient falls

[17] For reference, the first three of these four measures are summarized in Table 1.

[18] We will generally use the terms "insurer," "contract," and "issuer" interchangeably when referring to firms like Humana or United.

Table 2: Correlation between Preferred Pharmacy Contracting and Retail Prices

Dependent Variable: Retail Price / Days Supply					
	(1)	(2)	(3)	(4)	(5)
Panel A: All Drugs					
1{Preferred-Network Plan}	-0.588***	-0.158***	-0.0510***	-0.0434***	-0.0422***
	(0.0375)	(0.0127)	(0.00790)	(0.00778)	(0.00778)
	-0.263	*-0.071*	*-0.023*	*-0.019*	*-0.019*
% Preferred	0.795***	0.239***	0.113***	0.101***	0.0975***
	(0.0637)	(0.0197)	(0.0115)	(0.0114)	(0.0116)
	0.355	*0.107*	*0.050*	*0.045*	*0.044*
Panel B: Generic Drugs					
1{Preferred-Network Plan}	-0.178***	-0.0572***	-0.0307***	-0.0268***	-0.0271***
	(0.0124)	(0.00609)	(0.00523)	(0.00523)	(0.00506)
	-0.268	*-0.086*	*-0.046*	*-0.040*	*-0.041*
% Preferred	0.226***	0.0989***	0.0547***	0.0494***	0.0480***
	(0.0220)	(0.00924)	(0.00794)	(0.00797)	(0.00771)
	0.341	*0.149*	*0.082*	*0.074*	*0.072*
Quarter-Region FE	Yes	Yes	Yes	Yes	Yes
Plan FE	No	Yes	Yes	Yes	Yes
NDC FE	No	No	Yes	Yes	Yes
Pharmacy Chain FE	No	No	No	Yes	Yes
Contract-Pharmacy Chain FE	No	No	No	No	Yes

Notes: Each coefficient is estimated $\hat{\beta}$ from a separate regression of p_{djhq} on the relevant preferred pharmacy contracting variable for the row (1{Preferred-Network Plan} or % Preferred), for a given sample (All Drugs [N=131,091,890] or Generic Drugs Only [N=100,115,691]) and fixed effects specification. Quarter-by-PDP Region, NDC, Plan, and Contract-by-Pharmacy Chain fixed effects are included in the richest specification. Standard errors clustered by plan are reported in parentheses. In italics below each coefficient and standard error, we normalize the coefficient estimates by dividing through by the weighted average retail price per day supply for the regression sample: $\bar{p} = 2.238$ across all drugs and $\bar{p}$ =0.663 for generic drugs.

substantially – within plan, years with preferred networks entail retail drug prices of 16 cents less per day supplied (or 7.1 percent of the mean). For the same specification estimated only within generic drugs, the coefficient estimate implies that preferred-network plans pay 5.7 cents less per day supplied (or 8.6 percent of the mean). Of course, plans that adopt preferred networks could attract different enrollees, with different drug needs. To investigate this issue, column (3) adds NDC fixed effects, so that we now examine the association between preferred network contracting and pricing for a narrowly-defined product. The coefficient again falls dramatically, implying that preferred network status is associated with prices that are 5.1 cents lower per day supplied (2.3 percent), for the same exact drug.[19]

We next turn to the role of steering across pharmacies; i.e. by examining the extent to which the above results are solely driven by preferred-network plans sending enrollees to cheaper pharmacies using differential copays. Column (4) adds pharmacy chain fixed effects, so that we are now examining the association between preferred network status and prices within a plan at a given pharmacy chain over time. The coefficient is slightly smaller than that without pharmacy chain fixed effects: preferred-network plans pay 4.3 cents less per day supplied (1.9 percent).[20] Results are similar if we go further to control for the bargaining pair: column (5) includes contract-pharmacy chain fixed effects and estimates are nearly identical. Comparing the results in column (5) to those in column (3), we see that the effect of preferred network contracting on prices within bargaining pair (-0.0422) is 83 percent of the effect within plan (-0.0510). We find it reassuring that the patterns of estimated coefficients documented above are similar for the full sample of drugs, and within generic drugs only. This suggests that unobserved manufacturer rebates are not a significant source of bias in these regressions.

The second set of rows in each panel of Table 2, and the results in Appendix Table A.6, present variations on this result in both absolute and relative terms, leveraging variation in the comprehensiveness of preferred networks as well as the decision to adopt preferred networks. Focusing on the top panel (All Drugs), in the second set of rows, we show that plans with higher percentages of local pharmacies in their preferred networks pay higher prices per day supplied.[21] In the first set of rows in Appendix Table A.6, we estimate

[19] The analogous estimate is 3.1 cents per day supplied, or 4.6 percent, within generics.

[20] Our results are also similar if we include richer pharmacy- and drug-specific trends. For example, the coefficient on "% Preferred" in panel A, column (4) of Table 3 is 0.101. If we add pharmacy chain-by-year fixed effects to this specification, the coefficient on "% Preferred" is 0.099. If we also add NDC-by-quarter fixed effects to the specification, the coefficient on "% Preferred" is 0.076. All of these estimates are statistically significant at the 1% level.

[21] The standard deviation of "% Preferred" in our sample is 27.1 percentage points; therefore, the estimated coefficient of 0.0975 in our richest specification implies that a one standard deviation increase in "% Preferred" is associated with a 2.6 cent increase in price per day supplied.

that plans with "restrictive networks," defined as those covering less than 50 percent of local pharmacies, have 2.6 percent lower prices, conditional on NDC, plan, and pharmacy chain fixed effects.[22] The second set of rows in Appendix Table A.6 shows that plans in the top 25 percent of plans in terms of network coverage *within a given year* (82 percent of local pharmacies covered on average in 2011-2014, and 71 percent in 2014 alone) negotiate 2.2 percent higher prices than plans in the bottom 75 percent. Panel B shows that the results are quite similar when we restrict attention to generic drugs.

The above results indicate that, by any measure of selective pharmacy contracting, plans with more restrictive preferred networks pay lower prices. However, they do not shed light on the relative contributions of overall network size and preferred network size.[23] In Table 3, we estimate a specification that regresses prices simultaneously on "% Preferred" and "% In-Network," where "% In-Network" is the share of local Part D-contracting pharmacies in a plan's overall network, as in Table 1:

$$p_{djhq} = \alpha + \beta^{Pref} * \{\%Preferred\}_{jy} + \beta^{In-Net} * \{\%In-Network\}_{jy} + \mathbf{X}'_{djhq}\gamma + \varepsilon_{djhq}.$$

Naturally, preferred-network plans tend to have small preferred networks – the mean of "% Preferred" is 26 percent in preferred-network plans, vs. 68 percent in non-preferred-network plans. However, preferred pharmacy contracting is not associated with restrictive *overall* networks – the mean of "% In-Network" is 70 percent in preferred-network plans, vs. 68 percent in non-preferred-network plans. As shown in Table 3, higher values of "% Preferred" and higher values of "% In-Network" are each independently associated with higher retail prices. With the inclusion of "% In-Network" in the regression, the coefficient on "% Preferred" falls slightly, from 0.0975 in column (5) of Table 2 to 0.0764 in column (5) of Table 3.[24] The coefficient on "% In-Network" in Table 3 is large and positive: the richest specification has a coefficient of 0.457 for all drugs, and 0.272 for generics only. However, as noted in Section 2.2, there is much more variation in preferred network contracting in the panel than there is in overall network contracting. Whereas we observe a dramatic transition from standard pharmacy networks to preferred networks between 2011 and 2014, overall networks were fairly stable. To summarize these results, the standard deviations of the *residual* variation in "% Preferred" and "% In-Network" in our richest specifications are 0.1554 and 0.0215, respectively.

[22] To put this in perspective, recall that 41 percent of plans covered less than 50 percent of local pharmacies in 2011-2014 overall, versus 76 percent in 2014.

[23] E.g., 89 percent of preferred-network plans cover less than 50 percent of local pharmacies.

[24] The analogous comparison for generic drugs only is 0.0480 in Table 2, vs. 0.0360 in Table 3.

Table 3: Correlation between Generosity of Preferred and Overall Networks, and Retail Prices

Dependent Variable: Retail Price / Days Supply					
	(1)	(2)	(3)	(4)	(5)
Panel A: All Drugs					
% Preferred	0.778***	0.226***	0.0900***	0.0802***	0.0764***
	(0.0617)	(0.0196)	(0.0107)	(0.0107)	(0.0107)
	0.346	*0.101*	*0.040*	*0.036*	*0.034*
% In-Network	0.144	0.284	0.478***	0.437***	0.457***
	(0.155)	(0.193)	(0.0881)	(0.0884)	(0.0878)
	0.064	*0.126*	*0.213*	*0.194*	*0.203*
Panel B: Generic Drugs					
% Preferred	0.257***	0.0794***	0.0402***	0.0366***	0.0360***
	(0.0225)	(0.00876)	(0.00798)	(0.00797)	(0.00774)
	0.384	*0.119*	*0.060*	*0.055*	*0.054*
% In-Network	-0.260***	0.428***	0.319***	0.282***	0.272***
	(0.0451)	(0.0638)	(0.0594)	(0.0598)	(0.0590)
	-0.389	*0.640*	*0.477*	*0.422*	*0.407*
Quarter-Region FE	Yes	Yes	Yes	Yes	Yes
Plan FE	No	Yes	Yes	Yes	Yes
NDC FE	No	No	Yes	Yes	Yes
Pharmacy Chain FE	No	No	No	Yes	Yes
Contract-Pharmacy Chain FE	No	No	No	No	Yes

Notes: Each panel presents estimates of $\hat{\beta}^{Pref}$ and $\hat{\beta}^{In-Net}$ from a separate regression of p_{djhq} on % Preferred and % In-Network for a given sample (All Drugs [N=131,091,890] or Generic Drugs Only [N=100,115,691]) and fixed effects specification (Quarter-Region, NDC, Plan, and Contract-Pharmacy Chain fixed effects are included in the richest specification). Standard errors clustered by plan are reported in parentheses. The coefficient estimates normalized by the mean retail price per day supply for the relevant sample ($\bar{p} = 2.248$ for all drugs; $\bar{p} = 0.6689$ for generics only) are shown in italics.

Controlling for time trends and time-invariant variation in prices by bargaining pair, we find that a (residual) standard deviation increase in "% Preferred" is associated with 1.2 percent higher prices, and a (residual) standard deviation increase in "% In-Network" is associated with 0.98 percent higher prices. While we focus on the "% Preferred" estimates in this paper, the "% In-Network" estimates are quite interesting, as they suggest that total exclusion of pharmacies from Part D networks may yield savings (consistent with Ghili (2018), Ho & Lee (2018), Liebman (2018)). The limited variation in overall network size in our data may be due to network adequacy regulations, and we consider this an important issue for future research.

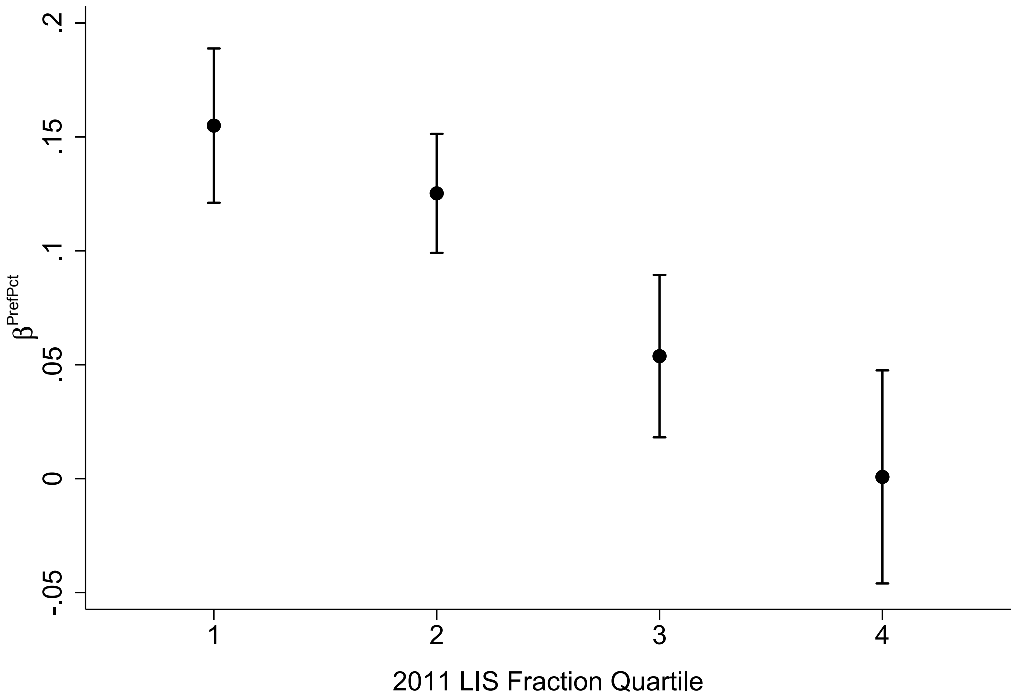
3.1.1 Prices and steering

The above analyses indicate that plans with larger preferred networks pay significantly higher prices. Moreover, the comparison of these results with and without pharmacy chain (or bargaining pair) fixed effects suggests that savings from preferred pharmacy contracting are driven in part by reductions in negotiated prices, and cannot be entirely explained by steering to ex ante cheaper pharmacies. Of course, as noted in Section 2.3, the "steering" and "bargaining" mechanisms are entangled. Theory suggests that plans' ability to extract discounts from pharmacies upon adopting preferred networks will depend on their ability to steer enrollees to preferred pharmacies. We now further explore steering by estimating how our results depend on the interaction between preferred networks and enrollment of low-income subsidy beneficiaries. For the most part, due to their cost-sharing subsidies, LIS beneficiaries do not face the differential cost sharing that is a key feature of preferred-network plans. In the following specifications, we interact "% Preferred" with dummies for each quartile of "% LIS," constructed as in Table 1. Because LIS enrollment can vary over time within a plan, these specifications also include uninteracted controls for LIS quartile. If the ability to steer enrollees to low cost pharmacies matters, we predict that the effects of preferred pharmacy contracting will be strongest in the first quartile, with the lowest percentage of LIS beneficiaries (average "% LIS" is 6 percent), and weakest in the fourth quartile, with the highest percentage of LIS beneficiaries (average "% LIS" is 40 percent).[25] The complete results are in Appendix Table A.7. Here we summarize the results, focusing on the continuous "% Preferred" measure of preferred network contracting. In the richest specifications (columns (3)-(5)) that control for quarter-region, plan, and NDC fixed effects, the effect of a 10 percentage point increase in "% Preferred" is 1.2-1.4 cents per day supply (0.7-0.8 percent of the mean) for the 1st quartile of LIS enrollment. Put another way, a standard deviation increase in "% Preferred" is associated with 3.3-3.7 cent higher prices per day supply (1.9-2.1 percent of the mean) for the 1st quartile of LIS enrollment. In contrast, this association is 0 cents per day supply for the 4th quartile. Results are similar with and without pharmacy fixed effects, and with and without bargaining pair fixed effects.

One concern we may have with these analyses is that plan enrollment and characteristics are jointly determined over time. For example, preferred-network plans may attract a different pool of LIS beneficiaries than non-preferred-network plans. The ideal experiment to explore the impact of steering would be to randomly vary consumer types holding the supply side fixed. We note that preferred-network plans were virtually non-existent in 2011. To address this concern, we also present results in which we classify plans based on 2011 "% LIS." The argument behind this strategy is that, as noted by Ericson (2014) and Ho et al. (2017), there is a high degree of inertia in Part D plan enrollment. Thus, past LIS share is a very

[25] We specify "% LIS" in terms of the "subsidized spending" rate so that this variable captures how important LIS beneficiaries' consumption is to overall spending. For the average plan in the bottom quartile of "% LIS," 4 percent of beneficiaries receive at least some cost-sharing subsidies. The analogous statistic for plans in the top quartile of "% LIS" is 90 percent.

Figure 3: Effect of "% Preferred" by LIS Quartile



Notes: Coefficients estimated from a regression of p_{djhq} on "% Preferred," alone and interacted with indicators for the $2^{nd} - 4^{th}$ quartiles of "% LIS," controlling for Quarter-Year-Region, NDC, Plan, and Contract-Pharmacy Chain fixed effects. "% LIS" is calculated for each plan in 2011. Figure reports the total effect for each quartile, with 95% confidence intervals based on plan-clustered standard errors.

good predictor of current LIS share, but is driven by pre-existing features of plans that do not change contemporaneously with adoption of preferred networks.

With this approach, we find similar results. The estimates by quartile for the richest specification Appendix Table A.7 (column (5)) are plotted in Figure 3. As predicted, "% Preferred" has the largest coefficient (a standard deviation of "% Preferred" is associated with a 4.2 cent increase per day supplied) in plans with virtually no LIS beneficiaries. By contrast, in the top quartile, there is no relationship between preferred pharmacy network breadth and point-of-sale prices.

3.1.2 Robustness and discussion

Taken together, the above regressions consistently find that preferred network contracting is associated with reduced point-of-sale prices. These findings are driven by changes in prices, within plan, when the plan adopts preferred networks, or alternatively restricts the size of its preferred network. The results are robust to a number of modeling decisions. First, each of the results above uses controls for a narrowly-defined product – the NDC code. To the extent that different pharmacy chains differ in their stocking of precise NDCs for a given molecule, these controls may limit the identifying variation available to identify the effects of preferred pharmacy contracting. In column (2) of Appendix Table A.8, we use a weaker drug designation and instead control for drugs' brand and generic names.[26] As shown in Appendix Table A.8, this increases the magnitude of the 1{Preferred-Network Plan} coefficient slightly, from -0.0422 to -0.0469, indicating that our fine controls for drug composition have a small attenuating effect on the estimated coefficient on preferred pharmacy contracting.

We also performed several analyses to address the presence of outlier prices. As noted in Section 2.2 and discussed in detail in Appendix B, the distributions of drug prices are quite heavy-tailed. While the inclusion of NDC fixed effects will alleviate this problem to a great extent, we also estimate a specification in which we trim the price distribution. Column (3) of Appendix Table A.8 shows results for the 1^{st} through 99^{th} percentiles of the price distribution; column (4) shows results for the 5^{th} through 95^{th} percentiles. In general, trimming the price distribution has no economically or statistically significant effect on these results. The stability of these results is all the more striking given that the mean of the price distribution changes dramatically after trimming. This suggests that savings obtained when plans adopt preferred pharmacy networks are applied per prescription fill, rather than scaling proportionally with drug prices.[27]

Each of the above results is consistent with our hypothesis that plans with more LIS beneficiaries have less ability to steer enrollees across pharmacies, and that prices are higher as a result. These reduced form results are credible but not conclusive. In particular, we offer them with the caveat that we consider a relatively short time horizon – 2011-2014, which is the key timeframe during which preferred networks proliferated in the Medicare Part D market – and this limits our ability to investigate differential pre-trends in retail prices in the lead-up to preferred network adoption, or to estimate rich dynamics in plans' prices after adopting preferred networks.

3.2 Other effects of preferred network contracting

In the following Section, we estimate a model of pharmacy demand and implicitly hold the beneficiary population and other plan characteristics fixed. In this Section, we examine the implications and limitations of this approach by estimating the association between preferred networks and other variables of interest.

[26] For example, there are many NDCs associated with the brand name "Lipitor" and generic name "atorvastatin calcium."

[27] It is also consistent with the point made in Section 2.2 above that copay differentials in preferred-network plans do not scale proportionally with drug prices.

Table 4: Correlation between Preferred Pharmacy Contracting and Other Outcomes

Dep. Var.:	(1)	(2)	Dep. Var.:	(1)	(2)
Days Supply	-49.25***	8.189*	Total Spending	-305.6***	-90.17***
	(6.529)	(4.756)		(31.22)	(24.59)
	-4%	*1%*		*-11%*	*-3%*
Monthly Premium	-2.309***	-2.356***	Drive Time	-0.0674**	0.0162
	(0.530)	(0.559)		(0.0276)	(0.0148)
	-6%	*-6%*		*-0.4%*	*0.1%*
Mail-Order %	-0.00274	-0.0127***	Generic Efficiency	0.00548***	0.00520***
	(0.00209)	(0.00221)		(0.000537)	(0.000592)
	-4%	*-20%*		*1%*	*1%*
Quarter-Region FE	Yes	Yes	Quarter-Region FE	Yes	Yes
Plan FE	Yes	Yes	Plan FE	Yes	Yes
Beneficiary FE	No	Yes	Beneficiary FE	No	Yes

Notes: N=5,342,284 beneficiary-years. Each coefficient is estimated $\hat{\beta}$ from a separate regression of y_{ijy} on 1{Preferred-Network Plan}, for the fixed effects specification noted. "Days Supply" ("Total Spending") is the sum of total days supplied (prescription costs) across all retail pharmacy claims within each beneficiary-year. "Drive Time" is the weighted average driving distance from the beneficiary's home ZIP to retail pharmacies, weighting by days supply. "Mail-Order %" is total prescription drug days supplied by mail-order pharmacies, divided by the total prescription drug days supplied by all pharmacies. "Generic Efficiency" is defined as in Dranove et al. (2017) to be total prescription drug days supplied for generic drugs, divided by total days supplied for drugs with a generic equivalent. Monthly premium and generic efficiency are plan-year-level variables. Standard errors clustered by plan reported in parentheses. The coefficient estimates normalized by the mean of the dependent variable (and displayed in percentage terms) are shown in italics.

Here, we again explore the implications of preferred network contracting, but with a focus on several annual plan- or patient-level outcomes. Table 4 presents estimates from regression specifications of the following form:

$$y_{ijy} = \alpha + \beta * N_{jy} + \mathbf{X}'_{ijy}\gamma + \varepsilon_{ijy},$$

where i indexes beneficiary and y indexes year. In Table 4, results are shown for six outcome variables: from left to right, top to bottom, we show results for total annual days supplied, total annual spending, monthly premium, average driving distance per prescription fill, the percentage of claims filled at mail-order pharmacies, and average generic efficiency.[28] For each outcome variable, the Table indicates the coefficient estimate with plan and region-year fixed effects (column (1)) and with beneficiary, plan, and region-year fixed effects (column (2)). Below each estimate, standard errors are indicated in parentheses, followed by the coefficient normalized by the dependent variable mean.

The top panel (total days supply and total spending) examines extensive margin effects and selection.

[28]In these specifications, we analyze data at the beneficiary-year level, for all enrollees in the 4,186 standalone PDP, non-employer-group plan-years summarized in Table 1.

Within plan, we observe that adoption of preferred pharmacy networks is associated with a decline in total quantity per enrollee-year of 49 days supplied, or 4 percent at the mean, and with a decline in total spending of \$306, or 11 percent at the mean. However, when we add beneficiary fixed effects to the specification, we find that adoption of preferred networks is associated with a marginally significant 8 days supply (0.6 percent) increase in consumption per enrollee-year, and only a \$90 decline in total spending (3 percent). This leads us to three observations. First, within a given beneficiary, there is no economically meaningful extensive margin effect of preferred networks on consumption, and the sign of the point estimate is the opposite of what we would expect if preferred networks led elderly enrollees to forego filling their prescriptions. Second, the comparison of columns (1) and (2) for each of these variables confirms that adoption of preferred pharmacy networks is associated with more advantageous selection of enrollees into Part D plans. Third, given the lack of a meaningful quantity effect, the estimated 3 percent savings on drug costs we document for preferred-network plans, after accounting for advantageous selection, is primarily accounted for by the price effects documented in Table 2.

The middle panel of Table 4 examines two variables of primary interest to enrollees: premiums and (realized) driving distance. Within plan and within beneficiary, premiums are about \$2.30 (6 percent) lower when plans use preferred networks. This translates to \$28 in premium savings per year. Within plan, preferred network contracting is associated with a statistically significant 0.07 minute decline in drive time; the effect essentially goes away when beneficiary fixed effects are included, suggesting that the small negative coefficient in column (1) was driven by a change in the composition of enrollees. The average beneficiary does not appear to travel farther to fill her prescriptions when her plan adopts a preferred pharmacy network.

The bottom panel of Table 4 examines whether adoption of preferred networks appears to be contemporaneous with changes in plans' use of other levers intended to reduce costs. For example, plans vary in the relative copays they set for retail vs. mail-order prescription drug fills, and in the relative copays they set for branded vs. generic drugs. Plans that impose large copay differentials along these margins may steer more enrollees to cheaper pharmacy settings and drugs, all else equal, and these types of initiatives may be complements or substitutes with preferred network contracting. To explore this issue, we estimate the association between preferred networks and "Mail-Order %" and "Generic Efficiency." In the left panel of the Table, we see that use of mail-order pharmacies goes down by 1 percentage point after adoption of preferred retail pharmacy networks, within beneficiary. This estimate is statistically significant, and is large relative to the already-low rate of mail-order utilization in this sample. However, it is small relative to the steering we document across preferred and non-preferred retail pharmacies in the pharmacy demand analyses below. Further, these results indicate that mail-order and preferred retail pharmacy contracting are, if anything, negatively correlated, suggesting that our estimate of the savings from preferred pharmacy contracting are a lower bound. Finally, we see that generic efficiency increases slightly when plans adopt preferred retail pharmacy networks, by 0.5 percentage points: this estimate is again statistically significant, but is small relative to the already-high generic efficiency observed within sample plans.

On balance, consistent with the results in Section 2.2, these results suggest that preferred network contracting has no meaningful effect on the average beneficiary's access to prescription drugs or to retail pharmacies. It is, however, associated with significantly lower premiums and drug costs, in part due to enrollment of healthier beneficiaries. In the following Section, we focus on savings due to preferred pharmacy contracting holding enrollment fixed. This implicitly assumes that price changes occurring when plans adopt preferred networks are attributable to the negotiation between plans and pharmacies, rather than to any other contemporaneous change in plans' strategies that impact costs.

4 Pharmacy Demand

The results in the previous Section show that preferred pharmacy contracting is associated with lower average prices paid. In this Section, we directly explore the interaction between preferred network contracting and enrollees' sensitivity to networks. We then go further to quantify the welfare trade-offs between cost and access. We measure consumer preferences over individual pharmacies, distance to physical pharmacy locations, and pharmacy-specific out-of-pocket prices. We also explore how heterogeneity in demand relates to steering ability by insurers. Specifically, we ask how much costs would increase if preferred networks were eliminated, and how this effect would vary by enrollee type. We will estimate modest but meaningful savings and quantify the welfare benefits and costs of restricting pharmacy access along multiple dimensions.

4.1 Pharmacy demand model

Our model of pharmacy demand builds on the approaches of Gowrisankaran et al. (2015), Ho & Lee (2017), among others. We suppose that, given exogenous drug consumption needs, heterogeneous enrollees choose a pharmacy to fill their prescriptions to maximize utility. Preferences are allowed to vary flexibly across drug and consumer type. We group individuals into types based on age (above or below age 75) and LIS status; we group drugs by formulary tier, and we separately analyze modal tiers 1, 2, and 3+.[29] A given individual can visit any in-network preferred or non-preferred pharmacy, but both out-of-pocket price and driving distance may vary across pharmacies. Each market is defined by a plan, quarter, ZIP code, enrollee type, and drug formulary tier.

We parameterize the utility of consumer of type i in ZIP z and region r, plan j, quarter-year qy filling their prescriptions at pharmacy h as:

$$u_{izjhqy} = \delta_{ijy} + \delta_{ihy} + \delta_{iqry} + \pi_{ijhqy}\beta^{c}_{l(i)} + dist_{zh}\beta^{d1}_{l(i)} + dist^{2}_{zh}\beta^{d2}_{l(i)} + \varepsilon_{ijhqy}.$$

The outside option in our preferred model is independent pharmacies, which are normalized to have a utility of zero. Thus, δ_{ijy} captures consumer preferences for chains vs. independent pharmacies among type-i enrollees in plan j, year y; δ_{ihy} is the average type-i enrollee's utility at chain pharmacy h in year y; and δ_{iqry} captures regional trends in substitution between chain vs. independent pharmacies for type-i enrollees. π_{ijhqy} captures how enrollees respond to preferred pharmacy contracting in choosing which pharmacies to frequent. In some specifications, π_{ijhqy} is parameterized as a dummy for pharmacy h being in plan j's preferred network in year y; in others, it is the expected out-of-pocket price for enrollee type i in plan-pharmacy combination jh in quarter q of year y. The variable $dist_{zh}$ represents travel distance (in minutes) from ZIP z to pharmacy h. ε_{ijhqy} is an idiosyncratic error term assumed to be i.i.d. Type 1 extreme value. The coefficients of interest – $\beta^{c}_{l(i)}$, $\beta^{d1}_{l(i)}$, and $\beta^{d2}_{l(i)}$ – are only allowed to vary by LIS status and drug tier in our preferred specifications; so we index them by $l(i)$. The first – $\beta^{c}_{l(i)}$ – is a separate "preferred" pharmacy or out-of-pocket price preference coefficient by LIS status and drug tier.[30] The second and third – $\beta^{d1}_{l(i)}$ and $\beta^{d2}_{l(i)}$ – are separate linear and quadratic distance preference coefficients by LIS status and drug tier.

This exercise focuses on steering between preferred and non-preferred pharmacies that are part of retail pharmacy chains. As noted in Section 2.2, the vast majority of independent pharmacies are non-preferred within plans that utilize preferred pharmacy networks; accordingly, within preferred network plans, only 10 percent of preferred pharmacy claims were filled at independent pharmacies. We explore robustness to our choice of outside option, as well as other modeling decisions, below.

[29]To avoid bias induced by any potential correlation between plans' allocation of particular drugs across formulary tiers, and their reliance on preferred pharmacy contracting, we assign each drug to the modal formulary tier it appeared on across all sample plans in each year. Hereafter, we simply refer to modal formulary tiers as "tiers."

[30]To be precise, the index i references, for a given consumption opportunity, the enrollee's age (above/below 75), interacted with enrollee's LIS status, interacted with modal drug tier. For brevity, we refer to this as enrollee type, but many enrollees consume in multiple drug tiers.

The model predicts pharmacy shares, which we aggregate to the enrollee type-ZIP-plan-quarter (market) level. In reality, enrollees may (and usually do) visit multiple pharmacies in a given quarter; aggregation across individuals within each market allows for this feature. Using an approach similar to that in Berry (1994), we estimate the following equation:

$$log\left(s_{izjhqy}\right) - log\left(s_{izj0qy}\right) = \delta_{ijy} + \delta_{ihy} + \delta_{iqry} + \pi_{ijhqy}\beta^{c}_{l(i)} + dist_{zh}\beta^{d1}_{l(i)} + dist^{2}_{zh}\beta^{d2}_{l(i)}.$$

Identification of preferences relies on variation in choice sets and preferred network coverage across markets. The preferred dummy and out-of-pocket price coefficients are identified using variation in networks/prices for the same pharmacies across plans, and are allowed to vary with enrollees' drug needs and LIS subsidy status. In our baseline specification, we assume that there is no correlation between enrollees' idiosyncratic preferences over particular local pharmacies (within enrollee/drug type) and their plan choices. We also estimate specifications in which we instrument for contemporaneous preferred network status using preferred network status of enrollees' lagged plans, using a similar approach to that employed in Abaluck & Gruber (2011) and Abaluck et al. (2017). This strategy addresses potential endogeneity due to selection: during the open enrollment period, enrollees may choose a plan based on the preferred network status of their favored local pharmacies for the upcoming year, but not based on anticipated *changes* in preferred status of those pharmacies in future years. As discussed below, the results are qualitatively similar.

4.2 Data and parameter estimates

The pharmacy demand sample, for the subset of markets (plan, quarter-year, 5-digit ZIP code, LIS status, age group, and drug formulary tier) with driving distance data and non-zero consumption of the outside option, is summarized in Table 5.[31] The average enrollee-year chose among 4 pharmacies in 3 retail chains. In the raw data, LIS beneficiaries are much less likely to enroll in preferred-network plans, and much less likely to choose preferred pharmacies: 51 percent of non-LIS enrollee-years were in preferred-network plans, vs. only 23 percent of LIS enrollee-years. Within preferred-network plans, 44 percent of non-LIS claims in retail chains went to preferred pharmacies, versus only 20 percent for LIS claims. LIS also have different drug needs: they purchase fewer tier 1 generic drugs (65 percent, vs. 70 percent for non-LIS beneficiaries),

[31] Compared to the full sample of 5.3 million enrollee-years in the analyses in Table 4, the 3 million enrollee-years in the preferred specification of the pharmacy demand analysis is a dramatic loss of sample. This is primarily driven by the use of 5-digit ZIP code to define "markets." As discussed regarding Appendix Table A.12 below, much less sample is lost if we use 3-digit ZIP code, but this distinction has little effect on the demand parameter estimates.

and more tier 3 drugs, which tend to be expensive branded drugs (15 percent, vs. 12 percent for non-LIS beneficiaries). That said, due to cost-sharing subsidies, LIS beneficiaries have much lower out-of-pocket prices for their prescription drugs: average out-of-pocket cost per day supply was 76 cents for non-LIS beneficiaries, versus 10 cents for LIS beneficiaries.[32]

Table 6 presents the demand parameters for the preferred specification, which includes plan-year-enrollee-type, pharmacy-year-enrollee type, and quarter-year-region-enrollee type fixed effects, and allows distance to enter with both a linear and a quadratic term. In Panel A, π_{ijhqy}=1{Preferred}$_{jhy}$, so we model enrollees' responses to pharmacies' categorical preferred status within their plans, rather than to out-of-pocket cost. Several interesting patterns emerge. First, preferred network status (the first row in each panel) has a strong positive effect on demand for all non-LIS beneficiaries. Second, LIS beneficiaries – who are not exposed to preferred network out-of-pocket price differentials, other than for tier 1 generic drugs – are only about a quarter as responsive. Third, consumers with and without LIS subsidies are less responsive to preferred status for high-formulary-tier, high-cost drugs (for which a $1 difference will be a smaller percentage of the total bill). All else equal, making all pharmacies preferred would increase non-preferred pharmacies' market share in preferred-network plans by 3.9 percentage points (or 9.5 percent) among non-LIS beneficiaries, versus 0.79 percentage points (or 1.3 percent) among LIS beneficiaries. We can also compare the "preferred" coefficients to enrollees' distaste for traveling far to fill their prescriptions – our estimates suggest that non-LIS beneficiaries in our sample were willing to travel an extra 8.6 minutes to reach a preferred pharmacy, vs. 2.1 minutes for LIS beneficiaries. Taken together, our estimates present a consistent picture of non-LIS

[32] We use the data to construct market-pharmacy-specific retail and out-of-pocket prices, which we use to estimate patient behavior. In our setting, most preferred-network plans use differential copays to steer enrollees from non-preferred to preferred pharmacies, but some plan-year-tier combinations employ coinsurance instead. Thus, a patient's out-of-pocket price for a given prescription fill will in general be a function of the drug's formulary tier, the quantity being filled, and the retail price. This introduces several potential problems. First, there is a classic simultaneity problem if preferred network contracting results in lower retail prices for preferred pharmacies. Second, in contrast to the price regressions in Section 3, the aggregated analysis we perform here cannot include NDC fixed effects, which creates the potential for bias due to correlation between unobserved patient sickness (which will tend to increase retail prices within drug tiers) and preferred pharmacy demand. Finally, ideally we want π_{ijhqy} to capture enrollees' expected out-of-pocket price, and it seems unreasonable to assume that each enrollee knows exact retail drug prices at each pharmacy, or how prices scale with days supply. Thus, we follow Gowrisankaran et al. (2015) to formulate an expected out-of-pocket price. We sample 1,000 random enrollees in each year-LIS status-age group, across all plans, and run each such enrollee's claims through the plan characteristics (formulary, deductible, donut hole) of each sample plan. Then, we define the expected out-of-pocket price as the average simulated out-of-pocket spending for the relevant LIS status-age group-modal formulary tier-plan-quarter, in preferred pharmacies ($OOPC_{ijqy}^{Pref}$) and non-preferred pharmacies ($OOPC_{ijqy}^{NonPref}$). When a plan-tier-year uses coinsurance instead of a copay, we use average retail price for the NDC across all claims for 30-day supplies in the given year. We use a linear spline with nine knots to simulate how retail price scales with days supply; the majority of claims are for 30-day supplies, and on average a 90-day supply costs about 2.5 times as much as a 30-day supply of the same drug. Finally, as we do not observe beneficiaries' incomes but can observe whether a given beneficiary receives any LIS subsidy, we apply the cost-sharing subsidy rules for non-institutionalized LIS beneficiaries with incomes over 100 percent of FPL. For a 10 percent sample of beneficiaries run through their own plans in this simulator, the correlation between observed *OOPC* and simulated *OOPC* is 0.96.

Table 5: Pharmacy Demand Sample

	Non-LIS Beneficiaries			LIS Beneficiaries			All Enrollees		
	Mean	Median	SD	Mean	Median	SD	Mean	Median	SD
N pharm. in choice set	4.09	3.00	3.35	3.57	2.66	2.94	3.82	2.85	3.16
N chains in choice set	2.93	2.60	1.78	2.38	2.00	1.35	2.64	2.20	1.60
Drive time (minutes)	14.73	10.89	12.25	14.10	10.50	11.70	14.40	10.69	11.97
All tiers: $OOPC/Day$	0.756	0.615	0.723	0.098	0.099	0.017	0.414	0.119	0.599
All tiers: % Preferred	0.556	0.596	0.307	0.445	0.442	0.302	0.498	0.515	0.309
All tiers: % Preferred | Preferred network	0.441	0.441	0.300	0.200	0.090	0.248	0.362	0.325	0.306
Tier 1: Quantity share	0.696	0.745	0.276	0.649	0.668	0.242	0.671	0.702	0.260
Tier 1: $OOPC/Day$	0.254	0.274	0.073	0.082	0.084	0.016	0.163	0.101	0.100
Tier 1: % Preferred	0.516	0.555	0.336	0.428	0.419	0.314	0.470	0.482	0.328
Tier 2: Quantity share	0.187	0.143	0.217	0.206	0.193	0.183	0.197	0.174	0.200
Tier 2: $OOPC/Day$	1.008	0.636	0.621	0.119	0.114	0.020	0.517	0.144	0.607
Tier 2: % Preferred	0.380	0.354	0.349	0.353	0.303	0.319	0.366	0.325	0.334
Tier 3: Quantity share	0.117	0.037	0.200	0.145	0.115	0.176	0.132	0.076	0.188
Tier 3: $OOPC/Day$	3.873	3.344	1.656	0.141	0.139	0.014	1.757	0.152	2.146
Tier 3: % Preferred	0.290	0.094	0.339	0.293	0.189	0.312	0.292	0.157	0.325
N enrollee-years		1,429,551			1,546,754			2,976,305	
N plans		1,409			1,313			1,448	
1{Preferred-Network Plan}		0.505			0.227			0.361	

Notes: Table reports summary statistics for enrollees in the full analytic sample of markets for which we estimate pharmacy demand in 2011-2014, excluding Alaska and Hawaii. Markets are defined as each unique combination of plan, quarter-year, 5-digit ZIP code, LIS status, age group, and drug formulary tier. Included markets must have both: valid driving distance measures for pharmacies in their choice sets, and a non-zero utilization share in the preferred specification's outside option of independent retail pharmacies. An enrollee's "choice set" is the full set of retail pharmacies visited by any enrollee in her market.

beneficiaries being substantially more responsive to preferred pharmacy status than LIS beneficiaries.

In Panel B, π_{ijhqy}=$OOPC_{ijhqy}$, so we model enrollees' response to out-of-pocket cost per day supply, which varies at the individual (type)-plan-pharmacy-quarter-year level. As with the results in Panel A, we present the coefficient on the variable of interest ($OOPC/Day$) and the distance terms. For the sake of comparison with the results in Panel A, we also present a normalized version of the $OOPC/Day$ coefficient, dividing through by the average $OOPC/Day$ differential between preferred and non-preferred pharmacies in preferred-network plans; thus, the 1{Preferred} coefficient in Panel A and the normalized $OOPC/Day$ coefficient in Panel B each capture how preferred network status impacts steering between preferred and non-preferred pharmacies. For both non-LIS and LIS beneficiaries, the coefficient on $OOPC/Day$ is always negative and significant. As before, for non-LIS beneficiaries, demand is less responsive to out-of-pocket price for higher tier drugs. While the coefficient estimates for LIS beneficiaries are much higher than for non-LIS beneficiaries, a more informative comparison is between the 1{Preferred} coefficient in Panel A and the normalized $OOPC/Day$ coefficient in Panel B. LIS beneficiaries are more price sensitive than non-LIS beneficiaries. However, $OOPC/Day$ (and the preferred/non-preferred $OOPC/Day$ differential) is much lower among LIS beneficiaries.[33][34] Therefore, the results in Panel A and Panel B are qualitatively similar: preferred network contracting steers non-LIS beneficiaries to preferred pharmacies, and moreso for cheaper drugs where the relative price differentials are larger.

In our preferred version of this specification, we instrument for $OOPC/Day_{ijhqy}$ with the average out-of-pocket cost per day for type i, quarter-year qy, and the preferred-network status of plan j combined with preferred status of pharmacy h in plan j; we implement using two-stage least squares (2SLS) rather than ordinary least squares. In so doing, we eliminate variation across plan-years in the relative copay differentials they use to distinguish preferred and non-preferred pharmacies. If we instead use all the variation in $OOPC/Day_{ijhqy}$ and estimate using ordinary least squares, we obtain the results in Appendix Table A.9. The lower estimated price sensitivity implied by the results in Appendix Table A.9 suggests that enrollees are less sensitive to variation in the preferred/non-preferred $OOPC/Day$ differential across preferred-network

[33] Still, the "preferred dummy" specification implies greater steering of enrollees in preferred-network plans – for example, an overall preferred dummy coefficient of 0.394 for non-LIS, vs. a normalized $OOPC/Day$ coefficient of 0.18. The difference is likely driven by the fact that $OOPC/Day$ varies across enrollees within type based on the composition of the drugs they tend to take, and across quarters within years based on which benefit phase the average enrollee is in.

[34] As noted in the notes to Table 6, the average $OOPC/Day$ differential per 30-day supply is about \$2.42-\$4.45 per 30-day supply. The fact that these differentials are smaller than the raw copay/coinsurance differentials in Figure 1 and Appendix Table A.4 reflects that the differences presented in Figure 1 and Appendix Table A.4 are not weighted by enrollment, and that many enrollees spend some portion of the year in coverage phases (e.g., the deductible) with no preferred/non-preferred cost-sharing distinctions.

Table 6: Pharmacy Demand Parameter Estimates by LIS Status and Tier

	Non-LIS				LIS			
	Tier				Tier			
	1	2	3	All	1	2	3	All
Panel A								
1{Preferred}	0.474***	0.328***	0.255***	0.394***	0.172***	0.0897***	0.0489***	0.118***
	(0.00637)	(0.00713)	(0.00947)	(0.00433)	(0.00662)	(0.00657)	(0.00711)	(0.00406)
Distance	-0.0526***	-0.0415***	-0.0439***	-0.0488***	-0.0651***	-0.0458***	-0.0417***	-0.0562***
	(0.000377)	(0.000530)	(0.000681)	(0.000280)	(0.000283)	(0.000349)	(0.000393)	(0.000194)
Distance^2	0.000389***	0.000324***	0.000363***	0.000369***	0.000528***	0.000359***	0.000337***	0.000452***
	(5.14e-06)	(7.36e-06)	(9.34e-06)	(3.84e-06)	(3.85e-06)	(4.81e-06)	(5.38e-06)	(2.65e-06)
Panel B								
$OOPC/Day$	-4.964***	-1.755***	-0.554***	-1.643***	-9.195***	-9.643***	-15.71***	-9.325***
	(0.0705)	(0.0438)	(0.0300)	(0.0258)	(0.398)	(0.756)	(3.831)	(0.330)
Normalized Coef.	*0.401*	*0.26*	*0.079*	*0.179*	*0.154*	*0.079*	*0.024*	*0.105*
Distance	-0.0525***	-0.0414***	-0.0437***	-0.0486***	-0.0651***	-0.0458***	-0.0417***	-0.0562***
	(0.000378)	(0.000534)	(0.000684)	(0.000282)	(0.000283)	(0.000349)	(0.000393)	(0.000194)
Distance^2	0.000389***	0.000323***	0.000361***	0.000367***	0.000528***	0.000360***	0.000338***	0.000452***
	(5.15e-06)	(7.41e-06)	(9.38e-06)	(3.87e-06)	(3.85e-06)	(4.81e-06)	(5.38e-06)	(2.65e-06)
N Enrollee-Years	1,265,909	789,981	546,879	1,409,862	1,428,054	1,025,857	789,377	1,532,655

Notes: Table reports coefficient estimates from pharmacy demand analysis described in the text. Panel A: each column of coefficients is from a separate regression of demand dependent variable on $Preferred$ dummy, distance and distance-squared, plus plan-year-enrollee type, pharmacy-year-enrollee type, and quarter-year-region-enrollee type fixed effects, within relevant sample defined by LIS status and formulary tier. Panel B: same as Panel A, but steering captured using $OOPC/Day$ rather than $Preferred$ dummy. Normalized Coef. divides the $OOPC/Day$ coefficient by the average difference between the preferred and non-preferred $OOPC/Day$ in preferred-network plans in the given column. This differential is: -8.1 cents, -14.8 cents, and -14.2 cents for non-LIS beneficiaries in tiers 1, 2, and 3, respectively, and -1.7 cents, -0.82 cents, and -0.15 cents for LIS beneficiaries in tiers 1, 2, and 3, respectively.

plans, than they are to preferred network status per se. This would be consistent with enrollees responding to preferred pharmacy status but being less aware of the underlying price differentials implied by preferred status. This is a similar finding to that in Abaluck et al. (2017), in which Part D enrollees respond more to categorical coverage changes in their plans than to the out-of-pocket price changes that are most relevant for them given the drugs they take.

In the above specification, we implicitly assume away any correlation between enrollees' idiosyncratic preferences over pharmacies (within enrollee/drug type) and their plan choices. This is consistent with the high degree of inertia documented in Part D plans (Ericson (2014), Ho et al. (2017)), and with the identification approaches used in the insurer-hospital choice literature (e.g., Gowrisankaran et al. (2015) identify price sensitivity using variation in coinsurance rates and negotiated prices across payors, within hospital-year). In order to explore the sensitivity of our results to this assumption, we have also explored an alternative approach in which we instrument for preferred status ($OOPC/Day$) for a given market-pharmacy in year y using the *average* preferred status ($OOPC/Day$) of that pharmacy in year y if all enrollees in the market remained in the plans they chose in year $y-1$. We also control for the average preferred status ($OOPC/Day$) of that pharmacy in year $y-1$ based on the plans all enrollees in the market chose in year $y-1$. Thus, the coefficients capture how enrollees respond to exogenous year-to-year *changes* in preferred status ($OOPC/Day$), holding enrollment fixed. This is a similar approach to that employed in Abaluck et al. (2017): the identifying assumption is that enrollees did not choose their year $y-1$ plan based on anticipated *changes* in preferred status of any particular pharmacy between year $y-1$ and year y.

The results are presented in Appendix Table A.10. The patterns they present are qualitatively quite similar to our preferred specification above, though the average steering implied is smaller in magnitude – e.g., compare the average non-LIS preferred dummy response of 0.394 in Table 6 to the 0.211 in Appendix Table A.10.[35] This difference in magnitudes may be due to endogenous selection across plans based on their pharmacy networks; however, they may also capture other factors, such as a potential delayed response of enrollees to changes in preferred pharmacy status driven by inattention. Given our relatively short panel, our

[35] We find similar results if, rather than instrumenting for preferred status using lagged plan enrollment, we instead control for enrollees' favorite pharmacies as inferred from historical utilization. Appendix Table A.11 presents this finding, which is the usual preferred specification as in the top panel of Table 6, but also including a control for "Share Favorite", a continuous variable at the market-pharmacy-year level. "Share Favorite" for market ij, pharmacy h, and year y is calculated as the average, across all enrollees in market ij, of a dummy for pharmacy h being part of ij's most-frequented chain in year $y-1$. The coefficient on "Share Favorite" is large, positive, and significant, indicating that enrollees' preferences over pharmacy chains are persistent across years. The coefficient on the $Preferred$ dummy decreases in magnitude, to 0.21 for non-LIS beneficiaries and to 0.05 for LIS beneficiaries, when this control is included.

Table 7: Pharmacy Demand Parameter Estimates by LIS Status and Rural

	Urban		Suburban		Rural	
	Non-LIS	LIS	Non-LIS	LIS	Non-LIS	LIS
1{Preferred}	0.265***	0.0985***	0.385***	0.150***	0.512***	0.163***
	(0.00942)	(0.00680)	(0.00964)	(0.0103)	(0.00579)	(0.00612)
Distance	-0.0894***	-0.0785***	-0.0775***	-0.0755***	-0.0336***	-0.0394***
	(0.000818)	(0.000360)	(0.000917)	(0.000745)	(0.000388)	(0.000334)
Distance^2	0.000881***	0.000797***	0.000711***	0.000690***	0.000193***	0.000225***
	(1.33e-05)	(6.10e-06)	(1.33e-05)	(1.01e-05)	(5.14e-06)	(4.27e-06)
N Enrollees	277,545	583,141	296,488	231,051	807,953	654,669

Notes: Table reports coefficient estimates from pharmacy demand analysis described in the text. Each column of coefficients is from a separate regression of demand dependent variable on $Preferred$ dummy, distance and distance-squared, plus plan-year-enrollee type, pharmacy-year-enrollee type, and quarter-year-region-enrollee type fixed effects, within the relevant sample defined by LIS status. Demand estimation performed separately in urban, suburban, and rural ZIP codes.

data and framework have little ability to capture such dynamics; thus, we proceed with the counterfactuals using the estimates in Table 6. In Section 4.3, we also discuss how the counterfactuals would change if we instead used the parameters in Appendix Table A.10; briefly, they are qualitatively and quantitatively unchanged by this distinction.

Naturally, we expect Part D enrollees' behavioral response to preferred network contracting to depend not only on their own latent drug needs and price sensitivity, but also on the accessibility of preferred vs. non-preferred pharmacies in their local markets. As noted in Section 2.2, preferred pharmacies are more readily accessed by urban than by rural enrollees, and some PDP regions have more comprehensive preferred networks than others. To explore this issue, we estimated the preferred specification above separately for urban vs. suburban vs. rural enrollees, and separately in each PDP region. Table 7 splits enrollees into urban, suburban, and rural. In general, we again see larger non-LIS than LIS coefficients, and a strong distaste for travel distance. Putting the $Preferred$ dummy and distance coefficients together, the results suggest that urban non-LIS beneficiaries are willing to drive 3.1 minutes to access a preferred pharmacy, vs. 5.2 minutes for suburban enrollees and 16.9 minutes for rural enrollees.

Variation across regions is represented in Appendix Figure A.6. Each marker represents a point estimate of the coefficient on the $Preferred$ dummy for the same models as above, but estimated for all non-LIS or LIS individuals within a given PDP region. Bars represent 95 percent confidence intervals. Panel (a) shows that the majority of $Preferred$ dummy coefficients for non-LIS beneficiaries are in the range 0.25-0.7 and statistically significant.[36] While it is surely the case that numerous factors drive the the differences

[36]One prominent (curious) exception is a small, but negative and significant coefficient for New York state. Panel (b) shows the

in the *Preferred* response across regions, one important factor is heterogeneity across regions in preferred pharmacy network comprehensiveness. To illustrate this point, Appendix Figure A.7 presents a scatterplot of the same coefficients in Figure A.6, vs. "% Preferred" in preferred-network plans in each region in 2014. There is a positive association between the preferred response and "% Preferred" for non-LIS beneficiaries, consistent with enrollees in regions with lower average preferred network coverage having less ability to respond to preferred networks when they are adopted; there is no such association for LIS beneficiaries.

To explore the robustness of our results, we also estimated a number of alternative specifications of the demand system. Our baseline specification defines markets at the 5-digit ZIP code level; includes fixed effects for each type-i interacted with plan-year, pharmacy-year, and quarter-year-region; specifies independent pharmacies as the outside option, and identifies enrollees' preferences over near vs. far pharmacies using a quadratic distance specification. In Appendix Table A.12, rather than having markets defined at the 5-digit ZIP level and analyzing "local" preferences for pharmacies using driving distance, we instead define markets at the 3-digit ZIP level and analyze "local" preferences using full interactions between indicators for each 3-digit ZIP and all included fixed effects. This approach is similar in spirit to the semi-parametric model in Raval et al. (2017). Appendix Table A.13 compares our preferred specification results (columns (1)-(2)) to alternative specifications along three additional dimensions. First, the top panel compares the preferred specification to alternative specifications with fixed effects for each type-i interacted with plan, pharmacy, and quarter-year-region fixed effects, for the full sample (columns (3)-(4)) and for enrollees in preferred-network plans only (columns (5)-(6)). Second, the middle panel shows the results of specifications in which non-preferred independent (columns (3)-(4)) or mail-order pharmacies (columns (5)-(6)) are the outside option. Finally, the bottom panel tries alternative linear (columns (3)-(4)) and log (columns (5)-(6)) parameterizations of distance. The qualitative patterns are similar across all robustness specifications.

4.3 Counterfactuals

To further understand the implications of our estimates, we simulate the welfare and spending impact of preferred pharmacy networks. To do this, we "shut down" preferred networks in the final year of our sample. We leave overall networks fixed and counterfactually remove the adjustments to $OOPC/Day$ that

results for LIS beneficiaries; as expected, coefficients are generally positive and smaller than the non-LIS coefficients, and several are not statistically significant.

we observe when plans adopt preferred pharmacy networks.[37] This counterfactual is partial equilibrium: we hold enrollment fixed and do not account for any potential effect of enrollees' re-sorting across plans on prices.

Appendix Table A.14 summarizes baseline preferred and non-preferred pharmacy shares of utilization and total annual OOP spending for our counterfactual sample of non-LIS and LIS beneficiaries in preferred-network plans in 2014. As in the overall pharmacy demand sample, at baseline, non-LIS beneficiaries are much more likely than LIS beneficiaries to use preferred retail pharmacies. Non-LIS beneficiaries spend about \$627 out-of-pocket on \$2,077 in total drug costs, whereas LIS beneficiaries spend only \$81 out-of-pocket on \$5,226 in total drug costs.

Our counterfactual demand and welfare analyses require counterfactual preferred and non-preferred market shares and counterfactual preferred and non-preferred out-of-pocket prices. By "counterfactual preferred out-of-pocket price," we refer to the out-of-pocket price that would apply for pharmacy h in plan j's preferred retail pharmacy network, if plan j counterfactually removed preferred/non-preferred pharmacy distinctions from its beneficiary cost structure. To obtain counterfactual $OOPC/Day$, we first regress the out-of-pocket price per day supply at preferred pharmacies, separately within each LIS group and formulary tier, on a dummy for preferred-network plans, controlling for plan and quarter-year-region fixed effects. Thus, we estimate:

$$OOPC_{ijqy}^{Pref} = \alpha_i + \beta_{l(i)}^{Pref} * 1\{Preferred-Network-Plan\}_{jy} + \mathbf{X}'_{ijqy}\gamma_i + \varepsilon_{ijqy}.$$

To obtain counterfactual $OOPC/Day$, we then subtract $\hat{\beta}_{l(i)}^{Pref}$ from each observed price. We do the analogous procedure for non-preferred pharmacies.[38] Intuitively, we infer the effect of "turning on" preferred pharmacy networks on out-of-pocket costs, controlling for time-invariant plan cost-sharing strategies and broader trends in OOP costs. When a plan adopts preferred pharmacy contracting, it introduces a wedge of just over 10 cents per day supply (\$3.03 per 30-day supply) between the unsubsidized OOP prices of

[37]The prior literature on insurer-hospital bargaining has focused on counterfactuals that expand the size of overall networks; see, e.g., Ho (2006), Ho & Lee (2018). We have also explored the welfare effects of overall pharmacy network size. In Appendix Table A.17, we document that both non-LIS and LIS beneficiaries have increased consumer surplus under comprehensive pharmacy networks, but these increases are slight: \$2.35 per non-LIS beneficiary-year, and \$0.68 per LIS beneficiary-year. These impacts are small because, as shown in Table 1, total exclusion of chain pharmacies from the overall network is rare.

[38]This is similar to the regressions in Section 3, but analyzing preferred and non-preferred pharmacies separately. Recall that $OOPC/Day$ is simulated based on a random sample of 1,000 enrollees in each LIS/age group cell, in each year, so there is no need to control for NDC fixed effects, and $OOPC/Day$ only varies across plan-quarter-enrollee type-formulary tier and preferred vs. non-preferred, so there is no need to control for pharmacy chain (or bargaining pair) fixed effects.

Table 8: Counterfactual Policy Impact

	Non-LIS	LIS	All
ΔShare Preferred	-0.05	-0.01	-0.04
%Δ OOPC, No Behavioral Response	4.24	-2.18	3.57
%Δ OOPC, Inc. Behavioral Response	3.89	-2.23	3.25
Δ in Consumer Surplus ($)	-32.71	4.08	-19.35
%Δ in Consumer Surplus	-2.8	2.32	-2.39
%Δ in Spend/Year	2.04	0.59	1.17

Notes: Each cell reports the change induced by moving to the counterfactual scenario. "ΔShare Preferred" indicates the change in "preferred" pharmacy market share, in percentage points. "Δ in Consumer Surplus ($)" is in dollars per enrollee-year. All other cells are percentage changes; e.g., comparing simulated counterfactual OOP spending per enrollee-year to baseline observed OOP spending per enrollee-year. For illustrative purposes, OOP spending shown without the behavioral demand response (i.e., counterfactual OOP prices, but observed shares), and with the behavioral response (counterfactual prices *and* shares).

tier 1 drugs at preferred and non-preferred pharmacies. The wedge is split between an increase in the non-preferred *OOPC* per 30 days ($1.37) and a decrease in the preferred *OOPC* per 30 days ($1.66).[39] To obtain counterfactual market shares, we substitute counterfactual $OOPC/Day$ from the above procedure into the pharmacy demand model, holding everything else – enrollment, overall pharmacy networks, driving distances, and consumption – fixed. Counterfactual OOP spending is the inner product of the vector of counterfactual $OOPC/Day$ and market shares across pharmacies in the choice set (and the outside option of independent pharmacies), multiplied by total quantity consumed across all retail pharmacies. To explore welfare effects, we calculate the consumer surplus for enrollee i in plan j in year y with overall pharmacy network G_{jy} following the approach in Capps et al. (2003), among others:

$$WTP_{izjqy} = log\left(1 + \sum_{h \in G_{jy}} exp\left(\hat{\delta}_{ijy} + \hat{\delta}_{ihy} + \hat{\delta}_{iqry} + OOPC_{ijhqy}\hat{\beta}^{c}_{l(i)} + dist_{zh}\hat{\beta}^{d1}_{l(i)} + dist^2_{zh}\hat{\beta}^{d2}_{l(i)}\right)\right).$$

We present these consumer surplus estimates in dollar terms by dividing them through by the (enrollee-type-specific) $OOPC/Day$ coefficients.

The (consumer) welfare impact of eliminating preferred contracting is ex ante ambiguous. While $OOPC/Day$ at non-preferred pharmacies falls, enrollees no longer get a "discount" at preferred pharmacies. Distributional consequences are important: the impact for a given enrollee will depend on her access

[39]The analogous 30-day price differentials for non-LIS *OOPC* in tiers 2 and 3 are $6.10 and $8.23, respectively. The analogous 30-day price differentials for LIS *OOPC* in tiers 1, 2, and 3 are $0.60, $0.34, and $0.04, respectively. See Appendix Table A.15 for full regression results. These OOP price differentials are averaged over the year and thus pooled across all coverage phases encountered by enrollees in the simulation samples. This results in price differentials across preferred and non-preferred pharmacies being muted relative to the averages presented in Figure 1, due to the small or zero differentials present outside the initial coverage phase of the Part D benefit.

to preferred and non-preferred pharmacies, her LIS status, and her willingness to switch. The results are in Table 8; full results by LIS status and formulary tier are shown in Appendix Table A.16. Eliminating preferred networks decreases preferred pharmacies' total market share by 5.1 percentage points for non-LIS beneficiaries, and 0.8 percentage points for LIS beneficiaries. The OOP spending implications are nuanced. For non-LIS enrollees, OOP spending would increase by 4.2 percent absent any behavioral response. Enrollees re-sorting from preferred to non-preferred pharmacies mitigates this somewhat – on net, OOP spending increases by 3.9 percent for non-LIS beneficiaries – but re-sorting can only do so much, as shutting down preferred pharmacy networks equalizes OOP costs at preferred and non-preferred pharmacies. In contrast, shutting down preferred pharmacy networks causes OOP spending to go down by 2.2 percent for LIS beneficiaries; this is mostly due to the OOP price change, given the limited behavioral response of LIS beneficiaries. The main difference driving the differential effects on non-LIS and LIS beneficiaries is that non-LIS beneficiaries frequent more preferred pharmacies than LIS pharmacies do at baseline. Shutting down the discount they receive at those pharmacies increases their out-of-pocket costs; the converse occurs for LIS beneficiaries, though at a much smaller magnitude given LIS cost-sharing subsidies.[40]

The welfare impact is similarly nuanced: welfare decreases by $33 (2.8 percent) for non-LIS beneficiaries, but increases by $4 (2.3) percent for LIS beneficiaries. While the magnitudes of the impact of counterfactually shutting down preferred networks on *OOPC* are similar for non-LIS and LIS beneficiaries in percentage terms, the effects are much smaller in dollar terms for LIS beneficiaries. Given that most enrollees have convenient access to preferred pharmacies, these OOP spending effects dominate the welfare calculation; thus, the (negative) welfare impact of the counterfactual on non-LIS beneficiaries is much larger in magnitude than the (positive) impact on LIS beneficiaries. This qualitative pattern is similar if we use the coefficient estimates from the alternative IV specification of pharmacy demand, as shown in Appendix Table A.18, and if we instead remove preferred pharmacy distinctions *after* counterfactually imposing comprehensive overall pharmacy networks, as shown in Panel B of Appendix Table A.17.

For the sake of comparison with our reduced form results in Section 3, we also use the pharmacy demand model to simulate counterfactual POS spending. For this exercise, we additionally require counterfactual POS prices. This is difficult, as we do not estimate a model of insurer-pharmacy bargaining. We infer counterfactual POS prices using a regression approach similar to that used above for counterfactual OOP

[40]Looking across PDP regions sheds further light on distributional effects: the OOP spending impact for non-LIS (LIS) enrollees ranges from 0.9 percent to 7.7 percent (-3.6 percent to -0.3 percent).

prices. Given that LIS subsidies apply to out-of-pocket prices, but not to retail prices, we do not distinguish here between non-LIS and LIS enrollees. The estimates suggest that, on average across tiers, plans receive a \$2.22 per 30 day supply discount from pharmacies they designate as preferred.[41] Counterfactual *POS* spending is the inner product of the vector of counterfactual *POS* prices and market shares across pharmacies in the choice set (and the outside option of independent pharmacies), multiplied by total quantity consumed across all retail pharmacies.

The results are presented in the final row of Table 8. The shift in market share from "preferred" to "non-preferred" pharmacies, combined with eliminating preferred-network plans' POS discounts at "preferred" pharmacies, leads to increased POS spending for all enrollees. However, the effect is larger for non-LIS beneficiaries (2 percent, vs. 0.6 percent for LIS beneficiaries). The total implied effect of preferred network contracting on spending, across all sample enrollees, is about 1.2 percent. This is slightly smaller than the price effects presented in the richest specifications in Table 2 (2.3 percent savings within plan, 1.9 percent savings within bargaining pair) and less than half the magnitude of the effects in Table 4 (3% savings within beneficiary and plan).[42]

Our most conservative estimates suggest that preferred networks lead to modest savings relative to overall spending. These modest 1.2 percent savings are large when aggregated across enrollees. For example, if we applied our estimated savings to the full sample of enrollees described in Table 1, we would obtain an estimated \$50 savings per non-LIS enrollee-year (\$31 per LIS enrollee-year) if all sample plans had used preferred pharmacy contracting throughout 2011-2014. Aggregating across enrollees and scaling by a factor of 10 to account for our data being a 10 percent sample, this adds up to \$2.2 billion dollars over four years. Of course, we must consider both the costs and benefits of preferred pharmacy contracting. The consumer surplus analysis indicates that non-LIS beneficiaries benefit from preferred pharmacy contracting due to their willingness to frequent preferred pharmacies, while LIS beneficiaries have small welfare decreases under preferred pharmacy contracting. On average across all beneficiaries, we find that the consumer surplus impact of shutting down preferred pharmacy contracting would be about -\$19 per enrollee in 2014.

We estimate that preferred-network plans reduce costs and increase consumer surplus for non-LIS enrollees. Table 4 further shows that preferred network plans have lower premiums on average. Taken together, these results can explain some of the dramatic growth of this plan type. However, one important caveat is

[41] See Appendix Table A.19 for detailed results.

[42] The results in Table 4 would include compositional effects driven by enrollees taking cheaper NDCs after plans adopt preferred networks; the results in Table 2 control for NDC fixed effects.

in order. Plan demand estimates in Appendix C show that consumers are willing to pay to avoid enrolling in preferred network plans — ex ante and ex post welfare appear to diverge. While this result is consistent with previous findings in the insurance plan choice literature (Abaluck & Gruber (2011)), we believe this is an important avenue for future research.

5 Conclusion

The rise of preferred pharmacy networks in commercial and public prescription drug insurance markets raises important questions about health care costs and consumer welfare. This paper provides the first evidence on the cost and welfare implications of selective pharmacy contracting.

We use both reduced form and structural demand analyses to illustrate three key insights. First, most unsubsidized enrollees are highly sensitive to copay differentials between preferred and non-preferred pharmacies; as a result, preferred pharmacy contracting yields small, but significant drug cost savings. For example, we find that the average standard deviation of retail price per 30-day supply across plans (within drug and pharmacy chain-year) is $14.74 (see Appendix B). Accordingly, the treatment effect estimates in the main specification in Section 3.1 (5.1 cents per day, or $1.53 per 30-day supply) suggest that adoption of preferred networks reduces prices by about 10 percent of a standard deviation. The analogous calculation just within generic drugs is about 13 percent of a standard deviation. Second, subsidized LIS beneficiaries are much less responsive to preferred pharmacy status, which limits the savings from preferred pharmacy contracting.[43] Third, non-LIS consumers benefit from preferred-network plans due to their willingness to frequent preferred pharmacies when they are discounted: while consumers may prefer to frequent closer or more desirable pharmacies, they still prefer monetary savings over expanded choice along the dimension highlighted in this paper. The benefits of preferred pharmacy contracting to non-LIS beneficiaries outweigh the small losses to LIS beneficiaries: although LIS beneficiaries are more price-sensitive, the substantial cost-sharing subsidies they receive insulate them from most of the wedge plans drive between preferred and non-preferred pharmacies when they adopt preferred-network plans.

The short time horizon we consider in this study prohibits us from investigating differential pre-trends in the years leading up to plans' adoption of preferred pharmacy networks. However, our analyses of the

[43] The positive effects of subsidized low-income enrollees on the prices paid in the Part D program are consistent with the findings of Duggan & Scott Morton (2006) regarding similar spillover effects from the Medicaid program. About one-third of government expenditure on Part D is directly for LIS-related subsidies; our results suggest that there are additional costs of LIS subsidies stemming from their effects on price levels.

interaction between preferred-network adoption and LIS enrollment suggest that, if another factor drives the preferred-network results, it must be a factor that only applies to plans with relatively low LIS beneficiary enrollment. Also, the preferred specification of the pharmacy demand analysis leverages a different type of identification than our reduced form analyses – variation of preferred status of the same pharmacy across different plans in the same year, rather than variation in preferred-network status within plan over time – and yields results that support our overall story. Thus, while no individual analysis is conclusive regarding the effects of preferred pharmacy contracting on steering or costs, together they represent a consistent body of evidence.

The setting considered in this paper presents perhaps a best-case scenario for analyzing the welfare trade-offs inherent in selective contracting: prescription drug needs are more predictable than, say, the need for inpatient hospital care, and frequent, repeated interaction with retail pharmacies implies that enrollees are likely aware at the plan choice stage of the relative convenience and cost of nearby pharmacies. We see several fruitful areas to extend this research. First, our reduced form evidence suggested that renegotiation is a significant source of savings due to restrictive preferred networks, but the high degree of network exclusion and presence of multiple network tiers we document introduce complications for structural analysis; future work should examine the impact of preferred networks on bargaining. A structural model of the supply side and bargaining process is necessary for alternative counterfactuals, such as exploring the policy impact of applying network adequacy rules to preferred pharmacy networks, or simulating pharmacy mergers. Second, our ex ante welfare analysis highlights the important caveat that consumers may not be fully aware of the benefits of preferred-network plans; future work should examine incentives for plan design in the insurance market. Finally, while we focus on selective contracting in Medicare Part D, it should be emphasized that commercial payers have begun to use narrow pharmacy networks in recent years as well. Almost half of all employers had a narrow pharmacy network in 2016 (Fein (2017)); future work should extend our analysis to other contexts.

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ELECTRONIC APPENDIX

A Background on Medicare Part D

Medicare's prescription drug benefit is provided through private health insurers. Plan enrollees pay a monthly premium for coverage, but 90 percent of plans' Part D revenues come in the form of payments from CMS (Decarolis (2015)): a risk-adjusted direct subsidy for each enrollee of any type; a low-income subsidy to cover low-income enrollees' premiums and cost-sharing (see below); reinsurance covering 80 percent of drug spending above the catastrophic threshold; and "risk corridor" transfers such that the issuers' profits/losses are within certain bounds.

Part D plans must meet standards for plan generosity in terms of actuarial value, types of drugs covered, and retail pharmacy accessibility. Each benefit year, CMS defines a "standard" plan, which determines the minimum actuarial value Part D plans must offer. The standard plan includes a deductible (no plan coverage of drug costs), an initial coverage region (75 percent plan coverage), another coverage gap known as the "donut hole," and a "catastrophic" region (95 percent plan coverage). There is no overall coverage limit. Prior to 2011, the donut hole in the standard plan involved no plan coverage of drug costs. The Patient Protection and Affordable Care Act of 2010 (ACA) stipulated that the donut hole be "filled in," with 75 percent plan coverage by 2020. The standard plan for the year 2014 had the following features: a deductible of \$310; 75 percent plan coverage in the initial coverage region, until total spending reaches \$2,850; 52.5 percent plan coverage of branded drug costs in the donut hole, until total spending reaches \$6,455; and 95 percent plan coverage in the catastrophic region. Many plans use alternative cost-sharing arrangements, including non-standard deductibles and/or donut holes, drugs grouped into formulary tiers, and specific networks of pharmacies.

Part D plans are allowed to use formularies and pharmacy networks to favor and/or exclude certain drugs and pharmacies in their beneficiary cost structures. For drugs, coverage generosity standards require that a certain number of drugs be covered (i.e., on-formulary) in each of a set of drug classes. In some "protected" classes, such as antiretrovirals, plans must include all drugs on their formularies. For pharmacies, CMS evaluates retail pharmacy networks against the "network adequacy" standards established for the U.S. military's TRICARE programs, which provide civilian health benefits for United States military personnel, military retirees, and their dependents. Under TRICARE standards, at least 90 percent of urban beneficiaries must reside within two miles of a network retail pharmacy. The analogous standards for suburban and rural areas are 90 percent within five miles, and 70 percent within fifteen miles, respectively CMS (2015*a*). Critically, retail pharmacy network adequacy standards apply to *overall* pharmacy networks but do not apply to *preferred* pharmacy networks, so *preferred* networks can be much more restrictive than plans' overall networks.

Unlike traditional Medicare, the private insurers participating in the Medicare Part D program are free to negotiate drug prices with upstream suppliers. Many insurers contract with PBMs to assist in these negotiations as part of determining plan formularies and networks. Some insurers rely on PBMs to contract with drug manufacturers and pharmacies on their behalf, while others use external PBMs only for administrative services (e.g., claims processing).[44]

B Price Variation Across Bargaining Pairs

Appendix Table A.1 summarizes the retail price variation in our sample in 2011 and 2014, separately by year, drug generic/branded status, and drug identifier. The rows indicated by "Brand" summarize variation across observations within a given brand name or generic name. The rows indicated by "NDC" summarize variation across observations within a national drug code. In the top two rows of Appendix Table A.1, we show the mean and standard deviation of retail price per 30 days supplied across all NDC-plan-chain combinations, weighted by quantity dispensed. There is substantial heterogeneity in drug prices, and the distribution of prices has a long upper tail within each generic status-year pair. The standard deviation of price across plans, within drug-year-pharmacy chain, is 14-23 percent of the mean for branded drugs, versus 32-42 percent of the mean for generic drugs. The coefficients of variation across chains, within drug-year-plan, are in a similar range. For generic drugs, the "across chain, within Brand" price dispersion is much larger than the "across chain, within NDC" price dispersion, reflecting the fact that different pharmacy chains may stock different generic NDCs, potentially from different pharmaceutical manufacturers, within a given drug.

To more concretely show how price dispersion persists even within narrowly defined product categories, Appendix Figure A.1 summarizes the observed price variation for two drugs that are commonly used in our data. First, in the top two panels, we display prices for Crestor, a popular branded statin drug for

[44] The PBM industry is highly concentrated, with the two largest PBMs accounting for 59 percent of industry revenues in 2013 (Danzon (2015)), and has accordingly received a great deal of attention as a potential driver of prescription drug costs.

Table A.1: Price Summary Statistics

	2011			2014		
	Branded	Generic	All	Branded	Generic	All
Price	188.9	19.89	66.97	271.2	18.41	71.56
	(455.4)	(52.24)	(255.9)	(1002.1)	(56.83)	(473.6)
CV across Plan, w/in Brand	0.143	0.318	0.279	0.227	0.406	0.377
CV across Chain, w/in Brand	0.153	0.343	0.315	0.227	0.464	0.443
CV across Plan, w/in NDC	0.141	0.325	0.281	0.232	0.420	0.386
CV across Chain, w/in NDC	0.133	0.252	0.218	0.187	0.280	0.262
N	4,308,886	11,987,079	16,295,965	3,976,904	13,725,537	17,702,440

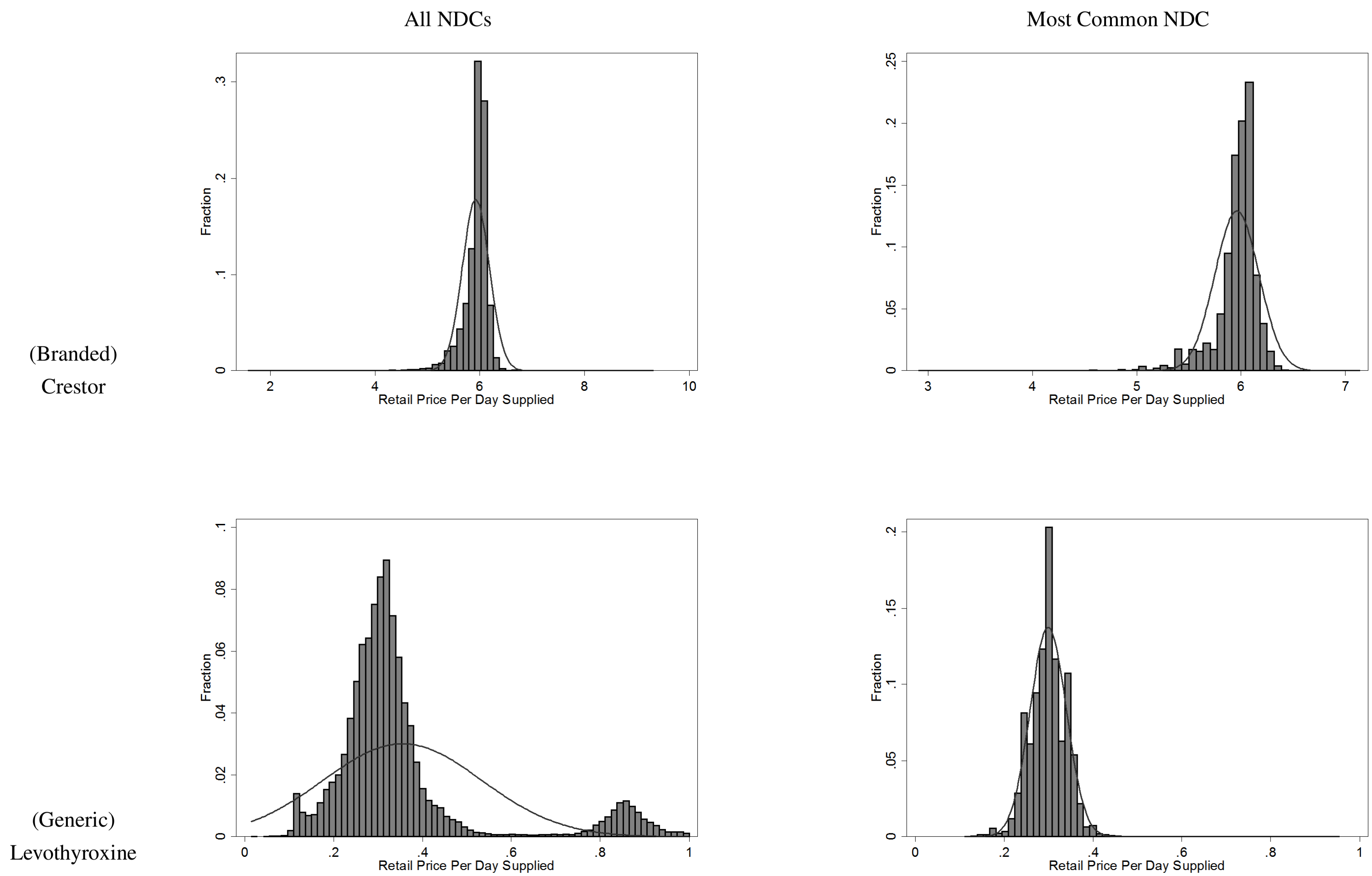
Notes: The number of observations is the number of NDC-plan-chain observations for each year-generic status. Pharmacy chains identified by the parent and relationship ID variables in the CMS pharmacy files. NDCs grouped into "Brands" using the brand name and generic name fields in the CMS prescription drug event files.

hyperlipidemia. Among all NDCs, there is evidence of price dispersion (the coefficient of variation is 0.34), and even within the most popular single NDC – 10mg of the drug packaged in a 90 day supply – the interquartile range in price per day supply across plan-chain pairs is \$1.23 (the mean is \$5.15 and the coefficient of variation is 0.15). Among generics, there is even more dispersion in relative terms. In the bottom two panels, we display prices for levothyroxine, a popular drug used to treat hypothyroidism. Among all NDCs, we see substantial variation, though the bimodal price distribution could reflect variation across products and manufacturers. However, when we restrict attention to the highest volume NDC – 50 microgram tablets, manufactured by Mylan – we still see substantial variation in prices across plan-chain pairs (the coefficient of variation is 0.40).

C Plan Demand

We flexibly estimate Medicare Part D plan demand using a logit model that allows preference parameters to vary with LIS status and lagged drug spending quintile. A consumer's choice set is defined at the PDP region level and a product is a plan-region-specific insurance contract (contract-plan ID combination, as with the plan fixed effects in Sections 3 and 4). For each enrollee type $l(i)$ defined by LIS status and lagged

Figure A.1: Retail Price Variation – Top Drugs



Notes: Figure reports quantity-weighted histograms of retail price per day supply in prescription drug event data. Drug names (Crestor and levothyroxine) identified using the brand name and generic name fields.

spending quintile, consumer utility for plan j in market m and year y is given by:

$$u_{l(i)jmy} = \overline{\xi_{l(i)j}} + \alpha^{p}_{l(i)} prem^{D}_{jmy} + \alpha^{x}_{l(i)} PrefNet_{jy} + \xi_{l(i)jmt} + \varepsilon_{ijmt}, \quad (1)$$

where $\overline{\xi_{l(i)j}}$ are time-invariant, vertical plan characteristics (i.e., contract-plan fixed effects) that vary across consumer types, $prem^{D}_{jmy}$ is the plan premium (in hundreds of dollars per year), $PrefNet_{jy}$ is an indicator for preferred-network plans, and $\xi_{l(i)jmt}$ represents time-varying shocks to unobservable vertical plan characteristics.

The outside option is Medicare Advantage plans. This model is consistent with consumers choosing a plan before they realize the exogenously given need to fill a prescription. To exposit expected utility, denote $\widetilde{u}_{l(i)jmy} = \overline{\xi_{l(i)j}} + \alpha^{p}_{l(i)} prem^{D}_{jmy} + \alpha^{x}_{l(i)} PrefNet_{jy} + \xi_{l(i)jmt}$. The predicted probability that a consumer chooses plan j in year y is given by:

$$\sigma_{l(i)jmy} = \frac{exp\left(\widetilde{u}_{l(i)jmy}\right)}{\sum_{k \in \mathscr{J}_{my}} exp\left(\widetilde{u}_{l(i)kmy}\right)},$$

where $\mathscr{J}_{my}$ is the set of all available plans in market m in year y. Following the approach in Section 4, we define as a unique combination of enrollee type-enrollee ZIP code-year. The plan demand sample is reported in Table A.2. The average sample enrollee-year chose from among 28 plans. The average non-LIS enrollee chose a plan with an annual premium of \$499, versus the subsidized premium of \$25 for LIS enrollees. Non-LIS enrollees were more likely to enroll in preferred-network plans (68 percent, versus 32 percent for LIS enrollees). The higher observed enrollment in preferred-network plans in this sample, relative to the pharmacy demand sample in Table 5, reflects the fact that we only estimate plan demand in the 2012-2014 sample, for which we observe lagged cost. Our incorporation of lagged cost to characterize enrollee type is intended as a replacement for our conditioning on drug formulary tier in Section 4. In analyzing plan demand, we must aggregate to the enrollee level: to condition on variation in enrollees' expected drug needs, we use total lagged drug expenditure and bin enrollees into quintiles.

Our estimates will be biased if $\xi_{l(i)jmy}$ is correlated with premiums or product characteristics. We address this issue via a two-pronged approach. First, we include contract-plan fixed effects, $\overline{\xi_{l(i)j}}$, that are allowed to vary with consumer type: the unobserved product characteristic is the deviation from the plan mean for the LIS-cost quintile group in question. Second, we instrument for premiums. As is common in this setting, we use Hausman-style instruments: we instrument for the premium for a given insurer-market-consumer

Table A.2: Plan Demand Sample

	Non-LIS Enrollees		LIS Enrollees		All Enrollees	
	Mean	SD	Mean	SD	Mean	SD
N plans in choice set	27.8130	2.6320	27.2430	3.7840	27.5360	3.2570
Premium (hundreds of $)	4.9850	2.1620	0.2460	0.6730	2.6750	2.8690
Preferred-Network Plans	0.6790	0.4670	0.3180	0.4660	0.5030	0.5000

Notes: Table describes baseline (observed) choice sets defined at the PDP region-year level. Plans are defined as unique contract ID-plan ID combinations. Premiums are in hundreds of dollars per year; LIS premiums assume that the beneficiary receives the full subsidy amount.

type-year using the average premium for the same insurer-consumer type-year in all other PDP regions.

We estimate pooled coefficients within non-LIS and LIS enrollees; these results are summarized in Table A.3. For each group as defined by LIS status, we show results for several different specifications of controls: columns (1), (4), and (7) include plan-LIS-lagged cost quintile fixed effects; columns (2), (5), and (8) add in year-LIS-lagged cost quintile fixed effects, and columns (3), (6), and (9) add in ZIP-LIS-lagged cost quintile fixed effects. The premium coefficients are generally quite stable with respect to the fixed effects specification employed. However, the coefficients on the preferred-network plan dummy are more sensitive: the controls for year are necessary to ensure a negative coefficient for non-LIS enrollees.

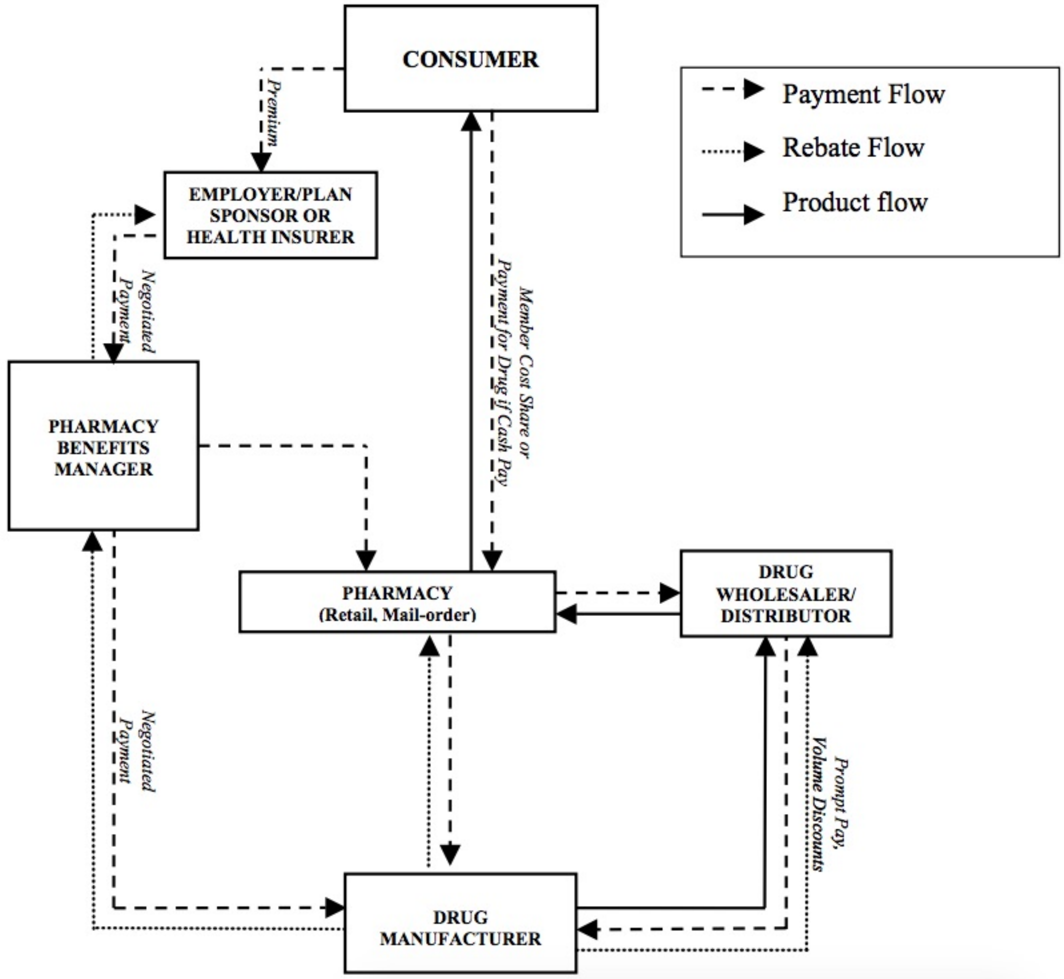
We observe that LIS enrollees are more sensitive to variation in their effective (post-subsidy) premiums than are non-LIS enrollees: this is not unexpected given the tendency of low-income individuals to be highly price-sensitive. LIS enrollees appear to have a stronger distaste for preferred network plans than non-LIS enrollees within each measure. At first glance it may seem surprising that LIS enrollees dislike preferred network plans, given that they are not subject to most preferred-pharmacy copay differentials. However, to quantify the trade-offs between preferred pharmacy contracting and ex ante consumer surplus, we must quantify enrollee preferences over preferred pharmacy contracting in dollar terms. For any enrollee type i, this can be calculated as the ratio of α_i^x to α_i^p. Our preferred specification uses the results in columns (3) and (6) in Table A.3, which imply that non-LIS enrollees are willing to pay \$135 in additional annual premiums to avoid preferred-network plans, whereas LIS enrollees are willing to pay only \$103. This may seem surprising, as preferred-network plans “save” non-LIS consumers money ex post in the form of reduced out-of-pocket costs. However, several factors – including non-pecuniary hassle or switching costs, choice inconsistency as in Abaluck & Gruber (2011), and learning – could rationalize this discrepancy. We believe this is an interesting avenue for future research.

Table A.3: Plan Demand

	Non-LIS Enrollees			LIS Enrollees			All Enrollees		
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Premium	-0.189***	-0.271***	-0.0688***	-0.375***	-0.408***	-0.293***	-0.232***	-0.300***	-0.297***
	(0.00712)	(0.0111)	(0.00374)	(0.0147)	(0.0163)	(0.0106)	(0.00639)	(0.00862)	(0.00861)
1{Preferred-Network Plan}	0.0320***	-0.151***	-0.0926***	-0.0933***	-0.170***	-0.302***	-0.0307***	-0.172***	-0.163***
	(0.00863)	(0.0130)	(0.00800)	(0.0105)	(0.0114)	(0.0117)	(0.00656)	(0.00844)	(0.00846)
N (enrollee-years)	1,763,069	1,763,069	1,764,037	1,709,130	1,709,130	1,711,403	3,472,199	3,472,199	3,470,693
Plan-LIS-Lagcost FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year-LIS-Lagcost FEs	No	Yes	Yes	No	Yes	Yes	No	Yes	Yes
ZIP-LIS-Lagcost FEs	No	No	Yes	No	No	Yes	No	No	Yes

Notes: Table reports coefficient estimates from plan demand analysis described in Appendix text. Each column represents an alternative specification (with fixed effects as described in the final rows) and sample. The market is defined at the geography-consumer type-year level.

Figure A.2: Pharmaceutical Supply Chain



Notes: Reproduced from The Health Strategies Consultancy LLC (2005)

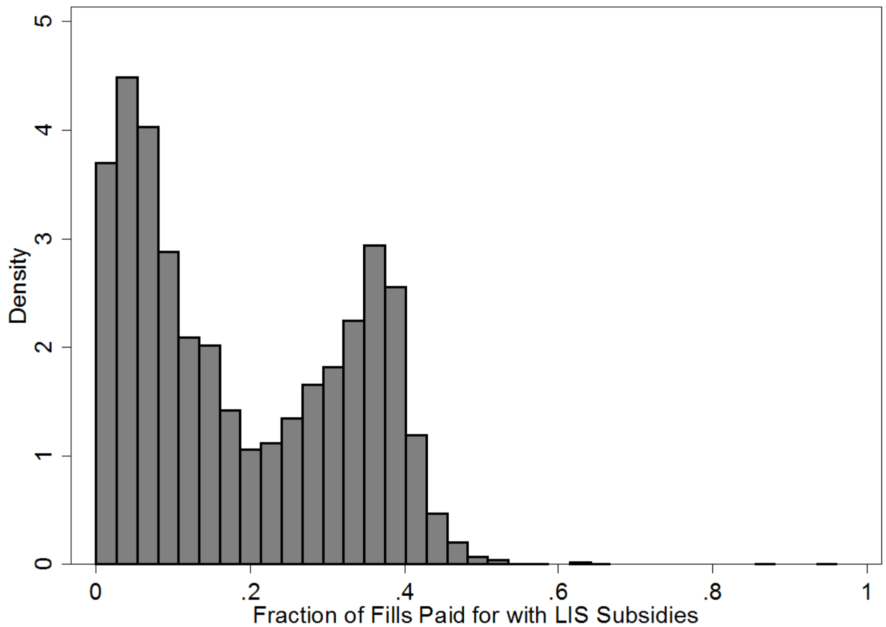
D Other Tables and Figures

Table A.4: Cost Sharing by Year, Formulary Tier, and Preferred Status

		Copay ($)			Coinsurance (%)		
Year	Tier	N	Preferred	Non-Preferred	N	Preferred	Non-Preferred
2011	1	143	3.71	8.64	1	15	20
			(2.14)	(2.98)			
	2	109	25.21	30.21	1	25	30
			(15.00)	(15.00)			
	3	74	62.49	67.49	36	20.78	37.11
			(19.21)	(19.21)		(3.25)	(0.46)
2012	1	211	2.36	8.13	-	-	-
			(2.66)	(3.02)			
	2	156	26.85	33.21	32	25.22	37.41
			(15.04)	(13.69)		(0.49)	(0.87)
	3	122	67.89	74.08	66	29.61	47.71
			(20.13)	(18.18)		(10)	(11.34)
2013	1	395	1.43	6.44	-	-	-
			(1.30)	(1.82)			
	2	387	14.54	21.46	7	20	25
			(14.24)	(15.48)		(0)	(0)
	3	223	45.09	53.81	108	29.78	38.16
			(16.05)	(20.41)		(6.94)	(9.25)
2014	1	760	1.00	6.9	-	-	-
			(1.01)	(2.85)			
	2	711	7.76	19.75	34	14.97	16.09
			(7.4)	(11.31)		(0.17)	(0.51)
	3	563	35.96	43.73	138	29.38	34.62
			(7.69)	(6.19)		(10.4)	(10.16)

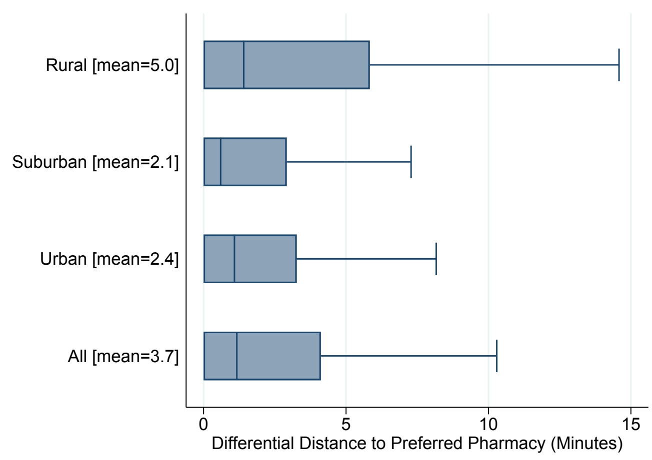
Notes: Cost-sharing statistics summarized across plans within each year and tier, preferred-network plans only. Cost-sharing reported for one-month supplies, retail fills, initial coverage phase. Standard deviations reported in parentheses.

Figure A.3: Distribution of LIS Coverage



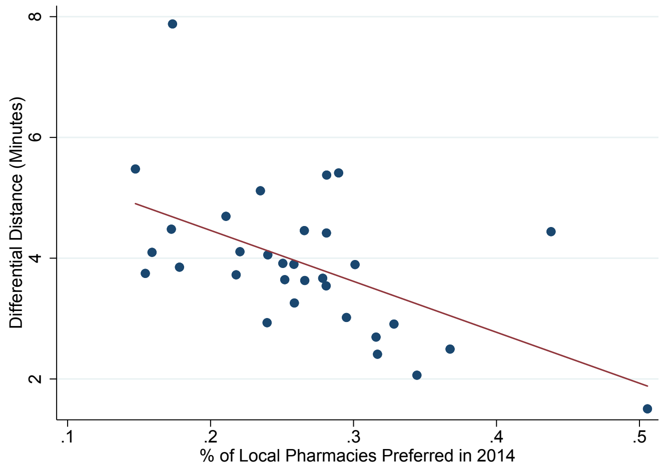
Notes: Figure reports histogram of "% LIS" across sample plan-years. "% LIS" is the percentage of the total drug spending paid for by the federal government in the form of cost-sharing subsidies for low-income beneficiaries.

Figure A.4: Differential Distance to Preferred Pharmacies



Notes: Driving distance to nearest preferred retail pharmacy, minus driving distance to nearest in-network retail pharmacy. Statistics are enrollment-weighted, for sample enrollees in preferred-network plans in 2014. Urban/suburban/rural flags for enrollee ZIP codes based on US Census data for 2010.

Figure A.5: Access Across Regions



Notes: Both Differential Distance to Preferred Pharmacy (calculated as in Appendix Figure A.4) and "% Preferred" (calculated as in Table 1) are enrollment-weighted averages within preferred-network plans in each PDP region in 2014.

Table A.5: Top Chains Preferred Status Transition Matrix, 2012-3

Chain A

Preferred Status t	Preferred Status $t+1$: Exit_{t+1}	Non-Pref	Pref	Total
Entry_{t+1}	0.0%	35.4%	20.7%	56.0%
Non-Pref	4.7%	14.9%	0.2%	19.8%
Pref	0.0%	7.0%	17.2%	24.1%
Total	4.7%	57.3%	38.0%	100.0%

Chain B

Preferred Status t	Preferred Status $t+1$: Exit_{t+1}	Non-Pref	Pref	Total
Entry_{t+1}	0.0%	55.4%	0.6%	56.0%
Non-Pref	1.0%	29.4%	0.2%	30.7%
Pref	3.7%	5.3%	4.3%	13.3%
Total	4.7%	90.2%	5.1%	100.0%

Chain C

Preferred Status t	Preferred Status $t+1$: Exit_{t+1}	Non-Pref	Pref	Total
Entry_{t+1}	0.0%	34.2%	21.9%	56.0%
Non-Pref	4.7%	6.1%	6.1%	17.0%
Pref	0.0%	0.0%	27.0%	27.0%
Total	4.7%	40.3%	55.0%	100.0%

Chain D

Preferred Status t	Preferred Status $t+1$: Exit_{t+1}	Non-Pref	Pref	Total
Entry_{t+1}	0.0%	21.7%	34.4%	56.0%
Non-Pref	4.7%	20.0%	0.2%	24.9%
Pref	0.0%	0.0%	19.0%	19.0%
Total	4.7%	41.7%	53.6%	100.0%

Notes: Transition matrices regarding top retail chains' preferred network status for $N = 489$ plans with preferred networks in 2012-3. Top retail chains identified as those with the highest aggregate spending across all years 2011-4. Rows identify chain's preferred status in each plan in 2012 (except for plans adopting preferred networks in 2013, identified by $Entry_{t+1}$). Columns identify chain's preferred status in each plan in 2013 (except for plans dropping preferred networks in 2013, identified by $Exit_{t+1}$).

Table A.6: Correlation between Preferred Pharmacy Contracting and Retail Prices

Dependent Variable: Retail Price / Days Supply					
	(1)	(2)	(3)	(4)	(5)
Panel A: All Drugs					
1{<50% Preferred}	-0.560***	-0.151***	-0.0672***	-0.0600***	-0.0583***
	(0.0410)	(0.0134)	(0.00772)	(0.00766)	(0.00771)
	-0.250	*-0.067*	*-0.030*	*-0.027*	*-0.026*
1{Top Quartile	0.441***	0.104***	0.0568***	0.0510***	0.0488***
% Preferred}	(0.0372)	(0.0113)	(0.00580)	(0.00566)	(0.00574)
	0.197	*0.046*	*0.025*	*0.023*	*0.022*
Panel B: Generic Drugs					
1{<50% Preferred}	-0.170***	-0.0590***	-0.0309***	-0.0278***	-0.0275***
	(0.0139)	(0.00614)	(0.00527)	(0.00526)	(0.00508)
	-0.256	*-0.089*	*-0.047*	*-0.042*	*-0.041*
1{Top Quartile	0.117***	0.0486***	0.0281***	0.0256***	0.0248***
% Preferred}	(0.0125)	(0.00470)	(0.00374)	(0.00367)	(0.00358)
	0.176	*0.073*	*0.042*	*0.039*	*0.037*
Quarter-Region FE	Yes	Yes	Yes	Yes	Yes
Plan FE	No	Yes	Yes	Yes	Yes
NDC FE	No	No	Yes	Yes	Yes
Pharmacy Chain FE	No	No	No	Yes	Yes
Contract-Pharmacy Chain FE	No	No	No	No	Yes

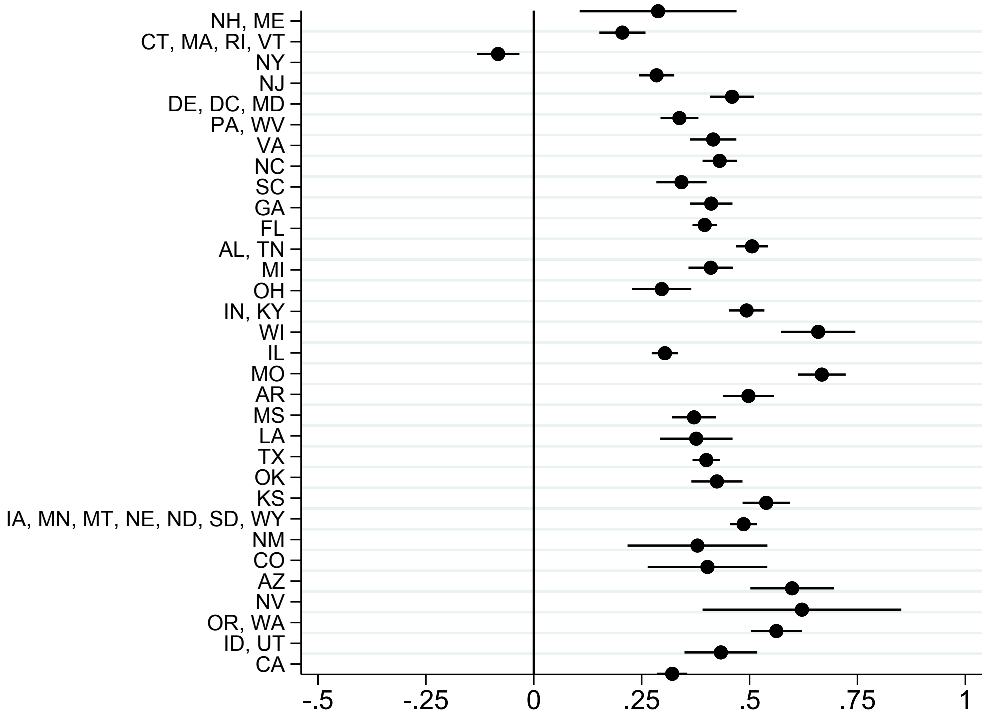
Notes: Each coefficient is estimated $\hat{\beta}$ from a separate regression of p_{djhq} on the relevant preferred network contracting variable for the row: 1{<50% Preferred} or 1{Top Quartile % Preferred}, for a given sample (All Drugs [N=131,091,890] or Generic Drugs Only [N=100,115,691]) and fixed effects specification. Quarter-Region, NDC, Plan, and Contract-Pharmacy Chain fixed effects are included in the richest specification. Standard errors clustered by plan are reported in parentheses. In italics below each coefficient and standard error (in parentheses), we normalize the coefficient by dividing through by the weighted average retail price per day supply for the regression sample. Mean retail price is $\bar{p} = 2.238$ across all drugs and $\bar{p} = 0.663$ for generic drugs.

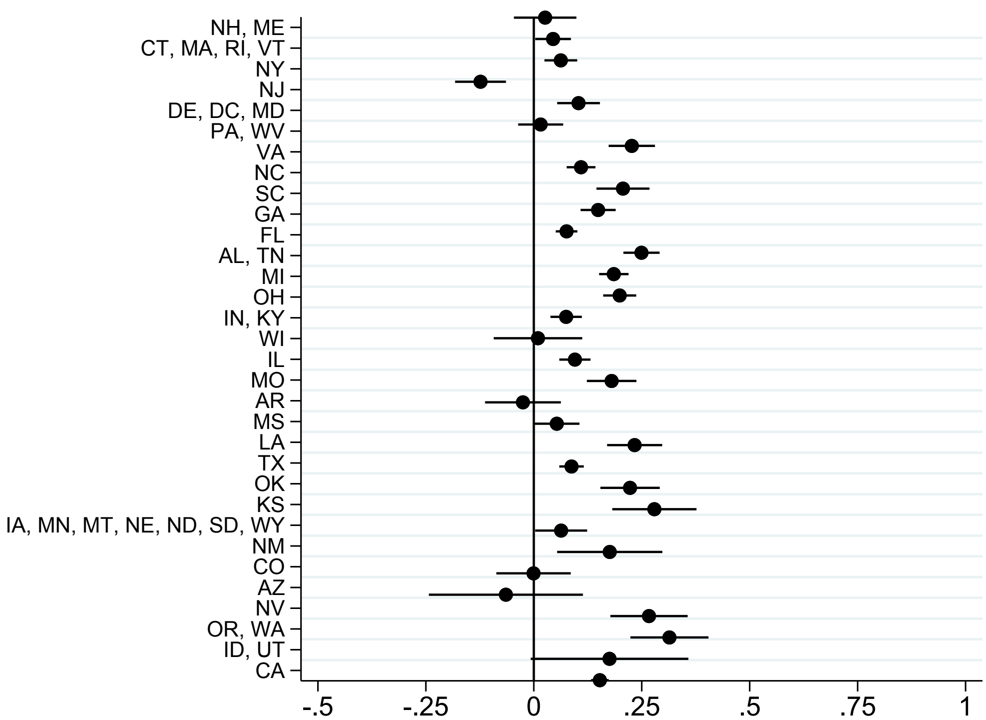
Table A.7: Correlation between Preferred Pharmacy Contracting and Retail Prices, by LIS Quartile

Dependent Variable: Retail Price / Days Supply					
	(1)	(2)	(3)	(4)	(5)
Panel A: Contemporaneous % LIS					
% Preferred	0.311***	0.163***	0.137***	0.128***	0.121***
	(0.0765)	(0.0366)	(0.0136)	(0.0136)	(0.0134)
% Preferred*	0.0857	0.0839**	-0.0279*	-0.0322**	-0.0291**
1{2^{nd} Quartile, % LIS}	(0.0750)	(0.0389)	(0.0151)	(0.0147)	(0.0143)
% Preferred*	0.386***	-0.000832	-0.0632***	-0.0624***	-0.0620***
1{3^{rd} Quartile, % LIS}	(0.0956)	(0.0474)	(0.0196)	(0.0195)	(0.0190)
% Preferred*	0.172	-0.0810	-0.143***	-0.141***	-0.138***
1{4^{th} Quartile, % LIS}	(0.131)	(0.0522)	(0.0243)	(0.0235)	(0.0229)
Normalized Coef., 1^{st} Quartile	*0.1759*	*0.0922*	*0.0775*	*0.0724*	*0.0685*
Normalized Coef., 2^{nd} Quartile	*0.1933*	*0.1203*	*0.0532*	*0.0467*	*0.0448*
Normalized Coef., 3^{rd} Quartile	*0.2708*	*0.0630*	*0.0287*	*0.0255*	*0.0229*
Normalized Coef., 4^{th} Quartile	*0.1877*	*0.0319*	*-0.0023*	*-0.0051*	*-0.0066*
Panel B: 2011 % LIS					
% Preferred	0.0516	0.201***	0.167***	0.160***	0.155***
	(0.106)	(0.0481)	(0.0174)	(0.0175)	(0.0173)
% Preferred*	0.554***	0.0793*	-0.0256	-0.0319*	-0.0297*
1{2^{nd} Quartile, % LIS}	(0.107)	(0.0478)	(0.0168)	(0.0166)	(0.0160)
% Preferred*	0.576***	-0.0162	-0.104***	-0.111***	-0.101***
1{3^{rd} Quartile, % LIS}	(0.125)	(0.0607)	(0.0226)	(0.0227)	(0.0222)
% Preferred*	0.601***	-0.0694	-0.145***	-0.147***	-0.154***
1{4^{th} Quartile, % LIS}	(0.147)	(0.0593)	(0.0279)	(0.0270)	(0.0254)
Normalized Coef., 1^{st} Quartile	*0.0288*	*0.1123*	*0.0933*	*0.0894*	*0.0866*
Normalized Coef., 2^{nd} Quartile	*0.2849*	*0.1319*	*0.0665*	*0.0603*	*0.0589*
Normalized Coef., 3^{rd} Quartile	*0.2484*	*0.0731*	*0.0249*	*0.0194*	*0.0214*
Normalized Coef., 4^{th} Quartile	*0.2505*	*0.0505*	*0.0084*	*0.0050*	*0.0004*
Quarter-Region FE	Yes	Yes	Yes	Yes	Yes
Plan FE	No	Yes	Yes	Yes	Yes
NDC FE	No	No	Yes	Yes	Yes
Pharmacy Chain FE	No	No	No	Yes	Yes
Contract-Pharmacy Chain FE	No	No	No	No	Yes

Notes: Each coefficient is estimated $\hat{\beta}$ from a separate regression of p_{djhq} on % Preferred, alone and interacted with indicators for the $2^{nd}-4^{th}$ quartiles of % LIS (coefficients on uninteracted indicators for % LIS omitted for brevity), and fixed effects indicated in each column (Quarter-Region, NDC, Plan, and Contract-Pharmacy Chain fixed effects are included in the richest specification). Panel A (N=131,091,890): % LIS calculated for each plan-year. Panel B (N=123,410,043): % LIS calculated for each plan in 2011. Standard errors clustered by plan are reported in parentheses. The coefficient normalized by the mean retail price per day supply for each group is shown in italics. Contemporaneous "% LIS" averages for plan-years in each quartile are 6 percent, 19 percent, 32 percent, and 40 percent in quartiles 1, 2, 3, and 4, respectively.

Figure A.6: Pharmacy Demand Parameter Estimates by LIS Status and Region





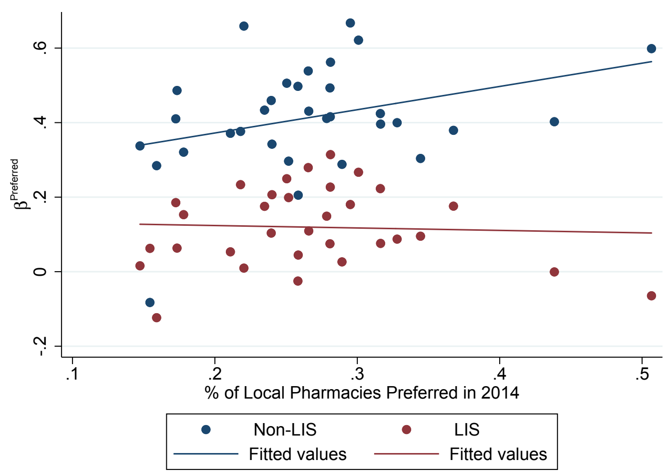
Notes: Each marker represents a point estimate of the coefficient on the Preferred dummy from the pharmacy demand analysis described in the text, estimated for all non-LIS (Panel A) or LIS (Panel B) individuals within a given PDP region. Bars represent 95 percent confidence intervals based on plan-clustered standard errors.

Table A.8: Correlation between Preferred Pharmacy Contracting and Retail Prices, Robustness Checks

Dependent Variable: Retail Price / Days Supply				
	(1)	(2)	(3)	(4)
Panel A: All Drugs				
1{Preferred-Network Plan}	-0.0422***	-0.0469***	-0.0312***	-0.0311***
	(0.00778)	(0.00857)	(0.00585)	(0.00492)
	-0.019	*-0.021*	*-0.018*	*-0.022*
N	131,071,897	131,074,188	128,264,900	117,950,497
Panel B: Generic Drugs				
1{Preferred-Network Plan}	-0.0271***	-0.0304***	-0.0303***	-0.0380***
	(0.00506)	(0.00513)	(0.00497)	(0.00485)
	-0.041	*-0.046*	*-0.046*	*-0.060*
N	100,097,287	100,098,421	98,464,708	92,764,161
Sample	All	All	1st-99th Ptile	5th-95th Ptile
Drug Classification	NDC	Brand	NDC	NDC

Notes: Each coefficient is estimated $\hat{\beta}$ from a separate regression of p_{djhq} on 1{Preferred-Network Plan}, for a given sample (All Drugs or Generic Drugs Only). All regressions include Quarter, NDC, Plan, and Contract-Pharmacy Chain fixed effects. Standard errors clustered by plan are reported in parentheses. The results from column (5) of Table 2 are reproduced here in column (1) for comparison. Column (2) classifies drugs by brand and generic name as reported in prescription drug event files, rather than by NDC. Columns (3) and (4) limit the sample to the 1st through 99th, and 5th through 95th, percentiles of the price distribution, respectively. The coefficients normalized by the mean retail price per day supply for the relevant samples are shown in italics.

Figure A.7: Correlation between Preferred Pharmacy Steering and "% Preferred"



Notes: $\beta^{Preferred}$ is the coefficient on the Preferred dummy from the pharmacy demand analysis described in the text (as in Appendix Figure A.7), estimated for all non-LIS or LIS individuals within a given PDP region. On the x-axis, "% Preferred" (calculated as in Table 1) is enrollment-weighted average within preferred-network plans in each PDP region in 2014.

Table A.9: Pharmacy Demand Estimates – All $OOPC/Day$ Variation

	Non-LIS				LIS			
	Tier				Tier			
	1	2	3	All	1	2	3	All
$OOPC/Day$	-2.276***	-0.285***	-0.0533***	-0.221***	-3.389***	-3.707***	-0.894	-3.350***
	(0.0425)	(0.0157)	(0.00914)	(0.00873)	(0.225)	(0.473)	(0.885)	(0.186)
Normalized Coef.	*0.184*	*0.042*	*0.008*	*0.024*	*0.057*	*0.028*	*0.001*	*0.038*
Distance	-0.0524***	-0.0412***	-0.0437***	-0.0485***	-0.0651***	-0.0458***	-0.0417***	-0.0562***
	(0.000377)	(0.000530)	(0.000681)	(0.000280)	(0.000283)	(0.000349)	(0.000393)	(0.000194)
$Distance^2$	0.000387***	0.000321***	0.000361***	0.000366***	0.000528***	0.000359***	0.000337***	0.000452***
	(5.15e-06)	(7.37e-06)	(9.35e-06)	(3.85e-06)	(3.85e-06)	(4.81e-06)	(5.38e-06)	(2.65e-06)
N Enrollee-Years	1,265,909	789,981	546,879	1,409,862	1,428,054	1,025,857	789,377	1,532,655

Notes: Table reports coefficient estimates from pharmacy demand analysis described in the text. Each column of coefficients is from a separate regression of demand dependent variable on $OOPC/Day$, distance and distance-squared, plus plan-year-enrollee type, pharmacy-year-enrollee type, and quarter-year-region-enrollee type fixed effects, within relevant sample defined by LIS status and formulary tier. Normalized Coef. divides the $OOPC/Day$ coefficient by the average difference between the preferred and non-preferred $OOPC/Day$ in preferred-network plans in the given column.

Table A.10: Pharmacy Demand Parameter Estimates by LIS Status and Tier – Instrumenting to Address Endogenous Selection into Plans

	Non-LIS				LIS			
	Tier				Tier			
	1	2	3	All	1	2	3	All
Panel A								
1{Preferred}	0.239***	0.198***	0.142***	0.211***	0.106***	0.0492***	0.00888	0.0659***
	(0.00852)	(0.00988)	(0.0125)	(0.00577)	(0.00981)	(0.00997)	(0.0105)	(0.00596)
Distance	-0.0526***	-0.0439***	-0.0444***	-0.0490***	-0.0659***	-0.0497***	-0.0428***	-0.0568***
	(0.000435)	(0.000617)	(0.000690)	(0.000316)	(0.000327)	(0.000407)	(0.000412)	(0.000218)
Distance^2	0.000379***	0.000339***	0.000368***	0.000365***	0.000528***	0.000392***	0.000346***	0.000454***
	(5.87e-06)	(8.47e-06)	(9.47e-06)	(4.29e-06)	(4.38e-06)	(5.53e-06)	(5.64e-06)	(2.94e-06)
Preferred Lag	0.337***	0.245***	0.220***	0.283***	0.133***	0.0855***	0.0808***	0.103***
	(0.0118)	(0.0128)	(0.0164)	(0.00773)	(0.0154)	(0.0149)	(0.0159)	(0.00913)
Panel B								
$OOPC/Day$	-3.260***	-1.274***	-0.308***	-1.185***	-6.727***	-7.747***	-14.38*	-6.982***
	(0.102)	(0.0578)	(0.0400)	(0.0345)	(0.544)	(1.184)	(7.950)	(0.462)
Normalized Coef.	*0.262*	*0.186*	*0.044*	*0.128*	*0.118*	*0.065*	*0.022*	*0.082*
Distance	-0.0526***	-0.0439***	-0.0442***	-0.0489***	-0.0659***	-0.0497***	-0.0428***	-0.0568***
	(0.000436)	(0.000618)	(0.000691)	(0.000317)	(0.000327)	(0.000407)	(0.000412)	(0.000218)
Distance^2	0.000379***	0.000339***	0.000366***	0.000363***	0.000528***	0.000392***	0.000346***	0.000454***
	(5.88e-06)	(8.48e-06)	(9.49e-06)	(4.31e-06)	(4.38e-06)	(5.53e-06)	(5.64e-06)	(2.94e-06)
$OOPC/Day$ Lag	-2.361***	-1.296***	-0.650***	-1.245***	-4.114***	-3.259***	5.710	-3.825***
	(0.118)	(0.0740)	(0.0638)	(0.0477)	(0.649)	(1.214)	(5.796)	(0.534)
N Enrollee-Years	913,041	598,732	521,678	1,040,265	1,018,191	758,221	708,290	1,107,851

Notes: Table reports coefficient estimates from pharmacy demand analysis described in the text. Panel A: each column of coefficients is from a separate regression of demand dependent variable on $Preferred$ dummy, distance and distance-squared, plus plan-year-enrollee type, pharmacy-year-enrollee type, and quarter-year-region-enrollee type fixed effects, within relevant sample defined by LIS status and formulary tier. Panel B: same as Panel A, but steering captured using $OOPC/Day$ rather than $Preferred$ dummy. Normalized Coef. divides the $OOPC/Day$ coefficient by the average difference between the preferred and non-preferred $OOPC/Day$ in preferred-network plans in the given column. Instruments constructed as described in the text.

Table A.11: Pharmacy Demand Parameter Estimates over Preferred Status and Lagged Preference

	Non-LIS				LIS			
	Tier				Tier			
	1	2	3	All	1	2	3	All
1{Preferred}	0.225***	0.201***	0.151***	0.207***	0.0731***	0.0304***	0.00848	0.0456***
	(0.00627)	(0.00739)	(0.00931)	(0.00427)	(0.00636)	(0.00659)	(0.00698)	(0.00391)
Share “Favorite”	3.051***	2.451***	2.394***	2.772***	3.180***	2.657***	2.484***	2.878***
	(0.00971)	(0.0129)	(0.0142)	(0.00683)	(0.00780)	(0.00917)	(0.00903)	(0.00503)
Distance	-0.0502***	-0.0410***	-0.0413***	-0.0463***	-0.0613***	-0.0457***	-0.0393***	-0.0527***
	(0.000416)	(0.000597)	(0.000669)	(0.000304)	(0.000309)	(0.000389)	(0.000394)	(0.000207)
Distance^2	0.000367***	0.000317***	0.000348***	0.000349***	0.000506***	0.000374***	0.000328***	0.000433***
	(5.61e-06)	(8.20e-06)	(9.17e-06)	(4.12e-06)	(4.14e-06)	(5.28e-06)	(5.38e-06)	(2.80e-06)
N Enrollee-Years	1,096,444	732,058	635,811	1,232,922	1,133,481	851,674	795,935	1,226,627

Notes: Table reports coefficient estimates from pharmacy demand analysis described in the text. Each column of coefficients is from a separate regression of demand dependent variable on $Preferred$ dummy, distance and distance-squared, plus plan-year-enrollee type, pharmacy-year-enrollee type, and quarter-year-region-enrollee type fixed effects, within relevant sample defined by LIS status and formulary tier. Specification also controls for “Share Favorite”, a continuous variable capturing the share of enrollees in each market for whom the current pharmacy’s chain was their favorite lagged pharmacy chain.

Table A.12: Pharmacy Demand – ZIP-Interacted Fixed Effects

	Non-LIS				LIS			
	Tier				Tier			
	1	2	3	All	1	2	3	All
1{Preferred}	0.370***	0.243***	0.221***	0.304***	0.115***	0.0659***	0.0387***	0.0816***
	(0.00244)	(0.00262)	(0.00343)	(0.00161)	(0.00348)	(0.00319)	(0.00341)	(0.00204)
Panel B								
OOPC/Day	-3.771***	-1.377***	-0.573***	-1.326***	-5.591***	-6.669***	-10.38***	-5.836***
	(0.0265)	(0.0176)	(0.0116)	(0.00996)	(0.211)	(0.372)	(1.797)	(0.169)
Normalized Coef.	*0.336*	*0.224*	*0.103*	*0.16*	*0.091*	*0.053*	*0.015*	*0.064*
N Enrollee-Years	2,607,307	1,898,987	1,387,503	2,730,705	2,226,095	1,753,794	1,404,795	2,301,690

Notes: Table reports coefficient estimates from pharmacy demand analysis described in the text. Each column of coefficients is from a separate regression of demand dependent variable on preferred pharmacy steering variable, plus plan-ZIP3-year-enrollee type, pharmacy-ZIP3-year-enrollee type, and quarter-year-region-ZIP3-enrollee type fixed effects, within relevant sample defined by LIS status and formulary tier. Panel A: preferred pharmacy steering variable is $Preferred$ dummy; Panel B: preferred pharmacy steering variable is $OOPC/Day$. Normalized Coef. divides the $OOPC/Day$ coefficient by the average difference between the preferred and non-preferred $OOPC/Day$ in preferred-network plans in the given column.

Table A.13: Pharmacy Demand – Robustness Specifications

	Non-LIS	LIS	Non-LIS	LIS	Non-LIS	LIS
	(1)	(2)	(3)	(4)	(5)	(6)
Panel A: Alternative Samples and Fixed Effects						
1{Preferred}	0.394***	0.118***	0.239***	-0.0398***	0.304***	0.0773***
	(0.00433)	(0.00406)	(0.00299)	(0.00310)	(0.00391)	(0.00454)
Distance	-0.0488***	-0.0562***	-0.0486***	-0.0567***	-0.0465***	-0.0456***
	(0.000280)	(0.000194)	(0.000268)	(0.000187)	(0.000375)	(0.000406)
Distance^2	0.000369***	0.000452***	0.000364***	0.000453***	0.000339***	0.000367***
	(3.84e-06)	(2.65e-06)	(3.65e-06)	(2.54e-06)	(5.03e-06)	(5.55e-06)
Fixed Effects	Plan-Year, Qtr, Pharmacy-Year		Plan, Quarter, Pharmacy		Plan, Quarter, Pharmacy	
Sample	Full		Full		Preferred Network Plans	
N Enrollees	1,409,862	1,532,655	1,425,435	1,543,276	717,212	346,917
Panel B: Alternative Outside Options						
1{Preferred}	0.394***	0.118***	0.387***	0.120***	0.452***	0.152***
	(0.00433)	(0.00406)	(0.00464)	(0.00407)	(0.00359)	(0.0162)
Distance	-0.0488***	-0.0562***	-0.0505***	-0.0565***	-0.0500***	-0.0571***
	(0.000280)	(0.000194)	(0.000292)	(0.000195)	(0.000240)	(0.000633)
Distance^2	0.000369***	0.000452***	0.000388***	0.000456***	0.000417***	0.000516***
	(3.84e-06)	(2.65e-06)	(4.00e-06)	(2.66e-06)	(3.30e-06)	(8.81e-06)
Outside Option	Independent Retail		Non-Preferred Independent		Mail-Order	
N Enrollees	1,409,862	1,532,655	1,287,369	1,516,983	1,422,365	224,642
Panel C: Alternative Distance Measure						
1{Preferred}	0.394***	0.118***	0.390***	0.116***	0.395***	0.119***
	(0.00433)	(0.00406)	(0.00434)	(0.00407)	(0.00433)	(0.00405)
Distance	-0.0488***	-0.0562***	-0.0241***	-0.0258***		
	(0.000280)	(0.000194)	(0.000112)	(7.65e-05)		
Distance^2	0.000369***	0.000452***				
	(3.84e-06)	(2.65e-06)				
Log(Distance)					-0.482***	-0.510***
					(0.00199)	(0.00132)
Distance Measure	Driving Time (Hours)		Driving Time (Hours)		Log(Driving Time (Hours))	
N Enrollees	1,409,862	1,532,655	1,409,862	1,532,655	1,409,862	1,532,655

Notes: Table reports coefficient estimates from pharmacy demand analysis described in the text. Each column of coefficients is from a separate regression of demand dependent variable (formed for indicated outside option) on $Preferred$ dummy, indicated distance variables, and indicated fixed effects, within relevant sample defined by LIS status.

Table A.14: Counterfactual Sample

	Non-LIS				LIS				All			
	Tier 1	Tier 2	Tier 3	All	Tier 1	Tier 2	Tier 3	All	Tier 1	Tier 2	Tier 3	All
Share Preferred	0.40	0.44	0.39	0.42	0.20	0.21	0.20	0.21	0.32	0.35	0.31	0.34
Share Non-Preferred	0.28	0.26	0.27	0.27	0.33	0.33	0.32	0.33	0.30	0.29	0.29	0.29
POS Spend/Year	163	294	1,619	2,077	232	696	4,298	5,226	189	444	2,621	3,254
OOP Spend/Year	103	135	389	627	24	22	35	81	74	92	257	423

Notes: Top panel reports baseline (observed) share of demand at preferred and non-preferred pharmacies, baseline (observed) point-of-sale spending, and baseline (observed) out-of-pocket spending, within preferred-network plans in 2014 only. Excluded category is non-chain retail pharmacies.

Table A.15: OOP Price Adjustments When Plans Adopt Preferred Pharmacy Networks

	Non-LIS				LIS			
	Tier				Tier			
	1	2	3	All	1	2	3	All
Panel A – Preferred Pharmacies								
1{Preferred-	-0.0554***	-0.0822***	-0.320***	-0.0881***	-0.0103***	-0.000395	0.00382***	-0.00583***
-Network Plan}	(0.00118)	(0.00439)	(0.0105)	(0.0144)	(0.000338)	(0.000244)	(0.000256)	(0.000460)
Panel B – Non-Preferred Pharmacies								
1{Preferred-	0.0455***	0.121***	-0.0455***	0.0562***	0.00959***	0.0109***	0.00523***	0.00894***
-Network Plan}	(0.00114)	(0.00445)	(0.0101)	(0.0147)	(0.000295)	(0.000198)	(0.000243)	(0.000411)

Notes: Estimates and standard errors from a regression of $OOPC/Day$ on 1{Preferred-Network Plan}, controlling for plan and quarter-year-region fixed effects. Each sample plan receives equal weight; quarters within each year are weighted by quantity based on the consumption patterns of the 1,000 random enrollees used to simulate prices. Panel A: preferred pharmacy prices only; Panel B: non-preferred pharmacy prices only. Prior to adoption of preferred pharmacy networks, pharmacies are neither preferred nor non-preferred, so pre-adoption regression sample is the same in panels A and B. As discussed in text, $OOPC/Day$ varies only with plan, quarter-year, enrollee type, drug tier, and pharmacy preferred status.

Table A.16: Counterfactual Policy Impact by LIS Status and Drug Formulary Tier

	Non-LIS				LIS				All			
	Tier 1	Tier 2	Tier 3	All	Tier 1	Tier 2	Tier 3	All	Tier 1	Tier 2	Tier 3	All
ΔShare Preferred	-0.06	-0.04	-0.03	-0.05	-0.02	-0.01	0.00	-0.01	-0.05	-0.03	-0.02	-0.04
%Δ OOP Spend, No Behavioral Response	5.22	0.86	5.11	4.24	-1.2	-3.58	-1.83	-2.18	3.78	0.18	4.72	3.57
%Δ OOP Spend, Inc. Behavioral Response	4.42	0.24	4.94	3.89	-1.2	-3.7	-1.88	-2.23	3.16	-0.37	4.56	3.25
Δ in Consumer Surplus ($)	-4.48	0.01	-28.24	-32.71	0.87	2.11	1.1	4.08	-2.54	0.77	-17.59	-19.35
%Δ in Consumer Surplus	-2.27	0.00	--4.65	-2.8	1.00	3.38	4.06	2.32	-1.62	0.30	-4.44	-2.39
%Δ POS Spend/Year	3.04	3.3	1.64	2.04	0.64	1.18	0.48	0.59	1.93	2.08	0.93	1.17

Notes: Each cell reports the change induced by moving to the counterfactual scenario. "ΔShare Preferred" indicates the change in "preferred" pharmacy market share, in percentage points. "Δ in Consumer Surplus ($)" is in dollars per enrollee-year. All other cells are percentage changes; e.g., comparing simulated counterfactual OOP spending per enrollee-year to baseline observed OOP spending per enrollee-year. For illustrative purposes, OOP spending shown without the behavioral demand response (i.e., counterfactual OOP prices, but observed shares), and with the behavioral response (counterfactual prices *and* shares).

Table A.17: Policy Impact – Full Networks Counterfactuals

	Non-LIS	LIS	All
Panel A: Full Pharmacy Networks			
Δ in Consumer Surplus ($)	2.35	0.68	1.74
%Δ in Consumer Surplus	0.20	0.38	0.22
Panel B: Full Pharmacy Networks, No Preferred Contracting			
Δ in Consumer Surplus ($)	-28.98	4.90	-16.75
%Δ in Consumer Surplus	-2.49	2.73	-2.07

Notes: Each cell reports the change induced by moving to the counterfactual scenario indicated. For each "Full Pharmacy Networks" counterfactual, we add to each market (plan-quarter-ZIP-LIS-age group-tier combination) the full set of *out-of-network* pharmacies frequented by *any enrollee* in that market's 3-digit ZIP code in the same calendar quarter. Panel A: counterfactual impact of adding all relevant excluded pharmacies to the plan's *non-preferred* pharmacy network. Panel B: counterfactual impact of adding all excluded pharmacies to the plan's overall pharmacy network and shutting down preferred pharmacy distinctions as in Table 8.

Table A.18: Counterfactual Policy Impact Using IV Estimates

	Non-LIS	LIS	All
ΔShare Preferred	-0.03	0.00	-0.02
%Δ OOP Spend, No Behavioral Response	3.20	-1.97	2.75
%Δ OOP Spend, Inc. Behavioral Response	3.00	-2.01	2.57
Δ in Consumer Surplus ($)	-26.09	3.70	-16.65
%Δ in Consumer Surplus	-2.30	1.90	-1.99
%Δ POS Spend/Year	1.53	0.65	1.05

Notes: Each cell reports the change induced by moving to the counterfactual scenario, using pharmacy demand parameter estimates from Appendix Table A.10. "ΔShare Preferred" indicates the change in "preferred" pharmacy market share, in percentage points. "Δ in Consumer Surplus ($)" is in dollars per enrollee-year. All other cells are percentage changes; e.g., comparing simulated counterfactual OOP spending per enrollee-year to baseline observed OOP spending per enrollee-year. For illustrative purposes, OOP spending shown without the behavioral demand response (i.e., counterfactual OOP prices, but observed shares), and with the behavioral response (counterfactual prices *and* shares).

Table A.19: POS Price Adjustments When Plans Adopt Preferred Pharmacy Networks

	Tier 1	Tier 2	Tier 3	All
1{Preferred-Network Plan}	-0.0145***	-0.0772***	-0.270***	-0.0741**
	(0.00146)	(0.00931)	(0.0284)	(0.0331)
N	66,976	66,976	66,976	200,928

Notes: Estimates and standard errors from a regression of simulated POS price per day on 1{Preferred-Network Plan}, controlling for plan and quarter-year-region fixed effects. POS price per day simulated by applying average observed point-of-sale price per day supply for each plan-NDC-year and preferred status, to the claims of the same random sample of 1,000 enrollees in each LIS/age group/year used for $OOPC/Day$, as described in text. POS price thus varies only with plan, quarter-year, enrollee type, drug tier, and pharmacy preferred status. Regression pools non-LIS and LIS beneficiaries, and considers preferred pharmacy prices only.